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# Pedagogical strategies in geosciences: connecting the academy, ancestral knowledge, and women potters in a post-pandemic scenario

Estrategias Pedagógicas en Geociencias: conectando la academia, el conocimiento ancestral y las mujeres alfareras en un escenario post-pandemia

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	ABSTRACT
<b>Palabras clave:</b> Social appropriation of knowledge, women miners and potters, social geology, service learning, social innovation	The specialized language in academic environments limits the processes of social appropriation of knowledge and causes a disconnection between ancestral components and the communities. This article explores university extension spaces that stimulate this relationship through art, pedagogy, and culture to facilitate the bidirectional knowledge exchange in a suburban community of women miners and potters in Sogamoso, Colombia. This initiative uses strategies such as social geology, Service Learning (ApS), and Social Innovation with a double- diamond methodology to seek solutions to social challenges. By combining these approaches, more effective and sustainable solutions can be developed that address the real needs of communities and promote positive social change. Pedagogical activities were developed in virtual and face-to-face environments during the social restrictions imposed by COVID-19 and post-pandemic in-person workshops during 2020-2023. The synergy between participants allowed for an approach to ancestral knowledge and its relation to research processes on clay materials, the artisanal process, and adaptation towards a sustainable community under a gender perspective. The importance of raising awareness, disseminating, and promoting the SDGs from an equal opportunities' standpoint and the vindication of women in activities such as mining and pottery is discussed.
	RESUMEN
Keywords: Apropiación Social del conocimiento, mujeres mineras y alfareras, geología social, aprendizaje servicio, innovación Social	El lenguaje especializado en ambientes académicos limita los procesos de apropiación social del conocimiento y provoca la desconexión entre los componentes ancestrales y las comunidades. Este artículo explora espacios de extensión universitaria que estimulan esta relación a través del arte, la pedagogía y la cultura para facilitar el intercambio bidireccional de conocimiento en una comunidad suburbana de mujeres mineras y alfareras en Sogamoso, Colombia. Esta iniciativa utiliza estrategias como la geología social, el Aprendizaje Servicio (ApS) y la Innovación Social con metodología de doble diamante para buscar soluciones a desafíos sociales. Al combinar estos enfoques, se pueden desarrollar soluciones más efectivas y sostenibles que aborden las necesidades reales de las comunidades y promuevan el cambio social positivo. Se desarrollaron actividades pedagógicas en ambientes virtuales y presenciales durante las restricciones sociales impuestas por COVID-19 y talleres presenciales postpandemia, durante el periodo 2020-2023. La sinergia entre los participantes permitió el acercamiento a los saberes ancestrales y relacionarlos con los procesos de investigación sobre materiales arcillosos, el proceso artesanal, y la adaptación hacia una comunidad sostenible bajo un enfoque de género. Se discute la importancia de sensibilizar, difundir y promover los ODS desde la igualdad de oportunidades y la reivindicación de las mujeres en actividades como la minería y la alfarería.

### Introducción.

Education for sustainable development entails a new educational paradigm and includes responding to different changes: economic, social, political, and cultural. Therefore, education for sustainable development in countries must focus on knowledge development (Correa, 2019) and comprehensive training from a critical point of view (Muñoz et al., 2017).

The Higher Education Institutions (HEIs) are a key to the progress of the fulfillment of the 2030 Agenda due to their responsibility for knowledge creation and divulgation. The sustainable development objectives (SDG) focus on meeting goals framed in the 2030 Agenda through articulation between individuals and collectives (people and countries) for overcoming inequality, adapting to climate change, and creating capacities for sustainable economic growth and productive capacity. However, the transversal work conditions the achievement of SDGs in all the different areas of university life, such as training, research, extension, and social commitment. This approach agrees with the most recent report of the UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC) entitled "Contribution of Higher Education to the Objectives of Sustainable Development: the analytical framework (2020)", launched on February 10, 2020, within the framework of the Meeting of Ministers, Ministers and High Authorities of Higher Education held in Havana, Cuba (Ramos Torres, 2020).

In Colombia, the national government issued Decree 1330 of July 25, 2019 (Ministerio de Educación Nacional, 2019) to strengthen the quality assurance processes in higher education. One of the aspects of the Decree relates to training for research/creation and the premise that the results contribute to social transformation and the country's construction. This activity integrates extension, one of the missionary axes of the Pedagogical and Technological University of Colombia (UPTC).

The extension is the social projection that links the research to Society; and that promotes access to these research results to improve their quality of life and environment (UPTC, 2019), as well as the commitment to contribute from Higher Education to the SDGs as reflected in the recent IESALC report (Ramos Torres, 2020).

Implications of the COVID-19 Pandemic in the Investigative and Social Projection process of HEI The United Nations Educational, Scientific, and Cultural Organization affirms that education is the priority to reinforce resilience and social cohesion among communities in crises caused by armed conflicts, natural disasters, or pandemics (N. U. CEPAL, 2020). The COVID-19 pandemic has provided the stage to understand the importance of implementing strategies, conducting research, and university extension processes. Also, reflecting on the role of HEIs in strengthening and identification tools is meant for maintaining compliance with the 2030 Agenda, especially in this scenario.

The situation created has highlighted the need to act and accelerate the processes underway to achieve the transformation of our societies. According to the (CEPAL, 2020), the self-isolation, quarantine, and social distancing measures have caused direct effects on supply and demand: suspension of productive activities and higher unemployment; they also refer to a global recession in education, trade, tourism, transportation, manufacturing, and natural resources (Negrín Medina et al., 2021). Antonio Guterres, Secretary-General of the United Nations, in the report The-Sustainable-Development-Goals-Report-2020 states: "Everything we do during and after this crisis [COVID-19] must be with a strong focus on building more equal, inclusive, and sustainable economies and societies that are more resilient in the face of pandemics, climate change, and the many other global challenges we face." (UN, 2020), and therefore the participation of universities becomes a priority.

Integration of Education, Science, and Culture with Rural Social Innovation and Social Geology for Social appropriation and knowledge transfer to the communities.

The United Nations Organization for Education, Science, and Culture establishes that cultural heritage is essential to generate rapprochement among human beings. Also, permanence and transfer of intergenerational ancestral knowledge must be guaranteed (Organization of United Nations Educational, Scientific and Cultural Organization (UNESCO, 2020). Likewise, using, including, and exchanging knowledge should be encouraged to construct a knowledge-based society (Minciencias, 2020). In this sense, rural communities have empirical knowledge that is perhaps underrated by academia. Science, technology, and innovation (STI) developments discard this knowledge that can constitute appropriation exercises with rural communities (Pabón, 2017), in addition to the need to strengthen and improve the links between science, innovation, sustainability, and inclusion (Bortagaray, 2016). Rural social innovation is the tool to facilitate the processes of social appropriation of science, technology, and innovation in rural environments (Ramirez, 2021).

According to (Ramirez, 2021), rural social multidimensional innovation emerges as а tool for science and technology appropriation. Transformation, learning, and education allow STI developments to respond to the needs of rural communities through the joint construction of strategies that articulate and dynamize the relationship between professionals, researchers, and Communities for new development creation. Social innovation allows the integration and exchange of knowledge for the ideation of innovative solutions that respond to social problems (Arcos Soto et al., 2015; Roa De La Torre, 2017), evenly, the generation of significant changes in population groups (Hernández and Sánchez, 2014). In Colombia, the different states unities lead various processes for the social appropriation of science, technology, and

innovation (SASTI) and achieve the articulation of the academy with communities and organizations; this approach generates ways for the exchange and construction of new knowledge (Jaillier C et al., 2015; Ramirez, 2021).

In the construction and social appropriation of new knowledge, understanding earth sciences is the key to adapting life sustainably on our planet. Geology responds to challenges such as the growth of urban areas in developing countries from territorial management for the well-being of the Society. Social Geology relates sociology and geology to preventing and reducing geohazards and limiting the effects of geological disasters. This discipline responds to problems of adapting sustainable development of humanity (Mata-Perelló et al., 2012), and geological museums allow the integration of mechanisms as mediators of geological (Tavera Escobar et al., 2020).

All geological elements, including economic, social, scientific, landscape, heritage, or educational value, should be complementary instruments. The inherited archaeological heritage from the indigenous Muisca culture and the clay deposits are part of the legacy and richness of Sogamoso municipality (Gómez-Montañez, 2011). There are gaps in historical memory and issues with geological/archaeological patrimony identification and preservation. For this reason, professionals in earth sciences must learn to transmit geoscientific knowledge and simultaneously interact with communities to preserve the historical memory of Ancestral knowledge.

A problem of social development in the pottery sector is identified, specifically with the ASOAMME collective (Association of Entrepreneurial Mining Women), where the paradoxes and tensions of social development contrast with the potter trade. The Association of women in socioeconomic vulnerability conditions has adapted to the dynamics of the local market and relegated their ancestral jobs for dedicating to tiles and brick manufacture due to higher demand in the market. However, the same fluctuating behavior between supply/demand and the low competitivity has resulted in rethinking and evaluating the possibility of returning to ancient productive activity, but decades and new generations have deteriorated traditions.

Although there is talk of economic growth and equal opportunities, these women face the environmental model of sustainability with little or no scientific-technical support; prevention and mitigation of the environmental impact of its pottery activity require robust investments to meet the minimum requirements of the environmental authorities. Based on the scenario, we tried to ask the following questions: what educational strategies are necessary to positively impact social and economic issues in the Community through pottery activities and small-scale mining? What strategies are optimal for recovering historical memory, heritage, and identity? ¿Is it feasible to rescue ancestral techniques through some pedagogical strategy and innovate the processes and products made with Sogamoso clays?

#### **Materials and Methods**

A pedagogical strategy adapted to a pandemic and post-pandemic scenario is developed through the coordination of activities with the Community, the implementation of available technological resources, and a differential approach for rural communities; design and innovation topics are addressed based on the identification of roles in each actor, the application of social geology, and the Service-Learning (ApS) methodology, to articulate ancestral knowledge with scientific knowledge. Entities such as the Eliecer Silva Celis Archaeological Museum -MAESC-, the Geological Engineering Museum -MUIG- of the UPTC, and the Association of Women Miners and Entrepreneurs ASOAMME from the pottery sector of Sogamoso participate in this initiative. These agents facilitate knowledge transfer to the Community, collaborate within the research process, and contribute to the rescue of ancestral knowledge. The methodology uses qualitative tools, and each result responds to the community context (MAESC, MUIG, ASOAMME) and the participating research groups. The British Design Council's double diamond method guided a scheme for rural social innovation addressing the problem and questions posed. Divergent and convergent actions in idea generation consist of four phases: discovery, definition, development, and delivery (Ramírez, 2021). This strategy was suitable for generating equitable ideas and facilitated the integration of academia with rural communities through knowledge transfer (Lomax et al., 2022; Londoño Montoya & Álvarez Giraldo, 2021). Here, creativity and subjectivity with a reflective approach created participatory, debatable, and transferable spaces (Gallego Cataño, 2017) for the social appropriation of ISTs. The stages of the defined method (figure 1) were: bibliographic study, implementation of Social Geology, Pedagogical Strategy, and evaluation of social and cultural impact.



Figure 1. Implemented procedure according to double diamond design thinking process

# Bibliographic study and implementation of Social Geology

The associated research and analysis phases with the problem discovery and definition began with arranging a time to dialogue with the Community involved to collect information, specify the problem, foster a user-oriented attitude, identify their needs, and know their behavior. This starting point linked the academy and the communities for inquiring about their motivations for a change. Implementing social geology and service learning identified and directly analyzed specific problems, the first step in the teaching-learning process (González, 2005). Formulated workshops on approach and knowledge promoted the initial integration with the participants. The listening, talking, and observing premises allowed for addressing topics, problems, or social situations that require change, improvement, or development (Echeverría, 2008). Likewise, museums lead geoscience dissemination processes by understanding scientific information and transmitting knowledge according to the public interest (Tavera Escobar et al., 2020).

Finally, semi-structured interviews ordered, classified, and reworked moments to identify social, cultural, environmental, or family factors with differential degrees of formality (Alberich et al., 2009) (Flick, 2007). It identified the problem, the context, the scope, and opportunities to implement the SDGs and the role of the University in compliance.



Figure 2. Correspondence between the project and the SDG.

# Generation and implementation: Pedagogical strategy, social and cultural impact

The other stages were the idea generation and the implementation. It involved aspects such as the creation and evaluation, the co-design with involved people, exploration of ideas and hypotheses, and redefinition of concepts.

Teaching and learning spaces articulated knowledge and proposed the dialogue for building a social innovation solution according to the requirements (communities provide knowledge about themselves and their environment). The application of pedagogical strategies promoted participatory and demonstrative spaces based on learning by doing (Drain, 2019). Finally, socialization divulged the results achieved during the process (Drain, 2019).

Developing projects using service-learning methodologies (ApS) involves active learning of the subject matter and implies service to the Community where all participating agents face reality from a more conscious and committed perspective. The primary motivation was to break away from the rigidity inherent in conventional engineering approaches, introducing a transformative perspective through community participation. In our case study, this participatory perspective promoted women's empowerment and allowed a deeper understanding of their daily context. Therefore, as criteria for selecting an appropriate theme for an ApS project, we could consider: (i) Being aware of the social problems in our environment. (ii) Choosing several themes related to our teaching and research training, we will be guides and learners with research capacity. (iii) Sharing the initiative, we have in mind with colleagues with whom we have some teaching and research affinity. (iv) Proposing the themes to our students and having them participate in their choice will increase their commitment and involvement. (v) Investigating the research on the themes and possible institutions interested in their scientific research. If possible, make them known to determine the actual level of interest they have. An ApS project employs a methodology that combines active learning processes and community service. As with any ApS project, students apply what they have studied to the real needs of the environment, intending to improve it (Spanish Network of ApS, 2019). These experiences have already been applied at different

educational levels, and in the case of the University, it is worth considering that it is a civic mission to fulfill (Santos, 2015) and to favor its institutional performance. With this methodology, students develop a solidarity project that brings into play knowledge, skills, attitudes, and values related to the educational practice developed in a specific subject. It is, therefore, about curriculum competencies emphasizing acquiring competencies in the social and civic sphere. The values that this type of work brings to students are, in addition to acquiring essential curricular competencies, the acquisition of prosocial values and attitudes (commitment to the environment), and life skills (strengthening social skills). Students realize they can provoke changes in their environment, and service reinforces learning. This methodology is a tool that improves educational success and social cohesion.

From a technical standpoint, approaches from the double diamond methodology (Figure 3) were used, which encompassed problem-solving based on community experiences (Gammaux, 2021), as a means of cooperative and collaborative learning, each member played an essential role in socialscientific integration; a workshop for storytelling and shaping with the Community was implemented. According to aptitudes roles were exercised such as mediators, in the function of disseminators and social appropriation of knowledge; session assistants who provided information, managed time, and ensured that everyone participated actively; connectors who resolved specific doubts with terms or aspects specific to the Community or academics; and information transmitters who compiled data and guided dialogue with potters. Audiovisual content was recorded to document the testimonies and information through semi-structured interviews while creating handicrafts. In this way, it is possible to understand the pottery community's social, cultural, and environmental context; spaces were generated that fostered dialogue between science, technology, and innovation, and the exchange of knowledge was encouraged in a democratic, responsible and respectful manner.



Figure 3. Diagram of the Double Diamond model, Design Council

#### Results

## Approach and diagnosis of the study community

Applying rural social innovation employs design elements such as the double diamond methodology, which consists of four phases: discover, define, develop, and deliver. In the initial stage of the project development, before the pandemic, an approach was made between the group of potters, the teaching researchers, and the students of the research seedbed. This stage corresponds to the Discover process within the double diamond methodology in social innovation projects that involve researching and understanding the social context and community needs. Interviews, observations, and analysis were conducted to gather information about social problems and challenges. In a second moment, through a collaborative virtual workshop, the Define phase is developed. In this stage, the social problem to be addressed is clearly established, and the project objectives and criteria or strategies for providing solutions are defined. The development phase is applied in this same space where potential ideas and solutions were generated. The perception of feelings and knowledge of adversities and challenges generated by the health contingency of the pandemic due to COVID-19 were identified. The activities brought knowledge closer to their needs and explored opportunities for social innovation.

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Part of the information about ancestral knowledge was documented, and current techniques used by artisans were recognized (Figure 4). Conversations and interviews identified general aspects of interest related to the recovery of ancestral techniques and preservation of historical heritage; additionally, the profile of ASOAMME women was established as 50 years old on average, mothers or providers of the household, potters by family tradition, education levels between primary and secondary school, almost exclusive dedication to pottery or mining activities, occasionally engaging in various activities or domestic service as a means of subsistence and resource acquisition.

The recognized technological gap and the restrictions in specialized topics have revealed limitations in the adoption of knowledge within rural communities. In this regard, there is dissemination of knowledge, but not necessarily its full appropriation. Several factors contribute to this situation: the technical and scientific language can be complex and challenging for the community to assimilate, the lack of suitable physical spaces and strategies for work and training, and insufficient technical training-all of which result in a disconnect in communication. Typically, artisanal communities, unlike large-scale producers with adequate infrastructure, lack access to primary information about their raw materials due to economic constraints. Even when government organizations provide support, they often fail to offer proper guidance to ensure effective utilization of the provided resources.

In post-pandemic times, the last stage of the project is developed and corresponds to the delivery phase. The chosen solution was implemented, and monitoring and evaluation of impact were carried out to ensure that the solution is sustainable and meets social innovation objectives. Social geology and service-learning methodology (ApS) were implemented at all moments, besides social innovation, as a pedagogical strategy to ensure interaction between academia and the Community.



Figure 4. Moments of the rapprochement with the group of women, in conditions of limitation of capacity and distancing because of the restrictions of the Colombian Health Ministry.

# Approach to SDGs: identification, sensitization, divulgation, and promotion.

Once social innovation was applied with the double diamond methodology, social geology, and service learning in the work developed with ASOAMME, several SDGs from the 2030 Agenda for Sustainable Development were identified. The opportunity was found to analyze them as a team and evaluate the role as an institution of higher education in achieving these. Notably, their impact and repercussions on this Community's activities, traditions, and ways of life were identified. The identified SDGs were:

SDG 4: Inclusive and quality education. Increasing research activity in a territory demonstrated geological and paleontological heritage as an educational tool at all levels. The belonging in the communities and the alternative vision for personal development in the future encouraged thinking of pottery from the clay deposits of the sector as a stable and sustained activity over time. New generations visualized opportunities for staying in the territories, forming specific employability niches, e.g., archaeology, restoration, architecture, masonry and stonework, heritage interpretation, and cultural management, without forgetting the expansion of new sensitivities for the different actors. i.e., merchants, rulers, entrepreneurs.

SDG 5: Gender equality. Projects or initiatives for rural communities are necessary to develop opportunities when inequalities increase. The actions to promote the work of rural women's associations as an element for dynamization in the social, economic, and cultural spheres sensibilize the role of women to prevent gender violence and foment equity in education, health, media, and social services.

SDG 8. Decent work and economic growth. The encouragement of the communities' enterprising spirit enabled the visualization of new companies with endogenous resources and exploring actions to keep the population in the territory, especially women in rural sectors. Formulation of opportunities in interlocal trade for product distribution with more diversity and quality increases the working market. Besides, the manufacture of products requires the use of diverse technology and specialized operators, as well as the creation and strengthening of microenterprises for generating wealth (employment, infrastructure. social and cultural) in their municipalities.

SDG 9. Industry, innovation, and infrastructure. Although the rural world is secondary in research, it is a practice field for university careers. This grasp transfers knowledge and innovation to these areas where imbalances exist and offers a specialization to learn from direct experience. Aspects from the theoretical level and low treatment in the classroom protect the heritage diversity conservation, e.g., geological, paleontological, and cultural.

### Implementation of pedagogical strategy

Each member of the Community and participating scientific personnel played an essential role in social-scientific integration as a means of cooperative and collaborative learning; this was evidenced by the conduct of storytelling workshops at various times during the execution of the project (2020-2023).

A course workshop addressed the stages of development of a pedagogical strategy for social appropriation and knowledge transfer in the pandemic scenario with the participation of women ASOAMME potters, the geological and anthropological museums (MUIG and MAESC), the hotbeds of research groups, and external participants interested in the subject. Research and Extension institutes of the University offered complimentary support and organization.

The course workshop integrated science, art, culture, and history with a social projection in a virtual environment to recognize the origin and use of mineral pigments in history, complemented by knowledge of the management of geological material (Figure 5). Moreover, it promoted these resources as raw materials in obtaining ceramic pieces supported by modeling and scientific illustration. Considering the diversity of participants, pottery enthusiasts, expert potters, young students, teachers, and the public, speakers guided the thematic topics under a dynamic, active, and participatory methodology.



Figure 5. Moments and artworks developed at virtual sessions of Mineral Pigments, Modellings and Scientific Illustration Workshop. Digital repository at UPTC - CITESA research group, multimedia resources are available at: https://repositorio.uptc.edu.co/

handle/001/3609.

The Course-Workshop addressed three modules of Mineral pigments, clay modeling, and scientific illustration synchronous classes with 1 hour per week dynamic sessions—conversations for community knowledge, speech circle mode, and formulation of local community development alternatives. Debate, comments, and feedback sections will be used to discuss the developed themes. The modeling of porcelain and clay, obtaining natural and mineral pigments, and making illustrations.

During the development of the Workshop, contributions emerged from professionals in different areas of knowledge dynamizing the process. Talks such as Journey to the Nanoworld through the Window of Science, Art History from Cultural Legislation, and a view of Coccolith positively impacted participants' perceptions.

Semi-structured interviews collected and synthesized the "Dialogue of knowledge - the potters' capsule" available on the YouTube platform (CITESA, 2021). This tool for the research and analysis phases opened a dialogue and exchange of knowledge among the participants. Figure 5 is evidence of the activity conducted under biosafety protocols for COVID-19 prevention.



Figure 5. Facets in the Dialogue of Knowledges with project participant potters. Images extracted from the Cápsula de Alfareros available on YouTube.

At the end of the Workshop, a course participants survey measured the social and cultural impact of the Knowledge dialogue. With the information collected, it was possible to interpret and define the main sociocultural aspects to subsequently apply service-learning methodologies and active and significant learning with a two-way impact on the geological and paleontological knowledge of the territory.

A visit was made to an interactive workshop in the municipality of Raquirá, Boyacá, where the members of ASOAMME had the opportunity to talk with master artisans with extensive experience in pottery, and they shared generational experiences and life stories of this craft. In addition, strengths, weaknesses, and opportunities for entrepreneurship with handicrafts were discussed, incorporating original designs, diversifying products, using lathes for rapid molding combined with manual molding, trying to preserve the mystique of the artisanal process to create a market niche, giving a differential character to their products in attributes such as artisanal value and traditional indigenous heritage (Figure 6). One of the testimonies from a female potter about the experience of visiting Raquirá, Boyacá, and the interactive Workshop says:

"You get so excited, super, at the wonder of how they make their utensils, how they do it from scratch to the finished product, the commercialization; it is a wonderful place... We come from Sogamoso, an amazing experience, making bricks and tiles, and how beautiful... adding another added value like utilitarian purposes, adding another added value like tourism, adding another added value like our ancestors, really wonderful, coming to visit older people who also tell us the story of the ancestral heritage of handling clay."



Figure 6. Community Immersion in Rural Social Innovation Practices.

#### Discusion

ASOAMME is a group of women from three consecutive generations who seek to revive the traditional pottery craft. Most of the participants are older women who share experiences of growth in a male-dominated culture with limited opportunities for personal development, and they are the ones who hold the most information about the traditional pottery process. The common denominator for the older generation of women in the group is a lack of opportunities since childhood, limitations in accessing education, economic and financial vulnerability, and a lack of recognition for their work outside their roles as mothers and wives. This scenario causes younger people to prefer seeking other opportunities, trades, and professions that require less effort and are better paid.

The members of ASOAMME are committed to dedicating time and effort to train and recover ancestral techniques used by their ancestors. Their goal is to produce quality pieces that can compete in markets already established in other parts of the province of Boyacá and the country. The challenge is taken from their personal life stories as a source of creative inspiration, using their skills and talents to mold and produce handicrafts from clay, representing an alternative that can be sustainable in the future, strengthening female empowerment in this maledominated sector. However, reaching the goal has, among other challenges, the investment of resources, the appropriation of scientific knowledge about their product, the improvement of the technological process, innovation in the design of ceramic pieces, and the strengthening of their marketing process.

This case study represents an interdisciplinary and interinstitutional experience where common objectives and mission-oriented approaches converge to build a sustainable environment that recognizes the women potters of the ASOAMME Association as the true protagonists of their territory. The academic connection goes beyond mere dissemination and professional training, aiming to connect these women with other perspectives, potters from other provinces, and successful ventures. Additionally, each component explored during the workshops delves into the unique aspects of each case, inviting the women to recognize their own identity values without compromising their ancestral knowledge. Ultimately, researchers play a guiding role, encouraging the women to discover that distinctive character in their ceramic pieces.

In response to this problem and with the development of the project, it was proposed that from social geology, the service-learning methodology (ApS) would be addressed to energize the relationship with the Community, vindicate the role of women and train professionals. In addition, within the framework of collaboration between the University of Alcalá (UAH), Carlos III University of Madrid (UC3M), and UPTC, an experience was developed that encompasses problem-solving based on community experiences. A workshop on storytelling and modeling with the Community of women was implemented as a cooperative and collaborative learning method. The experience was an opportunity for reflection and commitment between the University and Society, contributing to community well-being and student learning.

From a scientific and technical perspective, a synergy was created that allowed support from academia for women in understanding the raw material - clay - and through their life stories to demonstrate their importance within the productive chain and involve the pottery tradition towards a culture of economic, social, and environmental sustainability. This involves linking culture and pre-Hispanic heritage, recognizing artistic expressions or traits characteristic of their lifestyle, and contrasting them with knowledge acquired in the last century (Núñez & Barzuna, 2017). Cultural heritage and ancestral knowledge are fundamental parts of the identity and history of a community that should be valued, respected, and protected as part of our shared legacy as human beings.

The results of the project research implementation have allowed us to identify some causes of the fracturing of pieces during the drying and firing process, such as the lack of temperature control during the firing of the pieces. Technical recommendations have been delivered and socialized to avoid mixtures between clay levels and control temperature and firing times. In addition, knowledge of molding pieces was contributed through workshops that include concepts about proportions, colors, shapes, and the representation of pieces inspired by fossil organisms, indigenous culture elements, and rural environment elements. This allows them to innovate in their pieces' design and achieve unique products with their own stamp from the sector. The need to seek support in the marketing stage of improved products was also identified.

The diversification of products explored in one of the workshops is a response to the need for thinking outside the box and establishing a market different from traditional roofing tiles or bricks. Financial sustainability within this economic niche is crucial, especially considering the vulnerability context faced by women, as it allows them to generate their own income. As a strategy to balance the economic component with the artisanal value, exercises were conducted during which two ceramic pieces were presented to association members. The material was described from a utilitarian perspective, and questions related to design and finishes were posed. Importantly, the price and context of the

ceramic pieces—whether they were artisanal or mass-produced—were intentionally omitted.

In most cases, the women perceived the massproduced piece as the most expensive due to its intricate details and glossy glazes. Conversely, pieces with asymmetrical geometric details or matte finishes were often considered second-rate. However, when the workshop group provided their estimated prices, they were surprised to learn that these unique crafts, imbued with social and historical significance, held differential commercial value. These pieces, characterized by low production, storytelling, and the artisan's hands-on work, stood out. In this context, academia provides guidance to ASOAMME from various perspectives, but ultimately, the women themselves make the decisions. It's a valuable example of how interdisciplinary collaboration can empower communities and highlight the intrinsic value of their artisanal work.

From the perspective of university extension, an opportunity for curricular updating is generated in the geological engineering program at UPTC where the socio-humanistic component is combined with the engineering component to promote cooperation between Society and academia by addressing social and technological problems, thus promoting multidisciplinarity.

Furthermore, the community strategy contributed to raising awareness, disseminating, and promoting the SDGs, particularly in reducing gender gaps in access to opportunities, and vindicated the role of women in activities such as mining and pottery. In addition, the participation of the University Museum of Geological Engineering -MUIGand the Archaeological Museum -MAESC- was the space for adaptation and female empowerment by providing them with technical and scientific information in a dynamic language using information and communication technologies. Due to the crisis generated by the COVID-19 pandemic, economic, social, political, and educational problems were identified from different scenarios;

however, currently, for us as researchers, it has been considered an opportunity to generate environments for social appropriation of knowledge on different topics, for example, the 2030 Agenda, geologicalpaleontological knowledge, arts, history, culture, developing skills and abilities for the pottery craft. The dialogue of knowledge was the space for the Community to identify its social problems from a social geology perspective

Social innovation was an optimal tool for appropriating science and technology because it is a social process based on producing and exchanging knowledge among multiple actors (Jaramillo et al., 2005). Furthermore, involving the Community in social innovation processes is pertinent because many investigations fail to communicate the results beyond the scientific Community (Ramirez, 2021). Before this background, the approaches must identify motivations for a change. e.g., personal, economic, family, intellectual, or environmental. Is it out of curiosity or a feeling of identification, prestige, or recognition? (Hernández et al., 2016; Ramirez, 2021).

It is necessary to continue implementing the service-learning methodology in other subjects of the geological engineering curriculum so that it is not only technically solid but also prepares students to address social and technological challenges in an ethical and multidisciplinary manner, fostering cooperation between Society and academia. Teachers must train themselves permanently, continuously, and in an interdisciplinary manner, in addition to learning how to relate to the current multicultural student body and new education techniques that involve knowledge of group dynamics psychology, among others. Furthermore, we learn to understand specific social problems and challenges, know committed associations and individuals, have a realistic vision of the world we live in, acquire skills in project management and competence of the service itself, hobbies and personal abilities, be able to link curricular elements to social ones and build through research processes an inclusive model close to everyday reality.

The great challenge is to rethink human values, critical consciousness, commitment, teamwork abilities, prosocial attitudes, and communicative skills in our students and ourselves. This takes on relevance from the university context because this type of model should be implicit in the work of each higher education institution. However, there are difficulties in materializing it, thus causing a low level of appropriation of the integrative competencies of university culture as cognitive, emotional, and communicative abilities that guide the action of its actors. The appropriation of ApS (Service-Learning) projects depends on student motivation; at UPTC (Pedagogical and Technological University of Colombia), autonomy is supported in carrying out innovative and creative initiatives applied to reality, observing the repercussions in their environment and themselves. Teachers have a mission to be transformative agents in educational practices, placing students at the center of planning, which implies a dynamic and innovative effort to improve the teaching-learning process (Francisco Amat & Moliner Miravet, 2010).

### Conclusions

The application of social geology, social innovation with the double diamond methodology, social geology, and service-learning methodologies generated spaces for interaction between women and academia; they also contributed to the recovery of historical memory of the pottery process and reduced the communication gap. The findings represent the starting point for comparing current processes with their ancestors. The convergence between communities highlighted the importance of artisanal processes and allowed for the inclusion of improvement processes in productive terms that vindicate the role of women and communities in general. A town that knows its heritage from the population strengthens itself in managing its development. University students, children, and adults are, in themselves, the living heart of a society. With sufficient resources and relevant guidance, women can generate new knowledge that is impactful, aesthetic, and innovative. Creative and artistic skills are developed, which allows for shared knowledge.

As students take the lead and act as guides, they learn to communicate with people of different genders, ages, and educational levels. Barriers between the technical and the Community are broken down, overcoming social fears. Professional relationships with the Community are improved, doubts are dispelled, and they learn to put themselves in someone else's shoes, developing empathy.

This experience facilitated the creation of spaces and mechanisms for participation by providing technical inputs from the specificity of each sector with a vision of development tailored to the most vulnerable areas and rural communities. People identified actions for sustainability through recognizing potential, motivations for change, and geological-paleontological heritage. Traditional restrictions on access to specialized topics in cooperation with academia decreased.

Sustainable development has two educational objectives: to live within the limits of nature and to preserve social welfare, everything under a scheme of public policies based on economic, scientific, and technological development. The negative impact of the COVID-19 pandemic on compliance with the SDGs is undeniable. We need to continue promoting them through financing, adapting awareness about sustainable development, and designing tools adapted to the reality of the countries. This experience facilitated the creation of spaces and mechanisms for participation, providing technical input from the specificity of each sector with a vision of development that was adjusted to the most vulnerable areas and rural communities. People identified actions for sustainability through

recognition of the potential, the motivations for the change, and the geological-paleontological heritage. They decreased the traditional restrictions on access to specialized topics in cooperation with the academy.

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