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Enhancing Transboundary Freshwater Security: From Online Learning to Global Knowledge Exchange Platform

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Abstract: The management of transboundary water resources presents a complex challenge involving multiple stakeholders and countries. Negotiating a single rule for managing these resources can take years due to various factors, including political, socioeconomic, cultural, and historical backgrounds. To assist transboundary water practitioners worldwide, the GWP and GEF IW:LEARN have developed a free-access educational platform, the Massive Open Online Course (MOOC) on Governance for Transboundary Freshwater Security. The MOOC attracted 3855 learners from 166 countries and included 14 interactive online sessions to facilitate discussions among practitioners. In response to learners' desire for increased interaction and networking opportunities, the Transboundary Water Knowledge Exchange Hub was established. This global online community enables members to share knowledge and engage in direct peer-to-peer learning through an online knowledge management platform. The effort evolved from online course and interactive sessions into an online community, promoting knowledge sharing and peer-to-peer learning through an online knowledge management platform. Through examining this evolution and analysing key survey results, this paper analyses the role of MOOC and knowledge sharing and peer-to-peer learning for building capacity for improved transboundary water governance.

Keywords: Massive Open Online Course; transboundary freshwater security; governance; community of practice; knowledge exchange; peer-to-peer learning

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1. Introduction

Freshwater scarcity, stress, and crises are increasing in most regions. Approximately 80% of the world's population is already exposed to high levels of water security threats, and around 1.2 billion people live in river basins where human water consumption has exceeded sustainable limits. These pressures will disproportionately affect the world's poor, especially women, who often bear the responsibility for the health and welfare of children, the elderly, and the infirm. Pollution exacerbates the water crisis by diminishing the water available for human use and impacting aquatic life in rivers, lakes, aquifers, and ultimately our oceans.

Transboundary basins account for approximately 60% of the world's freshwater resources and are home to 42% of the global population. Currently, there are 310 shared rivers and lakes and 592 transboundary aquifers spanning 153 countries. As water bodies cross political jurisdictions, it becomes increasingly challenging to identify universally accepted solutions to satisfy competing uses. Therefore, collaborative transboundary solutions are essential to achieve outcomes that serve the best interests of both people and ecosystems. Effective management of transboundary waters necessitates collaboration among stakeholders from various sectors and states.

Despite its importance, the complexity of resource management makes understanding and implementing governance of transboundary waters challenging. There is a need to build the capacity of government officials and various stakeholders involved in managing and utilizing this shared resource [1]. Such capacity building benefits from peer-to-peer

learning on examples of how specific management aspects are implemented on the ground. This peer-to-peer learning is particularly important in capacity building for transboundary water governance, due to the complexity of implementing key principles of cooperation on the ground.

As one of the pathways for capacity building, Massive Open Online Courses (MOOCs) provide educational opportunities for many stakeholders at little or no cost to the learners. MOOCs can function as a static learning platform but could also benefit from supplementary interactive features, whether through in-person or virtual human interactions. While existing studies discuss evolution from online courses to communities of practices that foster peer-to-peer learning [2–5], there are no specific studies dedicated to how the MOOCs, catering to a large audience on the subject of transboundary water governance, can evolve into a global community using a peer-to-peer learning approach. Understanding this evolution can underline the importance of knowledge sharing and peer-to-peer learning in building capacity for enhanced transboundary water governance.

This paper examines the transformative role of integrating peer-to-peer learning in capacity development within the context of transboundary water management. The paper aims to understand how large-scale capacity building for improved transboundary water cooperation is achieved through Massive Open Online Courses (MOOCs), particularly examining their potential evolution into peer-to-peer learning mechanisms through a community of practice. More specifically, the paper examines how a MOOC on Governance for Transboundary Freshwater Security [6] contributed to fostering conversations and interactions among transboundary water management practitioners, and subsequently evolved into the Transboundary Water Knowledge Exchange Hub [7], a knowledge sharing and peer-to-peer learning online community.

2. Materials and Methods

The materials and methods used in this paper were selected based on the available data sources. To evaluate the impact of knowledge sharing and peer-to-peer learning on enhancing the capacity for improved transboundary water governance, we employed a comprehensive approach that integrates qualitative and quantitative methods. The quantitative data collection methods involved gathering MOOC enrolment data and statistics from the engagement sessions, including demographic information, learning behaviours, and engagement metrics. Learning behaviours were analysed by examining participation, completion, and return rates to assess the overall impact of the course. Qualitative data was also obtained from participant feedback collected through pre- and post-course surveys, as well as online session participant surveys. This provided us with insights into the quality of their learning experience, thematic interest in future events, and practical applications of the course content in their professional capacities. Collecting this data allowed us to identify emerging common themes and patterns, thereby providing us with the tools to trace the impact of the learning journey on the participants' abilities. The establishment of the community of practice was driven by feedback from participants, emphasizing the importance of interactive knowledge exchange beyond the course. We conducted extensive focus group discussions and surveys at the inception and within one year among the community members to gain insights into their engagement and interests. The multi-faceted approach allowed us to assess the effectiveness, impact, and evolution of the MOOC, online interactive sessions, and the establishment of the Transboundary Water Knowledge Exchange Hub.

3. Capacity Development and Knowledge Management in Transboundary Water

Addressing knowledge gaps, especially in transboundary settings where political boundaries intersect with resource systems, presents one of the biggest challenges to effective water governance [8–10]. Overcoming this barrier requires a focus on social learning and the coproduction of knowledge to enhance transboundary relationships in water resource management [11]. The key policy and regulatory requirements to advance water

management in transboundary basins involve promoting information sharing across government levels, industry, and stewardship groups [12]. Recognizing the importance of data exchange, tools are considered essential, especially through partnerships with universities and established collaborations with research institutes [13]. Ensuring online access to analysis results and interpreted data is becoming a top priority in water management [12].

Knowledge sharing plays a crucial role in enhancing capacity across different domains and sectors. Its significance lies in its capacity to facilitate learning, foster innovation, and empower individuals and organizations to grow and adapt effectively. The process of knowledge sharing involves distributing various resources among individuals who are performing specific tasks [14]. For the knowledge sharing process to create value for stakeholders, it is essential to design a knowledge sharing strategy. This involves creating a portfolio of knowledge, supporting a knowledge management structure, providing tools for collaboration among learners, and incentivizing knowledge sharing by rewarding the learners [15].

However, a common challenge in capacity-building initiatives lies in the transfer of knowledge from the learning environment to practical applications. Knowledge transfer also plays a crucial role in scaling local solutions to a global level [16]. In the context of transboundary water management, the selection of a delivery mechanism for capacity-building initiatives becomes increasingly important because of the diverse levels of applications for new knowledge.

Online course delivery facilitates knowledge transfer by providing a variety of tools to customize the learning process according to the learner's needs [17]. Virtual learning environments enable the adaptation of course content and teaching methods through a combination of audiovisual materials, discussion forums, immediate feedback tools, and a reward system [18]. Online courses also tend to foster greater ownership of the course material under a more independent learning process. Essentially, online training and virtual learning initiatives offer a flexible, cost-effective, and scalable approach to capacity building that can adapt to the evolving needs of organizations and learners, facilitating the application of theory to practice.

The use of online learning tools and training creates more opportunities for developing skills and capacity, especially for individuals in developing countries with limited access to education [19]. Online courses and interactive training programs create an environment for closely engaging with implementation challenges and addressing capacity gaps [20], especially for initiatives that aim to connect science and policy practitioner networks.

However, online learning environments also present challenges to knowledge retention due to a lack of interpersonal communication. Typically, learning initiatives can take place in either synchronous or asynchronous formats. In the former case, students attend the class to interact with instructors at a specific time, while the asynchronous format allows them to access the study materials at their convenience [21]. During the online synchronous course, students can participate in virtual lectures, join video-conference group discussions, and interact through pre-scheduled mingling sessions. Asynchronous courses offer pre-recorded lectures, assigned reading materials, and participation in discussion forums. One of the best examples of asynchronous learning are self-paced online courses. While synchronous online learning may not be as effective for discussing complex concepts or promoting deep reflection [22], it fosters the acquisition of practical skills and can positively influence learners' commitment and motivation to engage with course content [23–25]. At the same time, asynchronous learning can enable students to work at their own pace and independently of time and place, stimulating their capacity to produce meaningful and thoughtful contributions [25,26]. It is, therefore, recommended to combine these two learning formats to catalyze higher engagement and improve academic outcomes [27].

Among the various online learning tools, MOOCs present a unique opportunity to democratize the learning process [28] and to promote the popularization of informal learning settings to engage learners at various levels [29]. The architecture of the MOOC enables the collection of a significant amount of knowledge through case studies and

testimonials for water management practitioners. It also creates an adaptable knowledge management structure that guides learners through various aspects of transboundary water issues. The MOOC environment also allows learners to interact with each other and the course instructors, fostering knowledge sharing and collaboration that contributes to the peer-to-peer learning process. In contrast to traditional knowledge management systems, the peer-to-peer learning approach allows participants to actively and flexibly share their knowledge [30]. In developing country contexts, MOOCs bridge the educational gap among learners regardless of their socioeconomic status by providing openly accessible education with minimal or no fees [31].

4. MOOC on Governance for Transboundary Freshwater Security

4.1. Course Development

The development of the MOOC on Governance for Transboundary Freshwater Security was initiated through the Global Environment Facility's (GEF) International Waters Learning Exchange and Resource Network (IW:LEARN), a global initiative focused on knowledge management and sharing primarily for GEF-funded international waters projects. GEF IW:LEARN conducted a survey in April 2019 across the entire IW portfolio to assess the need for capacity building. The survey indicated a clear demand for training in transboundary water management, particularly in the governance aspects, such as diplomacy, negotiations, and financing. There is also a need for a better understanding of transboundary water management in practice among water practitioners. At the time of the development of the MOOC, there were existing MOOCs focusing on international water law, as well as on broader water resources management. However, there was no comprehensive course addressing the key aspects of transboundary water governance, including law, diplomacy, institutions, management tools, and finances. Therefore, the scope of the new MOOC was determined to focus on the essential governance aspects of transboundary water management.

With this background, the course primarily targeted transboundary water managers but was also intended to serve a wider audience interested in the subject. The course development was led by the Global Water Partnership (GWP), a key partner of GEF IW:LEARN. The GWP brings expertise in capacity building and draws on experiences from a wide range of transboundary water actors on the ground. The course was developed with modules coordinated by experts from organizations with expertise in transboundary water, including the United Nations University (UNU), IHE Delft Institute for Water Education, Northumbria University, the Water Convention Secretariat of the United Nations Economic Commission for Europe (UNECE), the Stockholm International Water Institute (SIWI), the GWP, and its technical experts.

The course includes six modules. Each module has end-of-module questions and discussion boards. Learners are able to enroll without gaining a certificate (free of charge) or enroll for a certificate course with a small certificate fee, which allows them to take mid-term and final examinations.

The design of the course involved several key considerations. First, each module consisted of 5–6 topics and associated case studies that illustrate how key topics are implemented in practice. The inclusion of case studies was very important since understanding the key concepts of transboundary water management may not be so difficult but implementation on the ground brings many challenges due to highly complex governance layers and the stakeholder groups that one needs to consider when managing water shared among countries. Second, emphasis was also placed on diversity in lecturers and case studies, which contributes to a broad network of global experts bringing diverse experiences and perspectives. This approach resulted in engaging 80 professionals from around the world who work with the topic. Third, each lecture and case study aimed to be relatively short, taking into account the attention span of online course learners. Lectures were designed to be approximately 7 to 8 min, while case studies were intended to be 3 to 5 min long. Each

video also incorporates various visuals, which enhances the engagement of online lectures and videos.

To ensure that a certain level of content quality was maintained, the production of the MOOC went through several review processes, including a review by module coordinators, lead faculty, GEF IW:LEARN, and SDG Academy, as well as two independent reviewers—one with expertise in transboundary water and another with expertise in the development of online pedagogy. The content and videos have been adjusted and edited to ensure that the course maintains a high level of quality in terms of both content and pedagogy.

The course was designed and developed in English with subtitles for all video materials. The availability of video subtitles has made it easier for learners who may not be proficient in English. During the course implementation, the video subtitles were translated into five languages: French, Spanish, Portuguese, Chinese, and Russian. The Cap-Net UNDP team translated the French version of the course hosted on its virtual campus platform [32]. These translations have made the course more accessible to a broader audience of transboundary water professionals.

4.2. Course Implementation

The course was launched in August 2019 and hosted on the SDG Academy platform. The platform was chosen because of its popularity among learners interested in the Sustainable Development Goals, which made the course more visible to the target audience. This was an important aspect because many learners who join the MOOC often discover new courses when they are taking another course.

As of February 2024, when this paper was written, the course had a total of 3992 enrolments from 167 countries. The gender balance of course learners is 45% female and 55% male. Over 90% of the learners have a university-level educational background, with 58% of learners holding a master's degree or higher [32]. The MOOC attracted a relatively younger audience, with 66.8% of the learners being 39 years or younger, and 12.6% of them being below 25 years old [32].

Both pre- and post-course surveys were integrated into the learning platform, and participants voluntarily responded to the surveys before and after completing the course. According to the pre-course survey, 44% of the learners were professionals in the related industry (see Figure 1). More than half of the respondents cited the relevance to their current professional field as their reason for enrolling in the course (see Figure 2). Over 75% of the respondents had either previous academic or professional experience in the subject area of the MOOC (see Figure 3). These statistics indicate that the course attracted the originally intended target audience of practitioners in transboundary water management, with additional participants primarily from the academic sector.

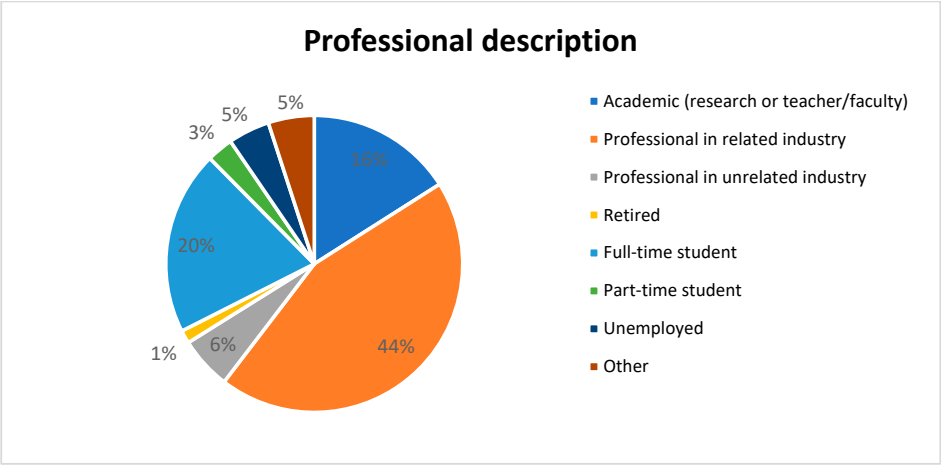

Figure 1. Professional description of the pre-course survey respondents [32].

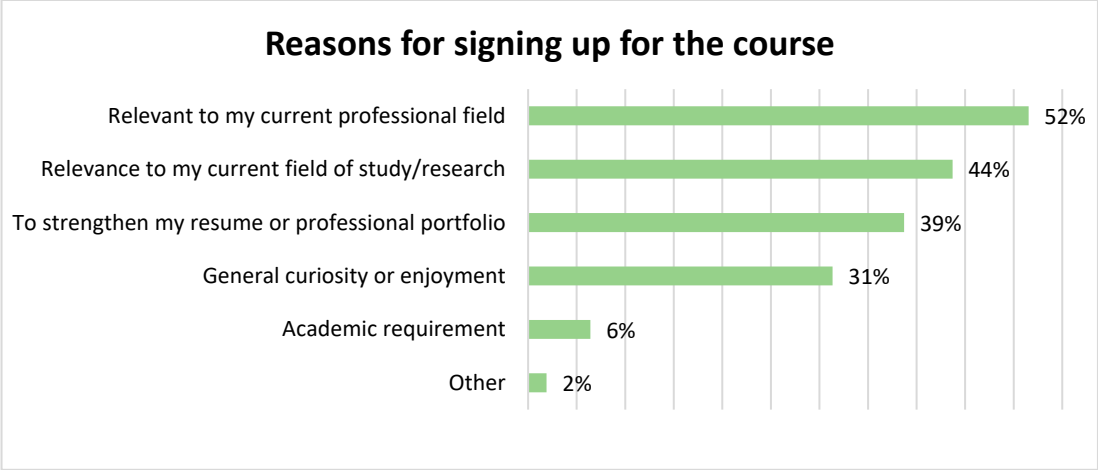

Figure 2. Reasons for signing up for the MOOC [32].

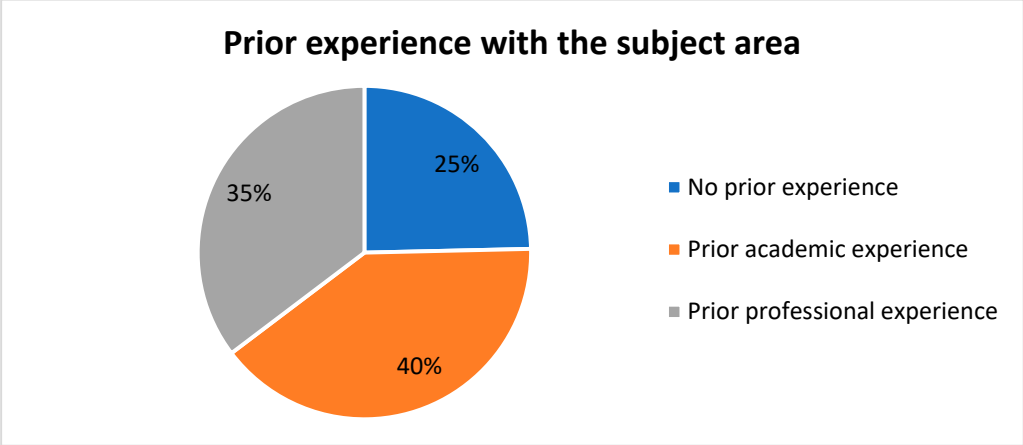

Figure 3. Prior experience with the MOOC's subject area [32].

4.3. Use of the Course by Participants and Learners

4.3.1. Through Post Course Survey

The learners also had the opportunity to share their thoughts on the learning experience by completing course surveys. The MOOC learners have been asked to complete a post-course survey upon finishing the course. The survey aims to assess the relevance of the course to respondents' professional and research interests. It also invites respondents to share examples of how they have applied the knowledge gained from the course. The feedback from course surveys indicates a high level of learner engagement and great satisfaction with the balance of theory and practical examples in the course.

The post-course survey indicates that 48.8% of the respondents spent 2–4 h per module, and 84% of the respondents found the overall length of the course to be just right (see Figures 4 and 5).

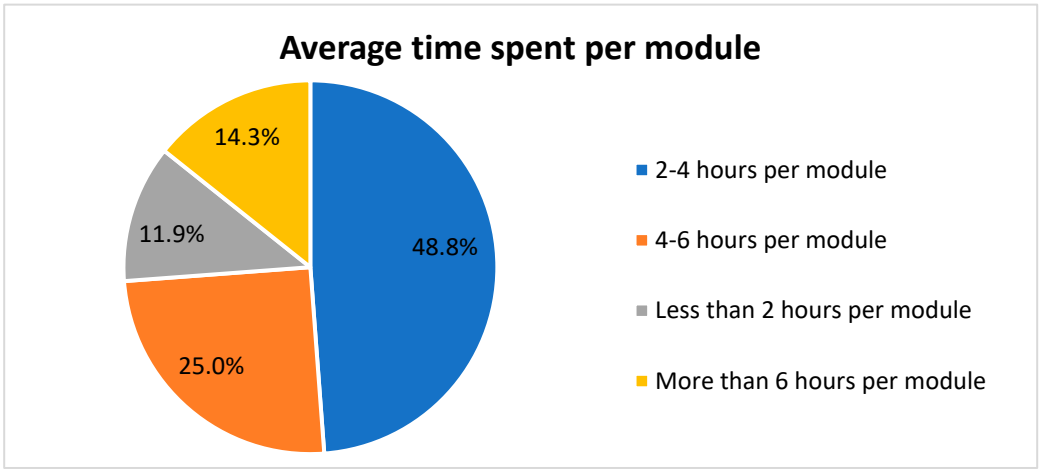

Figure 4. Average time spent per module [32].

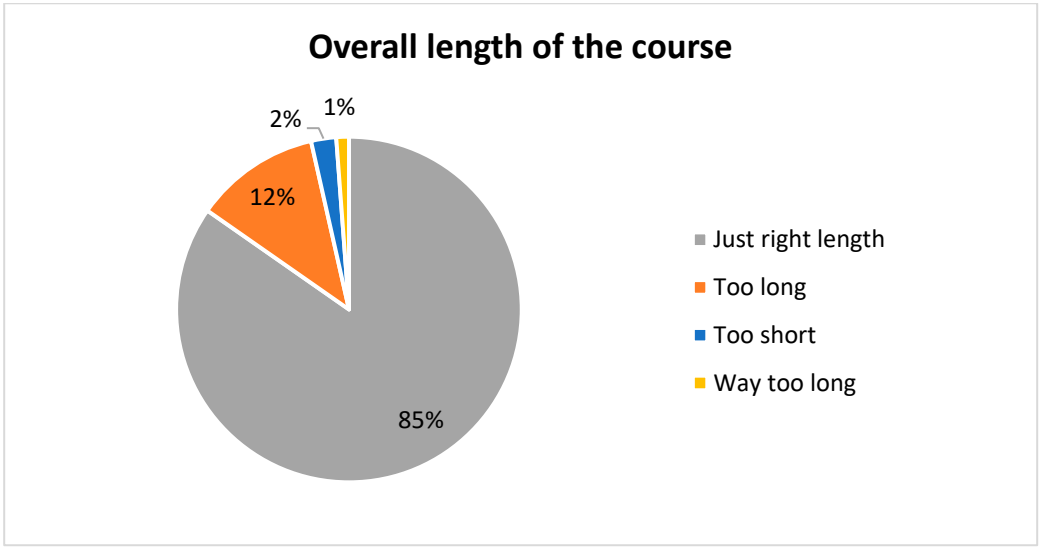

Figure 5. Overall length of the course [32].

The course feedback has been positive, with over 90% of respondents expressing agreement or strong agreement with each of the statements provided (see Figure 6).

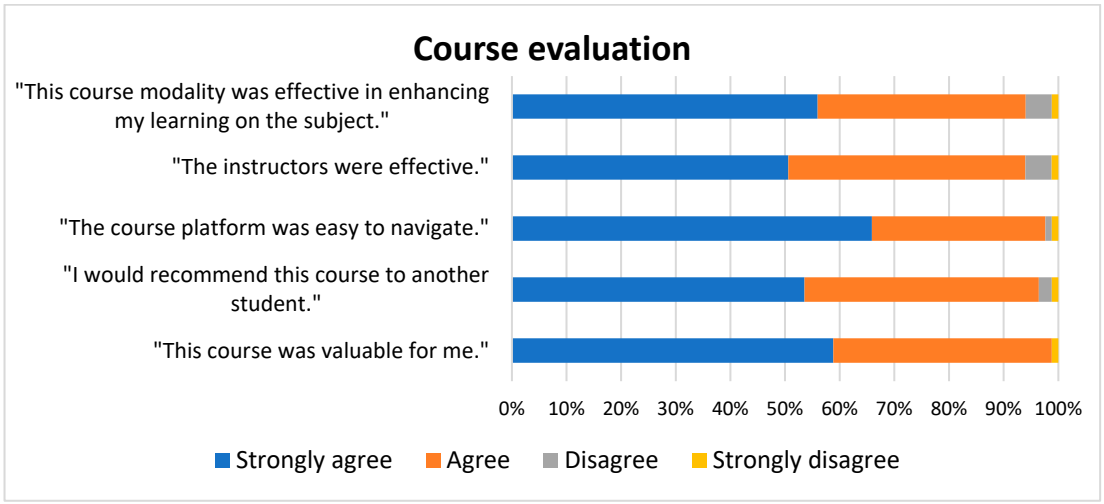

Figure 6. Agreement with the course evaluation statements [32].

One important lesson for learners from their studies is the acknowledgement of the crucial role of water diplomacy in the effective management of transboundary water resources. This understanding was closely linked to an excellent overview of the intricate connections between international water law and water security, emphasizing the importance of legal frameworks in ensuring fair utilization and peaceful cooperation.

When asked about their favorite aspect of the course, one-third of the learners highlighted the case studies as a standout feature. These real-world examples from various geographic locations helped to contextualize the course content and provided practical insights into addressing transboundary water conflicts. Learners appreciated the global perspective provided by these case studies.

Certain modules in the course were specifically highlighted. Module 6 on finance for transboundary water security stood out, with learners noting that it helped them understand how to seize opportunities for mobilizing funding in large water-related projects. Additionally, Module 2 on water diplomacy and negotiation skills, and Module 5 on management tools and mechanisms for governing transboundary freshwater security, were well-received for their relevance to the professional setting of some learners and the quality of analysis.

Respondents emphasized that the course content will have direct relevance to their daily work, whether they are employed in environmental consulting, government agencies, or river basin organizations. Practical examples of application include participating in governmental working groups on accession to global conventions, such as the Water Convention, conducting negotiations on behalf of the Ministry for Foreign Affairs team, implementing work programs of transboundary river basin organizations, and reporting on the global Sustainable Development Goals' (SDGs) indicators 6.5.1, 6.5.2, 6.6.1, and 6.3.2. Some respondents also indicated that the featured case studies and commentary from the course facilitators have provided them with adequate knowledge to advance their PhD research on transboundary water basins. The geographical focus of future knowledge application spans across the globe, including Northern American watershed projects, European river basin institutions, governmental offices in African countries, and major transboundary basin organizations, such as the Mekong River Commission. More specifically, the responses came from a number of basins, such as the Mekong, La Plata, the Nile, the Rhine Rivers, Lake Titicaca, the Sali Dulce basin in Argentina, and the Delaware–Pennsylvania–New Jersey–New York River basins, as well as the transboundary watershed shared between Canada and the US.

4.3.2. Use of the MOOC in Professional Education

The MOOC, widely acknowledged as a pivotal initiative contributing to the achievement of SDGs, has been actively utilized by various institutions for educational and capacity-building initiatives. For instance, it forms an integral part of a course offered through UN SDG:Learn, a United Nations initiative consolidating pertinent learning solutions on sustainable development topics [33,34]. Additionally, the MOOC has earned recognition as one of the SDG acceleration actions endorsed by the United Nations Department of Economic and Social Affairs [35,36]. This strategic action aims to positively impact SDG 6, emphasizing clean water and sanitation, with a particular focus on target SDG 6.5, promoting integrated water resources management. Furthermore, it extends its impact to SDG 14, supporting life below water, particularly addressing the source-to-sea approach in module 5d2 and the associated online session (session 8) conducted within the MOOC.

By delving into international water law, water diplomacy, and negotiation, the MOOC plays a crucial role in resolving the conflicts associated with transboundary water infrastructure development, aligning with the objectives of SDG 9 on industry, innovation, and infrastructure. Addressing themes of water and peace (SDG 16) and partnership (SDG 17), the MOOC encapsulates comprehensive coverage. Its overarching objective is to enhance transboundary water governance, impacting regions covering 40% of the land surface and affecting 2.8 billion people. This indirect contribution also aligns with SDG 2 (zero hunger)

and SDG 3 (healthy lives and well-being for all ages). Notably, the MOOC demonstrates inclusivity, with approximately 50% of its learners being women, thereby promoting and empowering women in line with SDG 5 [32].

The MOOC also complemented some of the ongoing training and education programs. For instance, the Finnish Environment Institute and Aalto University conducted a series of water diplomacy training sessions for the water diplomacy network of Finland. The MOOC was used as pre-session material, with more detailed conversations and discussions taking place on specific topics during in-person sessions. During the Pan Africa Water Governance and International Water Law training course organized by GWP, all participants were required to enroll in the MOOC as pre-course learning. This approach to combining learning methods has helped to enhance learning experiences and effectively utilize the 'in-person training' time in courses dedicated to practitioners.

The United Nations University, Institute for Water, Environment and Health (UNU-INWEH), and McMaster University in Canada collaborated on the Water Without Borders (WWB) graduate program to provide a comprehensive education in water, environment, and health matters. As a codirector of this program from 2019 to 2021, Nidhi Nagabhatla actively encouraged students to integrate Massive Open Online Courses (MOOCs) as an essential component of their learning experience, especially within the framework of the water security module [37,38].

This emphasis on MOOC integration aligns strategically with UN Water's (2013) conceptual framework for water security, emphasizing the pivotal role of international and transboundary cooperation as a fundamental element in achieving water security. Given the WWB program's focus on unravelling the complexities of water security for graduate students, the MOOC emerged as an invaluable learning resource seamlessly complementing traditional classroom instruction [37].

5. Online Interactive Sessions

The interactive online sessions, organized within the framework of the MOOC on Governance for Transboundary Freshwater Security, play a crucial role in enhancing the overall learning experience and achieving the course's primary objectives. Overall, 16 interactive sessions have taken place in the period 2020–2023 [39].

These sessions were strategically designed to address specific challenges encountered in delivering the course. One primary motivation was to address the limited participation observed in the MOOC's discussion forums. Recognizing that traditional lectures can be static, the interactive online sessions infused dynamism into the course. They allowed learners to actively participate, ask questions, and contribute their insights.

Additionally, the interactive online sessions provided real-time learning opportunities that complemented the self-paced nature of the MOOC. They ensured that participants could stay updated with the latest developments and trends in transboundary water management, thereby enhancing overall engagement in a self-paced learning environment.

Furthermore, these sessions encouraged active peer-to-peer interaction among participants in real time, fostering collaboration and expanding participants' professional networks. Renowned practitioners and experts were invited to participate in interactive online sessions aimed at bridging the gap between the course content and real-world practice. Learners had the opportunity to directly access the knowledge of experienced professionals.

Understanding complex topics, like water diplomacy tools or financing mechanisms in transboundary water infrastructure, can be challenging using traditional learning methods. The practical insights and case studies shared during the interactive online sessions enabled participants to apply theoretical knowledge to real-world scenarios, enhancing their understanding of how theory is put into practice. They demonstrated the impact and significance of their studies in the context of managing water across boundaries.

The sessions were designed to prioritize interactivity and foster a two-way exchange as fundamental principles. The interactive online sessions actively engaged participants,

ensuring that learners were not passively receiving information but were actively involved. This significantly enhanced their understanding and retention of the course material.

The sessions were conducted using the Zoom platform and were preceded by a comprehensive outreach campaign. Participants were encouraged to review particular modules and lectures from the MOOC and were invited to submit their questions to speakers during the registration process. This approach enabled session organizers to identify the main areas of interest of the participants and share their questions with the speakers in advance. This allowed the speakers to prepare for discussions based on specific cases.

The sessions were carefully structured to ensure ongoing participant engagement throughout the event. Each session began with an interactive poll to facilitate introductions and assess participants' current knowledge of the session's topic. Following the speaker presentations, participants had a special opportunity to engage in discussions with each speaker in dedicated breakout rooms. This arrangement frequently led to various groups of professionals convening in virtual spaces, exchanging their experiences, and collectively tackling daily challenges by learning from each other.

To ensure the sustainability and continuity of these initiatives, each session was evaluated at its conclusion through a poll, collecting feedback on potential topics for upcoming sessions. This allowed participants to actively influence the direction of the course and provided immediate insights to refine the content. Additionally, participants were encouraged to continue discussions on the MOOC's dedicated discussion forum, which functioned as a platform for ongoing interaction and knowledge sharing among participants.

Data collected throughout the interactive sessions suggests that, on average, more than 60% of participants had taken the MOOC before attending the sessions. The majority of participants came from Europe, followed by Asia and Africa [32]. The sessions have primarily attracted professionals in the related industry (over 50% of participants) but have also succeeded in engaging professionals from outside the transboundary community, such as those from the private sector and NGOs. Overall, more than 1100 unique participants joined the sessions, the majority of whom have attended multiple sessions [22].

Furthermore, the MOOC learners emphasized the added value of the online sessions conducted in parallel with the course, as indicated in post-course surveys. Many students discovered that the real-life applications featured in the interactive sessions helped them understand complex concepts and provided a more engaging learning experience. Online sessions were also considered easy to follow and accessible to individuals without prior professional experience in the field, making them inclusive and suitable for a wider audience.

6. From MOOC to Global Community: The Transboundary Water Knowledge Exchange Hub

Most MOOC participants expressed the need for interactive knowledge exchange. According to post-course and post-event surveys, participants most enjoyed the case studies and practical experiences. Additionally, over 80% of survey respondents expressed interest in participating in a broader transboundary community of practice after the course. The goal of such a community was to facilitate the translation of knowledge into action to improve transboundary water cooperation and management. The series of interactive sessions from 2020 to 2023 had a high number of returning attendees, who are considered key members to engage in the future community. Participants specifically remarked on the quality of speakers and the opportunity to interact with professionals from around the world as key motivating factors.

The opportunity to create an open knowledge exchange space for the transboundary water community would also address a gap in existing knowledge platforms. Renowned global platforms for transboundary water knowledge management, such as OSU Databases [40], IW:Learn [41], and TWAP RB Portal [42], offer an excellent overview of existing transboundary basins, related datasets, and programs for transboundary cooperation. These platforms

were primarily used as repositories with a comprehensive collection of knowledge and learning materials, offering limited opportunities for transboundary water stakeholders to directly engage with the presented information and interact with each other on the platforms. The creation of a space where the transboundary water community can exchange information was expected to complement the efforts of these knowledge platforms.

Established in May 2022, the Transboundary Water Knowledge Exchange Hub [7] is an online community of practice (CoP) on the GWP's IWRM Action Hub, designed to serve as a collaborative platform for water practitioners engaged in transboundary water management. Its core objectives include facilitating the translation of knowledge into practical actions, creating an interactive space for knowledge exchange among transboundary water practitioners, fostering global professional connections to enable the creation of new knowledge products, and nurturing a culture of peer-to-peer learning. By joining the community, its members obtain direct benefits, such as access to a network of transboundary professionals, regularly updated knowledge materials, and the opportunity to engage in peer discussions and learn together through events and courses. Hosting the community on the IWRM Action Hub also allowed us to introduce members to a platform where data and practical applications are located side-by-side. In particular, the community offers content for both experienced decision-makers and young professionals, which boosts ways for their collaboration.

Prior to the opening of the online CoP, the GWP Transboundary Water Cooperation team conducted a series of focus groups and conversations with potential partner organizations for the community. The focus group discussions aimed to understand user needs and content preferences; therefore, they were structured around the key questions on the added value for future members, top areas of interest, frequency of engagement, and types of activities organized by the community moderators. Participants were selected from among the MOOC learners and attendees of online interactive sessions. Two focus group discussions took place via Zoom in March 2022 to accommodate various time zones. Based on the outcomes of the focus group discussions and conversations with partners, the team developed a community concept, code of conduct, and community guidelines, as well as partnership arrangements with the co-organizers of the community.

The CoP features a diverse network of partner organizations, with key partners including the United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS), the UNESCO Intergovernmental Hydrological Programme (IHP), the International Groundwater Resources Assessment Centre (IGRAC), the International Network of Basin Organizations (INBO), the IHE Delft Institute for Water Education (IHE Delft), and Oregon State University (OSU).

To date, the community has gathered a membership of 155 users, attracting more than 2000 visits to community content. The community also comprises a dedicated team of moderators who ensure that discussions and materials align with the community's guidelines. These moderators actively engage with members to address concerns and promote productive interactions. However, it is worth noting that, at times, a challenge arises from the limited availability of GWP staff time that can be dedicated to the community, posing a potential obstacle to its sustained development and engagement. To overcome this challenge, ongoing efforts are being made to explore additional resources and avenues for moderator support and community expansion.

The most recent survey of community members conducted in early 2023 revealed actionable insights on community members' engagement and interests. For example, the members identified the opportunity to contact leading experts as the biggest value of being a part of this community (Figure 7). When asked about their purpose for joining the community, most respondents chose networking as a key motivator (Figure 8).

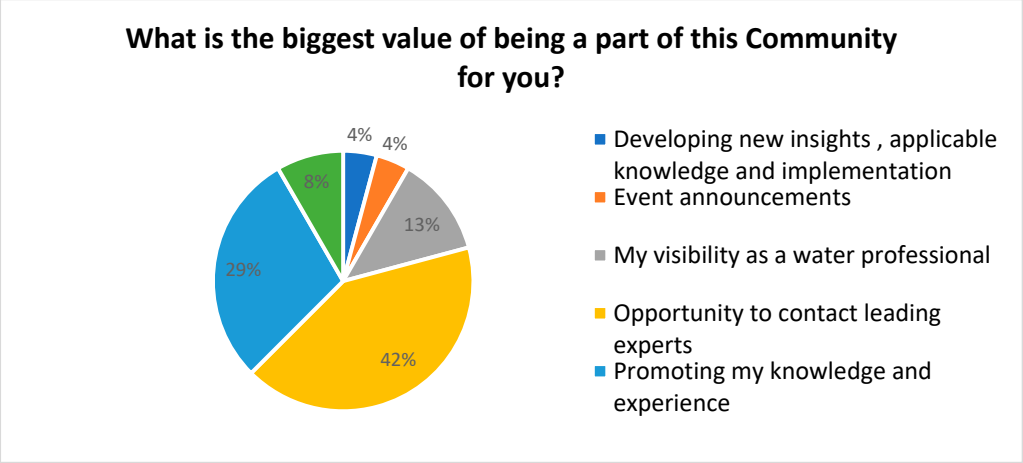

Figure 7. Results of the community survey, May 2023, Q1 [43].

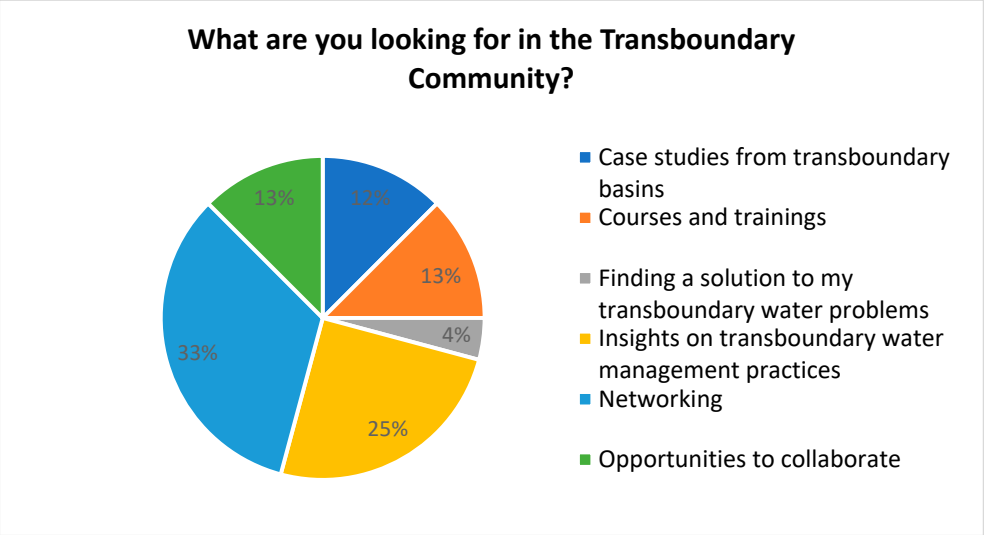

Figure 8. Results of the community survey, May 2023, Q2 [43].

This online community of practice fosters global connections, peer-to-peer learning, and direct engagement among transboundary water practitioners. The recent community survey in 2023 highlights the value of this initiative, emphasizing the opportunity to connect with experts and network with peers as key motivators for participation. Overall, the Hub fills a vital gap in existing knowledge platforms by providing a space for active information exchange and collaboration. It serves as a hub for collective action and knowledge sharing in transboundary water management.

7. Conclusions

This paper has examined the initiation and evolution of the MOOC on Governance for Transboundary Freshwater Security, tracing its transformation from an online course to a vibrant global community of practice among transboundary water practitioners through fostering peer-to-peer learning and knowledge exchange. These developments have grown beyond successful educational initiatives and represent a broader contribution to knowledge dissemination and collaborative problem-solving among practitioners. The analysis offers several valuable lessons and insights which are applicable to a wider range of management issues beyond transboundary contexts.

This evolution was made possible by several enabling factors. Firstly, the success of online learning platforms and communities of practice requires its organizers to play an

active role in initiating and driving interactions among the learners. The efforts put forward by GWP and GEF IW:Learn laid a solid foundation for the MOOC's success, which was later supported by a number of partners joining their efforts to develop the Transboundary Water Knowledge Exchange Hub. The MOOC experience demonstrates how digital education can transcend geographical boundaries, reaching a diverse audience of professionals, researchers, and policymakers worldwide. Furthermore, the use of a facilitator's knowledge platform, the IWRM Action Hub, as a vital hosting facility, extended the MOOC's impact beyond course content and helped to sustain this virtual community. By leveraging technology to deliver engaging and accessible content, similar initiatives could effectively disseminate knowledge on various management issues, fostering global networks of expertise and collaboration. However, challenges faced during the implementation of the online community of practice indicate the need for active facilitators. Organizations or CoP facilitators must prepare strategies to allocate human resources dedicated to community facilitation to ensure its sustainability.

Second, the success of the Transboundary Water Knowledge Exchange Hub underscores the importance of creating inclusive, interactive spaces for professionals to share experiences, discuss challenges, and explore innovative solutions. GWP's collaboration with the Wuhan International Water Law Academy, supporting the initial eight online interactive sessions, breathed life into the course, fostering the creation of a dynamic community of practice through synchronous interaction among learners. These online sessions transformed the static online course into a dynamic learning experience. It also added an important element of live communication among the learners typically missing in asynchronous learning environments. Essentially, the peer-to-peer learning element played the pivotal role in the evolution of an online course into a community of practice. While diverse case studies and online sessions facilitated direct interactions between learners and instructors online, the community solidified the approach as members began to share their views and information among themselves. The Hub's model of peer-to-peer learning and collaboration has a high potential for replication in other contexts, enabling practitioners to tap into collective wisdom and learn from diverse perspectives to drive meaningful change in their respective fields.

Finally, the emphasis on interdisciplinary collaboration and stakeholder engagement inherent in both the MOOC and the Hub shows tremendous value for addressing complex management issues beyond water governance. While the full impact from the MOOC is still unfolding under a combination of different factors, the GWP's capacity to bring together diverse stakeholders and expertise from various disciplines drove the evolution of an online learning tool into a vibrant global virtual community of practice. Engaging its global network and outreach has been particularly instrumental in attracting a diverse and esteemed set of lecturers and institutions to contribute to the MOOC. This diversity and caliber of contributors has been a significant draw for learners and session attendees which enriched the learning experience. The GWP's ability to engage professionals and experts from various regions created a rich set of perspectives and case studies both in the course content and complementary interactive sessions. This demonstrates the value of interdisciplinary collaboration in addressing pressing management issues.

In conclusion, the lessons learned from the implementation of the MOOC and the Transboundary Water Knowledge Exchange Hub extend beyond transboundary water management. They underscore the transformative potential of digital tools for education, the hidden power of collaborative communities of practice, and the great value of interdisciplinary collaboration in addressing complex management issues. Practitioners and researchers can utilize these principles and approaches to tap into the collective wisdom of global networks to drive change as well as to accelerate knowledge dissemination and exchange in their respective fields.

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