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PAPER

Global Shared Learning Classroom Model: A Pedagogical Strategy for Sustainable Competencies Development in Higher Education

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ABSTRACT

One of the most popular strategies to develop skills such as collaborative work, critical thinking, and problem-solving is the application of COIL (Collaborative Online International Learning) through a Global Shared Learning Classroom in which professors from at least two universities from different countries and cultures develop a period known as "Global Classroom" in which, through the Challenge Based Learning didactic technique, they solve a real-life challenge, but from a distance, using digital communication tools. In this study, 4-week global courses were held between groups from the Tecnológico de Monterrey in Mexico and groups from the Corporación Universitaria Minuto de Dios – UNIMINUTO in Colombia. The challenges developed were related to two fundamental issues: 1) management of natural resources and climate change and 2) biomimetics. Students were able to develop skills to communicate effectively through online interaction with people from different cultures and disciplines and use technological tools that facilitate communication and distance learning in multicultural virtual environments. The use of Global Classroom in their respective areas of study is made available to those interested as a valuable tool to provide students with the opportunity to live sustainable international experiences and promote the sustainable development goals. Current teaching models involve active and experiential learning and developing soft and hard skills. The Global Shared Learning Classroom experience is a tool that allowed continuity in the preparation of students during the COVID-19 pandemic.

KEYWORDS

digital competencies badge, educational innovation, higher education, socially oriented education, STEM, Global Shared Learning Classroom

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1 INTRODUCTION

When digital systems began to appear at the end of the 20th century, getting to know different cultures and places in the world through the internet became feasible for many people. This also triggered and facilitated the globalization of many markets, trade, and the economy. At the same time, the opportunities for the internationalization of higher education studies began to appear as a competitive opportunity. However, only students with financial capacity or access to scholarships could afford education at great institutions. It is then that the alternative of being able to have a digital international educational experience began to take shape. So, a novel strategy in teaching-learning called Collaborative Online International Learning (COIL) appeared. It was defined as a pedagogical resource employed to create an environment to foster the development of intercultural competence skills with the use of technology to connect classrooms in distinct geographical locations [1]. It is characterized by experiential international learning through communication technologies and online interaction with a shared syllabus, course material, or outcomes among faculty members [1, 2]. Villar-Onrubia & Rajpal established four key elements defining any COIL [2] (Table 1). The nonmonetary return on investment in COIL is one of its main benefits [3] (Table 2).

Table 1. Main components of COIL [2]

Element	Description
Cross-border collaboration	Interaction with people from different backgrounds and cultures
Student engagement	Synchronous/synchronous online interaction
Reflective component	It helps students to think critically.
Internationalized learning outcomes	Developing global perspectives and fostering students´ intercultural competencies

Table 2. Benefits and shortcomings of COIL [3]

Benefits	Shortcomings
Engagement Interdisciplinary nature Student and staff development International and professional collaboration Economic profits and resource savings A conversation that leads to other forms of collaboration	Issues of technology Quality assurance systems Lack of technical and administrative support Different • Time zones • Languages • Institutional cultures and expectations • Academic semester and requirements • Course contents • Assessments of learning

Global Classroom (GC) can be classified as part of the COIL strategy. Searching for reports using GC in the SCOPUS database indicates that the idea is not new (Figure 1a), but it was not until the development of the Collaborative Online International Learning theory (Figure 1b); and since the start of COVID-19 pandemic, the technologies developed for this purpose began to blossom.

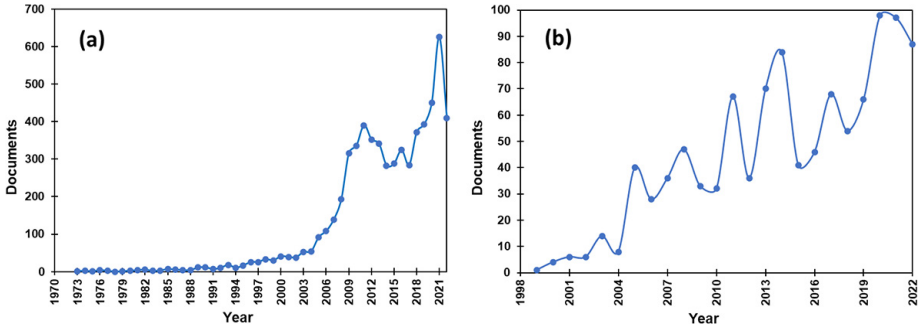

Fig. 1. Results of documents in SCOPUS by year of the search sequence a) global classroom and b) collaborative online international learning

Before the pandemic, educational platforms such as Zoom, Teams, and Google Meets were underused in teaching-learning. Learning management systems (such as Blackboard, CANVAS, and Moodle) were used only to manage face-to-face classes. In blended learning (face-to-face and digital), the best approach to a global classroom, the digital part was used only for team collaboration. There were no guidelines to define the necessary elements for online experiential learning. Little by little, with the increasing information available online, autonomous learning began to become evident. It is very interesting that in SCOPUS, only 1069 results of COIL appear, while for GC, there appear 6168 results, of which 3147 are from the year 2015.

On the other hand, sustainability in its three dimensions (social, economic, and environmental) has been established in the discussion as a priority in society. The 17 Sustainable Development Goals (SDGs) are a call to sustainability promotion by the United Nations member states to address the most critical troubles the current world faces [4]. From being a concept, it has become a public policy of extreme urgency in its application to lifelong competence [5]. Sustainability transcends disciplines and has increasingly become a graduation skill for any undergraduate degree, whether in the arts, natural sciences, engineering, or social sciences. Even though sustainability has not been systematically established as competence in many higher education programs [5], universities have isolated efforts that have created programs explicitly focused on sustainability [6]. There is no doubt that sustainable skills are a must in educational programs. So, more and more universities are developing programs that consider developing sustainable skills and SDGs closer to educational programs, trying to make sustainability transcend all programs, regardless of the career, through sustainability skills as a graduation requirement. As part of the assistance of UNESCO to the integration of SDGs into education, a set of critical competencies have been outlined for advancing sustainability, such as systems-thinking competency, anticipatory competency, normative competency, strategic competency, collaboration competency, critical-thinking competency, self-awareness competency and integrated problem-solving competency [7]. However, not all higher education institutions have adopted the mentioned competencies, and many do not have a consensus framework of key competencies in sustainability, although convergence has been searched [8]. In this way, the same program of different higher education institutions may have declared other competencies, which would be helpful to "standardize" or "share" them between universities. GC may be a valuable element for sharing and homologizing sustainability competencies. If substantial differences are present between the two programs, the assessment of these may be attended using digital badges. Digital badges are acknowledged displays in an online format for recognizing the achievement of skills/competencies [9]. These have been cited as

motivational elements with associated high-quality feedback and turning students into active learners with ownership of their learning [9, 10].

The main objective of this research was to evaluate the potential of the GC in achieving sustainable competencies attached to the development of the SDGs in an international environment with two distant higher education institutions. The competency development indicators to use were the development of deliverables, collaborative work, problem-solving strategies, and a final reflection on the resolution of the challenge and the overall experience, recognizing the acquisition of sustainable competencies with a digital badge. This analysis was carried out after the onset of the COVID-19 pandemic, which facilitated the use of digital tools by students who already had developed some digital skills.

2 METHODOLOGY

In this research, we wanted to examine the potential of the application of GC in the development of sustainable skills and whether, through GC, sustainable competencies could be transferred to other universities. For this purpose, three tools were used. The primary tool was synchronous digital communication (SDC), an educational strategy carried out through technological tools that allow students to develop other transversal skills such as digital knowledge, collaborative work, critical thinking, and oral and written expression. GC typically consists of a collaborative international online learning (COIL) strategy. Secondly, the challenge-based learning (CBL) didactic technique was used to establish a challenge with sustainability topics and try to solve it in hybrid teams with students from both universities combined with students of all science, technology, engineering, and mathematics (STEM) careers. It is necessary to confront students with lived experiences to obtain more lasting knowledge.

In addition, we implemented the use of competency digital badges to promote the engagement of the students (www.badgr.com). On the one hand, a GC interaction was conducted to establish whether the same conceptualization existed on sustainable development and climate change. On the other, the environmental problems of both geographical regions were analyzed, a common agenda was established, and the corresponding SDCs were addressed. Both exercises consisted of guest speakers, space for collaborative work, the construction of a solution, and a final reflection.

2.1 Global shared learning classroom

This GC experience is based on COIL, a teaching and learning methodology developed by Jon Rubin at the State University of New York (SUNY) (see Figure 2). The COIL consisted of three very well-defined stages: the icebreaker, which is a stage of presentation of the challenge; a personal introduction; and an international interaction between the students and the teachers involved. Once the collaborative work was established, the solution strategies of the problem were then designed; this stage included several physical deliverables in which there was collaborative work between team members. In the end, a video of reflection and self-assessment of the course by the student was uploaded to the Padlet application.

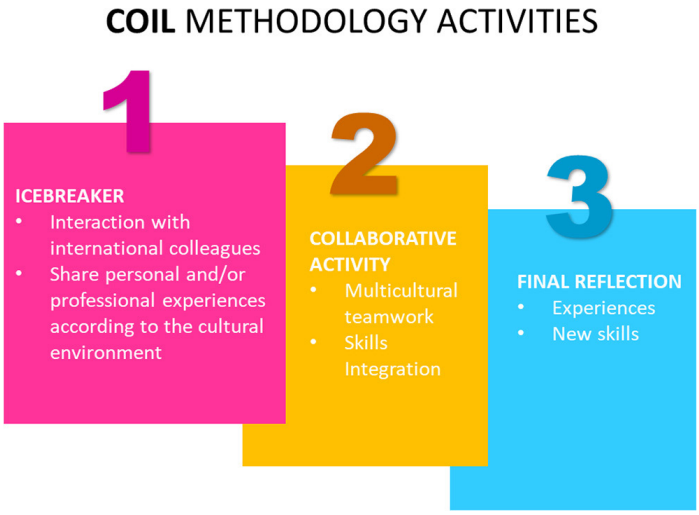

Fig. 2. COIL methodology implemented in this work

An additional benefit to the GC experience was obtaining the international GC badge, determining that the experience brought together students from different cultures, nationalities, and academic profiles, where they collaborated closely through elements that promoted the development of skills and meaningful learning in intercultural online environments. Skills reinforced critical thinking, ethics, decision-making, global perspective, collaborative work in intercultural online environments, and effective communication. The Vice-Rectory for International Affairs at Tecnologico de Monterrey issued the badge, having established that the criteria for earning it are that the recipient must have completed the GC experience through the COIL methodology as part of the Biomimetics and Sustainable Development courses or the Natural Resources course of the Tecnologico de Monterrey (Mexico) and the Soil Ecology course of the Corporación Universitaria Minuto de Dios – UNIMINUTO (Colombia) (https://badgr.com/public/badges/YGDRpUZkRrGIbXfBXIcoAw)

2.2 GC natural resources and climate change

Activities were implemented to establish the characteristics of natural resources in Mexican and Colombian ecosystems, detecting the importance of environmental services. From March 25 to April 22, 2021, the action took place, with students divided into mixed teams. The didactic strategy consisted of an icebreaker activity, didactic presentations, and a final reflection, together with the delivery of documents, posters, and videos evaluated through rubrics to award a digital badge. Digital tools such as Zoom, Padlet, and Kahoot were utilized.

A 4-week sustainability course was carried out using the GC tool of the Tecnologico de Monterrey, with students from the Mexico City Campus, and the Zipaquirá Campus of the Corporación Universitaria Minuto de Dios – UNIMINUTO in Colombia. Work was carried out through the pedagogical technique of challenge-based learning (CBL) in which the student was challenged to design an ecosystem management plan respecting the fulfillment of the SDGs, applying the concepts of climate change, causes, consequences, and mitigation actions.

2.3 GC biomimetics course

The biomimetics challenge was carried out similarly to the course on natural resources. The two courses were held for seven weeks in the spring and fall semesters of 2021, one class per week. The specific challenge of these two courses was to answer the question: What can we solve with the knowledge of the properties of the carnivorous plant Nepenthes? First, students had to understand what biomimicry applications existed with other plant systems and propose a new application for the assigned plant system, considering the nature-inspired design spiral [11] SDGs and environmental responsibility.

2.4 Skills to develop in COIL courses

The evaluation of the competencies was carried out using evaluation techniques such as interviews and questionnaires, as well as presentations with evaluation instruments such as compliance rubrics and oral presentations. The competencies to be evaluated were both transversal (collaborative work, critical thinking, problem-solving) and disciplinary (sustainability concepts, biomimetics, plant physiology, and application of compliance actions to the SDGs). Internal and external evaluators had checklists for the evaluation.

3 RESULTS

3.1 Natural resources global classroom experience

A critical part of natural resources is the environmental services that refer to the benefits that biodiversity generates for us. From maintaining the climate, renewing farmland, and pollination, to ecotourism, human beings benefit from these services [12]. Just because they are provided by nature does not mean they are free. Because we humans have not been willing to pay for services, we have taken advantage; but little by little, biodiversity has diminished its supplies.

The different links generated by natural resources about the human being, such as energy-water-food or growth-poverty-inequality, and the paradigms that emanate from them have direct applications to the objectives of sustainable development [13] and help develop an awareness of self and others and anticipation skills. Knowledge of the value of environmental services and asking questions regarding the uncertainty of their destiny can promote the emergence of strategic plans or, at least, the development of strategic skills to deal with today's challenges.

A particular case of environmental services is the Integrated Urban Hydrometeorological, Climate, and Environmental Services (IUS) initiative of the World Meteorological Organization (WMO), within the framework of SDG 11: *sustainable cities and communities*, to produce and provide said services for the development of smart cities [14]. The initiative studies the possible natural hazards in a city (e.g., typhoons) to understand the cascade of events that they can trigger, make informed decisions, and assign shared responsibilities to act in that case. Currently, there are more than 22 cities, including Mexico City, in which IUS has been implemented. It has been shown that the participation of the entire society (scientific disciplines, jurisdictions, organizations, authorities, and government) is necessary, as well as

open data, infrastructure, communication, and long-term planning, to overcome the challenges that nature is currently facing [14].

Another case is urban environmental services, such as solid-waste disposal, recycling, public transportation, drainage and water treatment, and maintenance of green areas. It is necessary to recognize the educational value of such services, for example, in protecting cultural heritage, to assign an economic value to it. This will be achieved over the years, beginning with their recognition and compensation at the behavioral and intellectual levels [15].

Specifically, at the end of this challenge, the students teams delivered a scientific manuscript-type document in which, after having carried out the research and analysis of both ecosystems (Mexican and Colombian), they reaffirmed the importance of ecosystems as a means of balance for life on the planet. As one of these documents affirms: "*Our life and human activities depend totally on the ecosystems that surround us; when these are in danger, it presents a great disruption in the environment that threatens the various forms of life and the human being. It is essential to redouble efforts to conserve the planet's ecosystems and mitigate human activities' effects on them to ensure the survival of all species on Earth*".

3.2 Biomimicry global classroom experience

Biomimetics (from the ancient Greek *bios*, life, and *mīmēsis*, imitation), it could be said, is one of the benefits we have obtained from the environment surrounding us. It is considered an ecosystem service to achieve the SDGs [16]. Biomimicry is the science that studies how nature has survived for 3.8 billion years, in part, by organisms using strategies to obtain elements from their environment that they can use for their survival. Biomimicry has been used by insects, which have great potential to help humans address global challenges [16] and develop theories for the use of natural principles for survival [17]. It has been considered a scientific discipline, problem-solving plan, creativity technique, and innovation strategy [18]. Specific examples are bacteria, plants, aquatic animals, birds, seashells, and biological systems [19].

Just as these examples were developed by university-trained biologists or engineers asking themselves research questions, universities also take these inventions as a model to teach students how nature works [20]. Competencies such as life-cycle, values, and system thinking are developed in this case.

In biomimicry, knowledge of biology and engineering is required, as well as the development of creative competencies, to develop solutions based on nature [20]. Courses related to biomimicry are usually given in certificates or postgraduate studies. Understanding and creating are the main dimensions of the cognitive process that involve learning objectives of design courses based on biodiversity, which intersect with conceptual and meta-cognitive knowledge [21]. Most classes have design processes. Some researchers mention that products developed from biomimetics can contribute to more sustainable human development [21]. At this stage, the engagement of stakeholders plays a vital role in developing sustainable solutions to society's problems.

A particular case of biomimetics is a branch of research that seeks to accelerate biomedical innovation in life-burden diseases related to aging, such as hypertension, diabetes, obesity, coronary and neurodegenerative diseases, and cancer [22]. Case studies of long-lived animals, such as the elephant and some types of rats, bats, and sharks, which through their evolution have adapted to environmental conditions, are suitable for biomimetic studies of this nature. Current climatic conditions

suggest this type of study – for example, how to survive a lack of oxygen or oxidative stress – that we can learn from nature [22].

Specifically, the students involved in this challenge studied tropical pitcher carnivorous plants (*Nepenthes* spp.) and generated a biomimetic application to solve a problem in their region (see Figure 3).

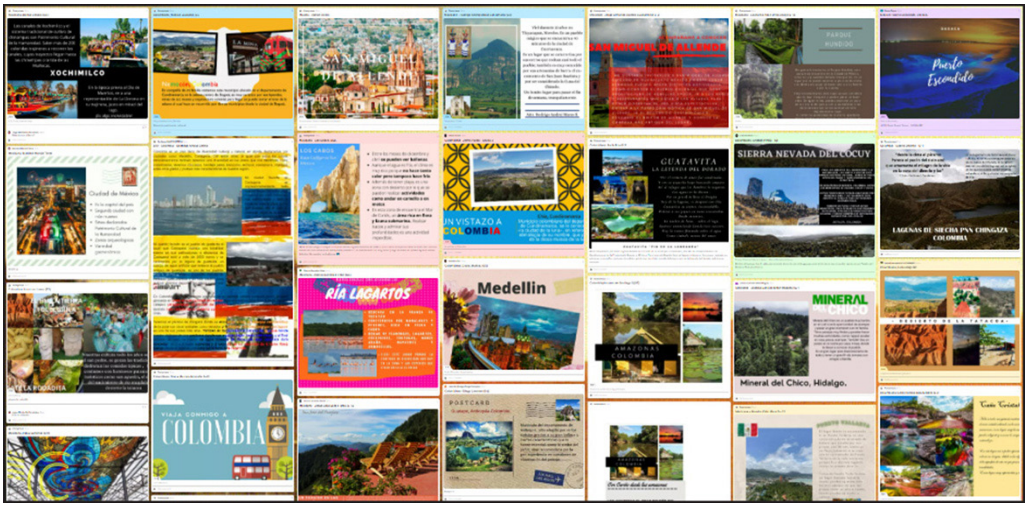

Fig. 3. Images of the icebreaker activity of the Nepenthes challenge students

Some responses, which can be a source of future research projects, from the students were as follows:

- Place aggressive bacteria like Nepenthes in soils used in agriculture to prevent soil contamination, improving crop quality.
- Generate a natural and beneficial food preservative for the health from the enzymes that can be found in the digestive cocktail of Nepenthes.
- Germinate Nepenthes seeds in these agricultural areas since these attract insects to your vases, thus decreasing the use of chemicals in soils.
- Develop a sole with topography inspired by the surface of the Nepenthes plant and use this same property for the coating of the footwear, to repel the water that may fall on them.
- Create and manufacture a biodegradable mask made with nanofibers extracted from the serum of milk and polyethylene oxide based on the macroscopic structure of Nepenthes.
- Manufacture a compound that can be applied on the surface of the lenses that avoids the adhesion of liquid compounds that can affect the field of vision.

3.3 The takeaway of this experience: a new step in green education

This work aimed to address a just, enriching, multicultural, and multidisciplinary experience through COIL and other digital tools during the COVID-19 pandemic to pursue the development of sustainability competencies.

The students were able to understand and transmit the knowledge and importance of natural resources and biomimetics in their respective countries in a global context, identifying the most significant sustainability problems and how, from their area of study, they could contribute to eradicating them, generating informative

material on environmental services and biomimetics. In the environmental systems class, only two students did not receive the digital badge due to poor participation in the activities.

The students were also instructed in the generation of challenges. We believe that this type of pedagogy is going to be the next step in higher education, where more schemes of experiential and adaptive education "*à la carte*" will be necessary to face increasingly complex and interdisciplinary challenges. We foresee the era where society's problems most likely determine the skills of higher education graduates; what we experienced during the COVID-19 pandemic was a dramatic example where digital skills, almost ignored before, were required in many jobs. Understanding and attending to our problems and tasks at the door is necessary to improve our lifestyle. The best tool, without a doubt, is education. With this same aim, the world's problems must be addressed to trigger future strategies for uncertain scenarios.

Regarding sustainability, even though there are isolated efforts to create sustainable skills in students, systematic education or some subject related to the various dimensions of sustainability is required. It is intended that the subject of biomimetics and sustainability be transversal. However, it is not very well promoted in nonengineering careers, as many think that sustainability has only to do with "green things".

3.4 Global shared learning classroom – COIL challenges to be addressed

As observed, COIL is an approach that can make education more equitable. COIL is a valuable tool in promoting the sustainable development agenda that universities from the first world or the northern hemisphere mainly use when collaborating with universities from the southern hemisphere.

Some of the questions arising from this GC initiative are how to evaluate competencies differently for both types of university. What is the basic knowledge to be evaluated? How is the student evaluated? For this analysis, GC offers this opportunity to compare defined sustainable competencies and redefine them. In the first approach, it is possible to generate a consensus between teachers before the course execution, as in our GC experience. Similarly, basic knowledge must be standardized, trying to combine and cover the contents of both courses. As observed, aligning competencies and basic knowledge is part of the design activities of the GC experience. Little has been said about evaluation in COIL. It may be a substantial aspect due to the differences in competencies and the use of adequate evaluation instruments. In this sense, Swan and collaborators have proposed a rethinking of the assessment process and recommend three categories for COIL evaluation: collaborative discussion, collaboration in small groups, and collaborative design of assessments. The preparation of rubrics for identifying behaviors is highly suggested [23].

Until today, COIL or GC has been applied in subjects of languages, nature [24], engineering [25], and social sciences [26, 27], which has implied that teachers have a diverse curriculum or formation, mainly specialized on the topics of their fields. Another doubt related to the success of COIL/GC strategies is if teacher readiness in digital competencies is necessary for this strategy and if the teacher must have a determinate profile.

Incorporating other technological resources into the GC or COIL courses will also improve them. In this sense, the use of educational software would undoubtedly enrich the learning experience in GC. For sustainability purposes, software that can increase good experiences in GC is EduPack software developed by Cambridge

University. This software can assist in materials, engineering, design, science, and sustainable development courses. The software includes a complete database of manufacturing processes, material properties, and eco-properties (embodied energy, carbon footprint, and water use), sustainability (sourcing and criticality of elements, material legislation, regulation, geoeconomic and social conditions, energy generation, and storage. Eco and Social Life-Cycle Assessment Audit Tools are included [28]. EduPack is already used in colleges and universities worldwide, with positive comments [29].

From a future perspective, GC may integrate the Metaverse to improve the students' engagement in the course. Remember, Metaverse is an interconnected web and immersive environment combining physical and digital realities across technological tools such as augmented and virtual realities [30]. Although some exercises approaching Metaverse and COIL have already been performed, this is not a reality yet for complete undergraduate courses and much less for developing sustainable competencies. For example, the Frame Virtual Reality (VR) metaverse platform was implemented in the fall semester of 2021 in English courses at two universities in South Korea, indicating that four digital competencies (creativity, communication, critical thinking, and creativity) were slightly improved between a pre- and a post-survey [31]. These [32] and other internet applications could add insights to the paradigm of education as a service [33].

4 CONCLUSION

Currently, the use of COIL in the university to promote a sustainable agenda has been scarce. In this work, a COIL approach is presented. The use of a GC in stakeholders' respective areas of study is made available to them as a valuable tool to provide students with the opportunity to live sustainable international experiences.

During the development of this work, students were able to develop sustainability competencies and skills to communicate effectively through online interaction with people from different cultures and disciplines, showing pride in their national identity and respect for the richness and characteristics of other cultures and the use of technological tools that facilitate communication and distance learning in multicultural virtual environments.

Very interestingly, we can report that the students indeed appreciated that the conceptualization of sustainability could give a better perspective for the professional questions they will face in the future. The expansion in the number of perspectives on sustainability principles increased awareness and appreciation of sustainable processes. Our results strongly suggest that COIL strategies, such as GC, are essential to developing sustainability competencies globally.

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