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**TRABAJO DE FIN DE MÁSTER**

HOW TO IMPLEMENT INQUIRY-BASED LEARNING THROUGH THE USE OF SERIOUS  
GAMES IN THE IB ECONOMICS PROGRAM?

DIDACTIC UNIT

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## **Abstract**

Since the Industrial Revolution the way of production and consumption changed dramatically leading to what is known as the Linear Economy. The consequences of this way of production and consumption are inducing multiple corporations and non-governmental organizations, such as the UNESCO and the COP27, to promote actions to address the multiple planetary challenges. One of its initiatives is inviting the educational sector to be part of a sustainable agenda, since schools are the outstanding arena to promote a sustainable mindset and contribute to a more profound social change. The present study develops an educational Unit Planner based on the Inquiry-based teaching and learning approach, in which the game-based learning methodology is implemented by using the ecoCEO game. This serious game allows to teach about the benefits, the complexity, and the importance of Circular Economy in today's world. The didactic proposal that has been developed collects both the values provided by the Circular Economy approach and the profile of the International Baccalaureate (IB) community. The work has been framed within the subject of Economics of the Diploma Program, under the following inquiry question: How a country's economy could thrive without depending on the overuse of finite resources and still meet people's needs? The Unit Planner aims to offer a didactic tool to teachers and enhance the subject curriculum in relation with sustainability, in order to improve the student learning.

*Key words: IB teaching, International Baccalaureate, Inquiry-based learning, Experiential Learning, Game-based learning, Circular Economy, Education for Sustainable Education, Sustainability, ecoCEO game.*

## **Resumen**

A partir de la Revolución Industrial la forma de producción y consumo cambió radicalmente dando lugar a lo que se conoce como Economía Lineal. Las consecuencias de esta forma de producción y consumo están induciendo a múltiples corporaciones y organizaciones no gubernamentales, como la UNESCO y la COP27, a impulsar acciones para enfrentar los múltiples desafíos planetarios. Una de sus iniciativas es invitar al sector educativo a formar parte de una agenda sostenible, ya que las escuelas son un escenario oportuno que permite promover una mentalidad sostenible y de esta manera contribuir a un cambio social más profundo. El presente estudio desarrolla una Unidad Didáctica fundado en el enfoque de enseñanza y aprendizaje basado en la Indagación, en el cual se implementa la metodología de aprendizaje basado en juegos, el juego propuesto es ecoCEO. Este juego educativo permite enseñar sobre los beneficios, la complejidad y la importancia de la Economía Circular en el mundo actual. La propuesta didáctica que se ha desarrollado recoge tanto los valores que aporta el enfoque de Economía Circular como el perfil de la comunidad del Bachillerato Internacional (IB). El trabajo se ha enmarcado dentro de la asignatura de Economía del Programa del Diploma, bajo la siguiente pregunta de indagación: ¿Cómo podría prosperar la economía de un país sin depender del uso excesivo de recursos finitos y aun así satisfacer las necesidades de las personas? La Unidad Didáctica tiene como objetivo ofrecer una herramienta pedagógica a los docentes y aportar con un nuevo instrumento que enriquezca el currículo de la asignatura en relación con la sustentabilidad, con el fin de mejorar el aprendizaje de los estudiantes.

*Palabras clave: enseñanza IB, International Baccalaureate, Aprendizaje basado en la indagación, Aprendizaje basado en la experiencia, Aprendizaje basado en juegos, Economía Circular, Educación para la sustentabilidad, Sustentabilidad, juego ecoCEO.*

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## 1. PART I

### a. Introduction

Before the Industrial Revolution societies lived in a closed system, where the term “waste”, “rubbish”, or “trash” were not used the way they do today. In those times what was broken was immediately fixed or repaired, the waste produced in one process became a resource in the next, food scraps were used to feed animals, and anything that was combustible was burnt for warmth. When the Industrial Revolution came into play the world was transformed and a new way of production and consumption was implemented: the Linear Economy. Since it has become easier and cheaper to produce and consume, people adopted the mentality to throw away the things they no longer need. Unfortunately, this practice has never been sustainable (Andrews, 2015).

In recent years, multiple corporations and non-governmental organizations have been working on projects which promote actions to address the many planetary challenges. These entities, such as UNESCO, invited the educational sector to be part of the sustainability agenda. As they argue “formal educational system is an appropriate arena to promote sustainability because it may influence students' worldviews and attitudes towards sustainability and contribute to a more profound social change” (Hermes & Rimanoczy, 2018). Additionally, in November 2022 Egypt hosted the 27th Conference of the Parties of the UNFCCC (COP27), where a four-year Action for Climate Empowerment (ACE) plan was endorsed. ACE’s aim is to empower “all members of society, including children and youth, to engage in climate action” (United Nations Climate Change, 2023). According to the organization, this longed for climate change action, start with climate change education.

This paper builds a design of an educational proposal that tries to respond to the call of UNESCO and COP27 to the educational sector to act in order to develop an Education for Sustainable Development. It is crucial that young learners are empowered to make informed decisions and take individual and collective actions that change society and care for the planet (UNESCO, 2022). The author is convinced that education plays an important role in supporting sustainability, and one of the ways to achieve this is through the transformation of the educational system, where new design skills are developed with a holistic and transdisciplinary thinking. The present study relies on previous research about Education for

Sustainable Development, Circular Economy and the Inquiry based approach to teaching and learning, and hypothesizes that serious games are a useful teaching tool which allows professors to teach about the benefits, the complexity, and the importance of Circular Economy. As well as relate the topic with government intervention, one of the themes of the IB Economics program.

The topic of circular economy has been chosen for its aforementioned importance in today's world. On the other hand, it has been selected to use games as a tool because Game Based Learning is part of Experiential Learning, which is a component of Inquiry Based Learning, one of the IB approaches to teaching. The goal is to provide an extra resource for IB economics teachers, which introduces students to the real-world issue 2 of Microeconomics: "When are markets unable to satisfy important economic objectives - and does government intervention help?" The Unit Planner revolves around the following inquiry question: How a country's economy could thrive without depending on the overuse of finite resources and still meet people's needs? And the subsequent key concepts: efficiency, equity, and sustainability. The didactic proposal is a great way to refresh students' knowledge about the circular economy and introduce them to the new topic, 2.7 Role of government in microeconomics. Furthermore, it is an excellent opportunity to delve into the advantages and limitations of the circular economy and its effect on externalities - market failures, which are the later topics. Additionally, a written reflection document is proposed as an assessment, this is an opportunity to introduce students for the internal assessment commentary, one of the main assessments on the IB Economics program.

The paper is divided into three main sections, the first one is focused on the Introduction, the International Baccalaureate Diploma Program and Economics, as one of its subjects, in order to give the reader a contextualized framework about the discipline where Circular Economy is taught. The second part contains a review of the literature about Circular Economy and Sustainable Development, Inquiry Based teaching, Education for Sustainable Development, Experiential Learning and Game Based Learning; in this section the reader finds the theoretical foundation for which it has been decided to implement Game Based Learning to deepen the knowledge about Circular Economy in the Diploma Program of the International Baccalaureate. Finally, the third part explains a case study of the ecoCEO



game for Circular Economy, the Unit Planner proposed, the simulation carried out, and the conclusions and recommendations for future studies.

## **b. International baccalaureate Diploma Program**

### **i. History**

The International Baccalaureate Program (IB) was founded in 1968 with the purpose of “facilitating the international mobility of students, by providing schools with a curriculum and qualifications recognized by universities around the world” (Stewart, 2011) and at the same time promote intercultural understanding and respect. Nowadays, the IB is a global leader in education, with the goal “to develop inquiring, knowledgeable, confident, and caring young people who help to create a better and more peaceful world through intercultural understanding and respect” (IBO, 2020). The IB program is Globally Recognized, according to the International Baccalaureate information provided to the SPC committee (2021), 156 countries apply the IB programs, there are 5,558 authorized IB schools around the world, 1,500,000 number of students with access to the four IB programs, and over 6,650 courses.

In 1994 the Middle Years Program was created and in 1997 the Primary Years Program was introduced to enrich the IB program. Later, in 2012 the Career-related Program was the last addition. These four IB programs, shown in figure 1, present a continuum curriculum for students aged 3 to 19. The courses can be implemented independently or in combination, “they all underpinned by shared values and a shared emphasis on developing students who are lifelong learners and who are able to not only make sense of, but to make a positive impact on, our complex and interconnected world” (IBO, 2020).



*Figure 1. The IB Continuum (IBO, 2020)*

In order to understand the IB philosophy, the organization suggests exploring the four foundational and interrelated elements of the four areas: international-mindedness; the IB learner profile; a broad, balanced, conceptual and connected curriculum; and the approaches to teaching and learning. All the IB programs allow students to develop an international-mindedness through the inquiry of local and global issues and ideas in order they can recognize the interconnection to others. The IB also wants students to engage with the community, so the programs aim to challenge students to think critically and to recognize that they hold this planet and its resources in trust for future generations, so they must create awareness and act to make a more peaceful and sustainable world for everyone. Additionally, the holistic nature of the IB is reflected on the ten attributes they want students to develop. They highlight the importance of curiosity and compassion, as well as the development of knowledge and skills; the program searches for cognitive development as well as social, emotional and physical well-being. The attributes are: inquirers, knowledgeable, thinkers, communicators, principled, open-minded, caring, risk-takers, balanced, and reflective.

Each program “provides a detailed and developmentally appropriate curriculum that is broad, balanced and conceptual” (IBO, 2020). The objective is to give students the tools in order to make connections, explore the relationship between academic disciplines, and “learn about the world in ways that reach beyond the scope of individual subjects” (IBO, 2020), allowing them to connect their learning to the world around them. The approaches to teaching and learning play a crucial role as they ensure that the aspirations of the IB

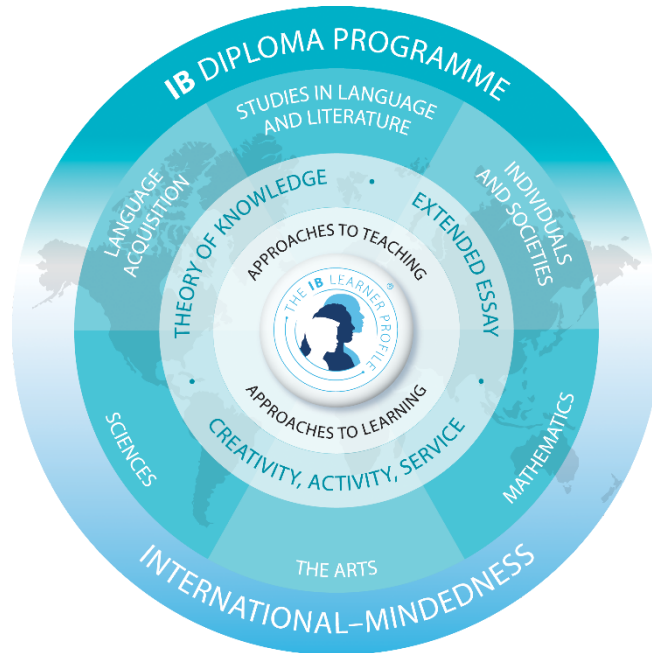
philosophy become a reality in the classroom, in the next section the approaches are going to be explained in depth.

## **ii. The Diploma Program (DP)**

The Diploma Program is a two-year meticulous curriculum designed for students between 16 and 19 years in order to prepare them for university entrance. The aim of the program is to “encourage students to be knowledgeable and inquiring” (International Baccalaureate Organization [IBO], 2020) and at the same time caring and compassionate; in order to boost an intercultural understanding, open-mindedness, and attitudes necessary to respect and evaluate a range of points of view.

The curriculum is made up of six subject groups and the core of the model, which includes Theory of Knowledge; Creativity, Activity, and Service; and the Extended Essay. Studies in language and literature, language acquisition, individuals and societies, sciences, mathematics, and arts are the subject groups, in each one the student can find different courses. Students are required to choose one subject of each of the six academic areas, although they can take two subjects from another area instead of an arts subject. Moreover, learners will take higher level (HL) and standard level (SL) subjects; the courses differ in the teaching hours (150 for SL and 240 for HL subjects) and the depth of the study (International Baccalaureate Organization, 2019). On the other hand, Theory of Knowledge (TOK); Creativity, Activity, and Service (CAS); and the extended essay make up the core of the model. TOK “is a course that is fundamentally about critical thinking and inquiry into the process of knowing rather than about learning a specific body of knowledge” (IBO, 2020). This subject encourages students to analyze knowledge claims and explore questions about the construction of knowledge; so that they can make connections between areas of shared knowledge and their personal knowledge in a way that they can become individuals who are aware of their own perspectives and how they might differ from others. On the other hand, the aim of CAS is that students flourish their identity in accordance with ethical principles, creative thinking, physical contributions, and unpaid and voluntary help. “CAS contributes to the IB’s mission to create a better and more peaceful world through intercultural understanding and respect” (IBO, 2020). Finally, the extended essay is an excellent opportunity to engage students to investigate a topic of their personal interest under the

guidance of a supervisor. The main purpose of the extended essay is to promote high-level research and writing skills, intellectual discovery and creativity; abilities required at university.



*Figure 2. IB Diploma Program (IBO, 2020)*

### **iii. Approaches to teaching and approaches to learning**

The IB Diploma Program adopts five approaches to learning and six approaches to teaching to enclose the key values and principles of the IB pedagogy.

Approaches to learning: developing (Verbatim from the original source):

- Thinking skills. Critical thinking, creative thinking and ethical thinking.
- Communication skills. Written and oral communication, effective listening, and formulating arguments.
- Self-management skills. Organizational skills (time and task management), affective skills (managing state of mind and motivation).
- Research skills. Comparing, contrasting, validating, and prioritizing information skills.
- Social skills. Forming and maintaining positive relationships, listening skills, and conflict resolution.

Approaches to teaching (Verbatim from the original source):

- Inquiry based. Students are required to find their own information and construct their own understandings.
- Conceptually focused. Concepts are explored in order to deepen disciplinary understanding and to help students make connections and transfer learning to new contexts.
- Contextualized. Developed in local and global contexts, the objective is to use real/life contexts and examples; students are encouraged to process new information by connecting it to their own experiences and to the world around them.
- Collaborative. Promotes teamwork and collaboration, between students and students and teachers.
- Differentiated. Remove barriers to learning. Teaching is inclusive and values diversity, the IB enables every student to develop and pursue appropriate personal goals.
- Informed by assessment. Assessment plays a crucial role in supporting, as well as measuring learning. This approach also recognizes the crucial role of providing effective feedback.

These approaches are linked with the learner profile attributes and seek to enhance and assist students for the DP assessment and beyond. According to the IB (IBO, 2020) the aims of approaches to teaching and learning are (Verbatim from the original source):

- Empower teachers as teachers of learners as well as teachers of content.
- Empower teachers to create clearer strategies for facilitating learning experiences in which students are more meaningfully engaged in structured inquiry and greater critical and creative thinking.
- Promote both the aims of individual subjects (making them more than course aspirations) and linking previously isolated knowledge (concurrency of learning).
- Encourage students to develop an explicit variety of skills that will equip them to continue to be actively engaged in learning after they leave school, and to help

them not only obtain university admission through better grades but also prepare for success during tertiary education and beyond.

- Enhance further the coherence and relevance of the students' Diploma Program experience
- Allow schools to identify the distinctive nature of an IB Diploma Program education, with its blend of idealism and practicality.

### **c. IB Economics**

#### **i. Nature of the subject**

Economics as one of the individual and societies subjects aims to help students understand the complexities and the interdependence of economic activities in a rapidly changing world. The economics course is divided into standard and high level, the main differences between them are the hours of teaching – 240 hours for HL and 150 to SL; the extended material for HL; and HL students develop quantitative skills and are assessed with an extra test. Nevertheless, both use economic theories and models to examine how society makes choices in order to face the main economic problem: scarcity – population has unlimited needs and wants, while there are limited resources to satisfy them. To tackle this issue, economic agents must make choices, which bring positive and negative effects directly affecting individuals and societies' well-being; and since economic theories propose that material well-being is achieved with the quantity of goods and services available to the society, economic growth and efficiency are the most important goals for nations. However, this mindset impacts the environment and challenges the policymakers to think in terms of fair access to resources, goods and services in order to achieve sustainability and equity. Students are expected to critically evaluate the values and limitations of economic models using real-world economic behavior and outcomes.

The Diploma Program grant students to explore these theories and models, apply them, and develop knowledge, skills, values and attitudes to encourage them to act as responsible global citizens through the inquiry of six real-world issues enveloped in nine key concepts (scarcity, choice, efficiency, equity, economic well-being, sustainability, change, interdependence and intervention). These issues are presented as economic questions (Verbatim from the original source):

- How do consumers and producers make choices in trying to meet their economic objectives? Microeconomics
- When are markets unable to satisfy important economic objectives—and does government intervention help? Microeconomics
- Why does economic activity vary over time and why does this matter? Macroeconomics
- How do governments manage their economy and how effective are their policies? Macroeconomics
- Who are the winners and losers of the integration of the world’s economies? The Global Economy
- Why is economic development uneven? The Global Economy

The IB economics program uses three points of view to answer these real-world inquiries (Verbatim from the original source):

- Microeconomics: producers and consumers in individual markets.
- Macroeconomics: government and national economy.
- The Global Economy: international trade and the movement of labor and capital.

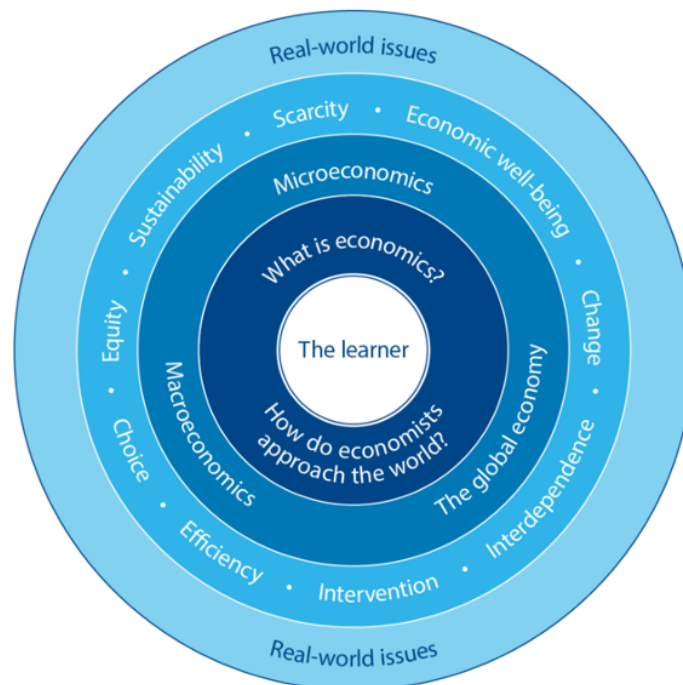


Figure 3. IB Economics (IBO, 2020)

## **ii. Economics and the IB core**

Is of crucial importance to de DP the relationship between each subject and Theory of Knowledge (TOK). “Students should be able to reflect critically on the nature, scope and limitations of knowledge used in human sciences, and in doing so, become the inquiring, knowledgeable and caring young people of the IB mission statement” (IBO, 2020). Three questions are going to be considered:

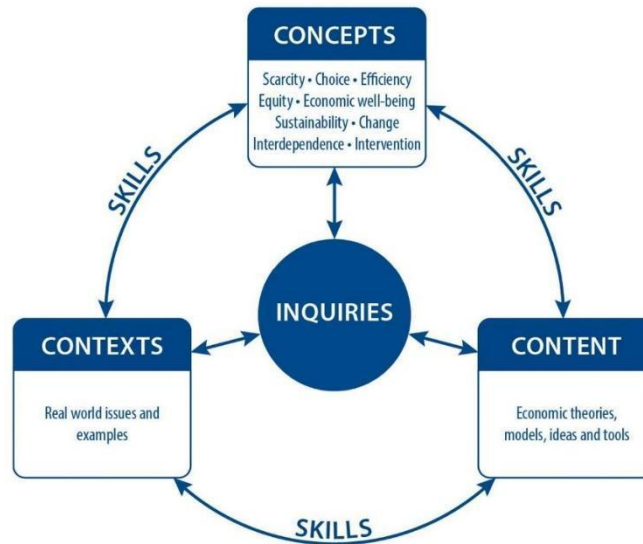
- How reliable is our knowledge regarding sustainable development?
- How have technological advances affected the nature and practices of economics?
- What are the implications of accepting that knowledge in economics changes over time?

The extended essay allows students to engage in an in-depth research related to an area of the subject. Students are expected to develop research skills by selecting and using relevant sources, as well as selecting and applying economic theories to develop an argument in response to a clearly posed research question. Finally, regarding the third branch of the core model, creativity, activity, and service (CAS), “the economics course highlights many economic issues that have local, national and global manifestations” (IBO, 2020). This allows students to develop awareness and take valuable steps to work in order to alleviate economic problems, especially those related with sustainability.

## **iii. Approaches to teaching and learning in economics**

According to the IB, the teaching of economics is conceptually focused and grounded in real-world issues. Concepts are settled in the economics subject content, and they are contextualized in real world issues and examples; in this way students can learn through the lens of real examples rather than just theory. These components help the learner to develop a holistic and integrated understanding of economics. Figure 4 illustrates the relationship between content, concepts and context:





*Figure 4. Economics and the content, concepts and context (IBO, 2020)*

“The economics course is focused on inquiry-based teaching and learning” (IBO, 2020). This approach promotes curiosity, critical thinking, organization, communication, collaborative, problem solving and reflective abilities skills, as well as the capacity to appreciate different viewpoints. Furthermore, it is important to remark the economics aims, which are enable students to (Verbatim from the original source):

- develop a critical understanding of a range of economic theories, models, ideas and tools in the areas of microeconomics, macroeconomics and the global economy
- apply economic theories, models, ideas and tools and analyze economic data to understand and engage with real-world economic issues and problems facing individuals and societies
- develop a conceptual understanding of individuals’ and societies’ economic choices, interactions, challenges and consequences of economic decision-making.

“Endless economic growth, based on the consumption of finite resources, cannot continue indefinitely. New economic models and social movements have challenged mainstream opinion about the purpose of growth and how the economy could be redesigned to support long-term prosperity. Economic thought: 21st century; increasing awareness of the

interdependencies that exist between the economy, society and environment and the need to appreciate the compelling reasons for moving toward a circular economy” (IBO, 2020)

Following these aims and what the IB urges, the subsequent inquiry question is the one that students are expected to ask themselves: *How a country’s economy could thrive without depending on the overuse of finite resources and still meet people’s needs?*

## **2. PART II - Review of related literature**

### **a. Circular economy and sustainable development**

The Industrial Revolution and periods of affluence and abundance, such as those during 1920s and from the mid-1950s – when the World Wars ended – brought a ‘take-make-use-dispose’ model of consumption, triggering into a Linear Economy mindset. Since then, the global economy developed around this model benefiting the manufacturing and retail industries, energy suppliers and raw materials producers (specially the oil and mining industries). Moreover, the take-make-use-dispose Linear Economy improves millions of people’s welfare and started a social, economic, and environmental change. Nevertheless, the environment suffers the consequences of the vast quantities of combusted waste and waste that ends in landfills. The linear model of production and consumption is unsustainable, increasing population, inequity, consumption, and demographic change make this model unfeasible. As a consequence, alternative economic models developed in recent years, such as the Circular Economy model, which focuses on the natural life cycles of the product (Andrews, 2015).

According to the Ellen MacArthur foundation (2019) “the circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution”. This concept was introduced by the Swiss architect and economist Walter Stahel in the 1970s, under the name ‘Cradle-to-cradle’. Stahel suggested that materials processed in a ‘close loop’ and ‘waste’ can become resources again, the economist also proposed that the product life needs to be extended through repair and manufacture (Andrews, 2015).

The circular economy is based on three principles: eliminate waste and pollution, circulate products and materials, and regenerate nature. Firstly, the term waste has been

introduced by humans – there is no waste in nature – even though it seems that waste is unavoidable, rubbish is the result of design choices. Producers and consumers must remember that the resources in our planet are finite and shift their mindset in order to treat waste as a design flaw, meaning that the materials re-enter the economy at the end of their use. For instance, many companies are creating innovative ways to eliminate plastic packaging such as Apeel, a layer of edible, plant-based coating applied to fresh products, this reduces water loss and oxidation, enhancing the natural defenses of fruits and vegetables without the need for plastic packaging (Ellen MacArthur foundation, 2019).

Secondly, products and materials can be kept in circulation in order to eliminate waste and retain its intrinsic value. This process can occur in two fundamental cycles – technical and biological. The technical cycle refers to “the process that products and materials flow through in order to maintain their highest possible value at all times” (Ellen MacArthur foundation, 2019), this process involves reuse through resale, cycles of maintenance, repair, refurbishment, remanufacture and recycling as the last option. On the other hand, the biological cycle refers to composting and anaerobic digestion where materials and nutrients (nitrogen, phosphorus, potassium), can be used to regenerate the land. “By doing so, we keep finite materials in the economy and out of the environment, and safely return biodegradable materials to the earth” (Ellen MacArthur foundation, 2019).

Thirdly, regenerate nature states that the focus is on how we can improve the environment and not only on doing less harm to it. Rewilding nature can occur “if we gradually decouple economic activity from material extraction by keeping materials in circulation after use” (Ellen MacArthur foundation, 2019), meaning that the finite resources will increasingly remain in circulation. Moreover, the Circular Economy also contributes to reducing unethical and corrupt practices, this fosters Sustainable Development due to the fact that this allows to carry out meticulous supply chain audits, select ethical suppliers and encourage unethical ones to change their production process.

Moreover, according to the Sustainable Development Commission "sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs". However, this concept can be interpreted in various ways, for this reason people cannot determine the issues and

challenges of sustainable development unless they identify with them (Venkataraman, 2009). This is where education plays a crucial role in supporting sustainability, this can be achieved through a transformation in the educational system where new design skills are developed with holistic and transdisciplinary thinking. The present study hypothesizes that serious games are a useful teaching tool which allows professors to teach about the benefits, the complexity, and the importance of Circular Economy (Whalen et al., 2018). Furthermore, since not all students are motivated to engage with sustainability issues, learning about Circular Economy means that education for sustainability is implicit since there is a change in the curriculum in terms of design thinking and practice, where the knowledge and the ability to apply the principles of circular economy are integrated (Andrews, 2015). In this way, instead of imposing a particular type of change, Education for Sustainable Development leads to a change in the individual behavior, developing responsibility, passion, and interest; therefore, a social change is achieved.

What Education for Sustainable Development proposes is aligned with the objectives of the IB program, which strive learners to be inquirers, meaning students should be curious, learn with enthusiasm throughout life; knowledgeable, teenagers are required to engage with issues and ideas that have a local and global significance; thinkers, students shall analyze and take responsible actions on complex problems, making reasoned and ethical decisions. Communicators, learners are expected to express themselves in a confident and creative way, listening carefully to the perspectives of other individuals and groups. Principled, students should act with integrity and honesty, with a strong sense of fairness and justice, taking responsibility for their actions and consequences; open-minded, meaning to seek and evaluate a range of points of view, willing to grow from the experience. Caring, it is hoped that students develop empathy, compassion and respect; risk-takers, young learners become resourceful and resilient in the face of challenges and change, they will explore new ideas and innovative strategies. Balanced, learners understand the importance of balancing the different aspects of life, as well as recognize the interdependence that exists with other people and with the world; finally, they are asked to develop reflective skills, they should thoughtfully consider the world, ideas, and experiences to support their learning and personal development (IBO, 2020).

## **b. IB Approaches to teaching: Inquiry Based learning**

Inquiry-based learning is one of the IB approaches to teaching. According to the organization through this lens “students are required to find their own information and construct their own understandings” (IBO, 2020). Moreover, educational policy bodies agree on the fact that pedagogical practices based on inquiry-based methods are more effective, and, in order to respond to the diverse needs of children, inquiry-based teaching, hands-on/minds-on activities, teamwork, independent work on open-ended questions, and trans-disciplinary activities are exemplary methods to achieve it (European Commission, 2007).

It is crucial to deepen the definition and phases of this approach to teaching, with the aim of focusing on the experiential learning methodology and later on game-based learning, in order to support with the literature the reason why the Unit Planner is proposed. Inquiry refers to “the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments” (European Commission, 2007). Pedaste et. al. (2015) defines inquiry-based learning as the “process of discovering new causal relations, with the learner formulating hypotheses and testing them by conducting experiments and/or making observations”. Keselman (2003) assures that through these educational activities, students are scientists who gather knowledge about the world, direct their own investigative activities, formulate hypotheses, design experiments, collect information and draw conclusions; in other words, “students at middle or high school level, construct their understanding of the world using methods similar to those of real-world scientists”. In this process, students are required to carry out a self-directed, partly inductive and partly deductive, learning process; it emphasizes the active participation and learner’s responsibility for discovering knowledge (Pedaste, et. al, 2015). “Inquiry-Based Education is a problem-based approach but goes beyond it with the importance given to the experimental approach” (European Commission, 2007).

“When students explore a topic they are truly passionate about, amazing things happen: engagement increases, attendance and work ethic improve, twenty-first-century skills are acquired, classroom energy and collaboration are fostered, and assessment of

student understanding becomes more clear and accurate” (MindShift, 2018). Nevertheless, it is important to be aware that some students can be overwhelmed and underprepared for this approach to learning, this is why MacKenzie and Bathurst-Hunt propose four types of inquiry: Structured Inquiry, Controlled Inquiry, Guided Inquiry, and Free Inquiry. This scaffolding division was created in order to ensure students acquire the skills, knowledge, understandings, be confident and empowered through their inquiry journey; allowing them to explore their passions, interests, and curiosities.

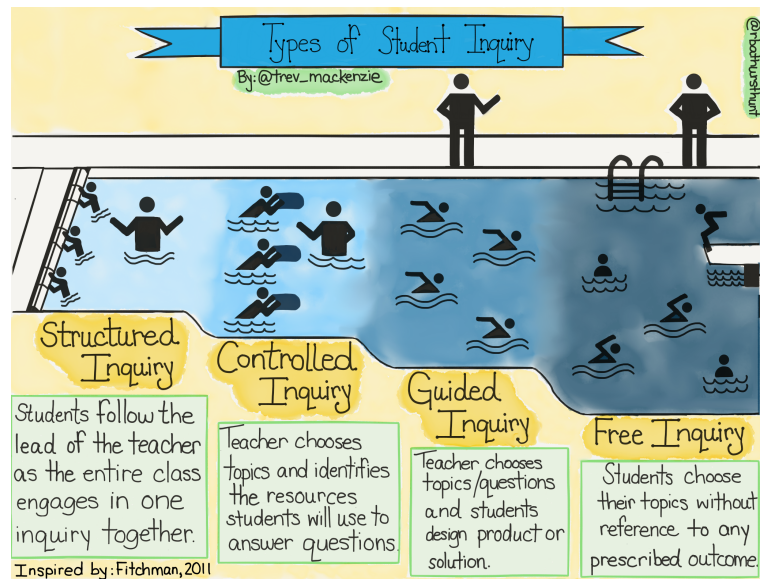
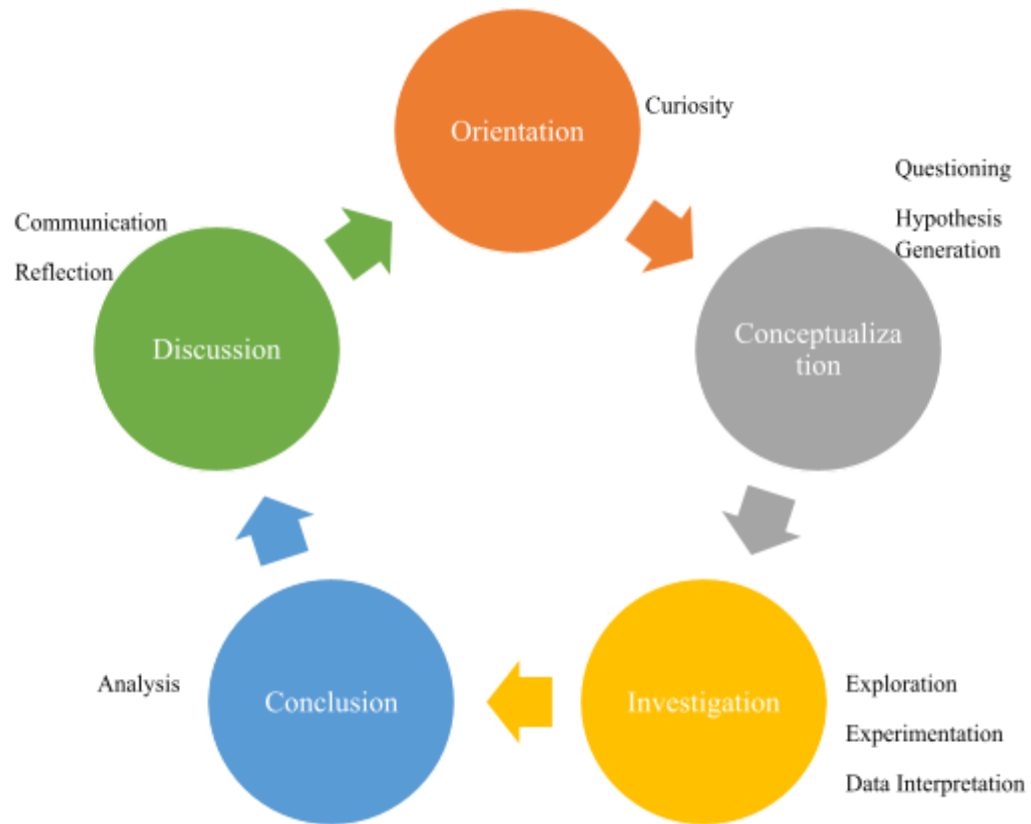


Figure 5. Types of Student Inquiry (MindShift, 2018)

In structured inquiry, the class engages in one inquiry question proposed by the teacher who has the control of the resources, evidence, and tasks. In controlled inquiry, the professor selects the resources and provides different essential questions to learners, they are asked to validate their learning in a common performance task. In guided inquiry, the teacher determines the topics and questions, students are encouraged to design a product or solution, in this type of inquiry they are asked to select where to search and how they will expose their learning. Finally, in the free inquiry learners select the topic, construct the essential question, research different resources, customize their learning evidence, and layout their performance task; the role of the teacher is to be a guide and facilitator for learning (MindShift, 2018).

To explain the inquiry-based learning phases the study developed by Pedaste, et. al. (2015) is going to be used since the authors offer a wide range recompilation of literature

related with the theme. The researchers warn to be careful to consider inquiry-based learning as a prescribed, uniform linear process, since it depends on the learner's context. Five general inquiry phases are described, which help teachers to structure their teaching according to the proposed framework and the learners' learning process. First, orientation is when the learning topic is introduced, either by the environment, the teacher or the learner. During this phase interest and curiosity develops giving a problem statement as the outcome. Second, conceptualization is when students go through the process of understanding the concepts related to the stated problem by questioning and generating hypotheses. The next phase is investigation, where curiosity turns into action in order to answer the stated research question through a process of exploration, experimentation, and data interpretation. Conclusion is the phase where learners analyze if the research question is answered or supported by the results of their discoveries. Finally, the discussion phase is when young adults communicate their findings and conclusions and receive feedback; and reflect on the success of the inquiry process by describing, critiquing, evaluating, and discussing the inquiry cycle, in order to suggest how the inquiry-based learning process could be improved.



*Figure 6. Inquiry Phases*

### **c. Education for sustainable development**

The UNESCO states that Education for Sustainable Development (ESD) (2022) “gives learners of all ages the knowledge, skills, values and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality. It empowers learners to make informed decisions and take individual and collective action to change society and care for the planet. ESD is a lifelong learning process and an integral part of quality education. It enhances the cognitive, socio-emotional and behavioral dimensions of learning and encompasses learning content and outcomes, pedagogy and the learning environment itself”. Their work focuses on five areas: advancing policy, transforming learning environments, building capacities of educators, empowering and mobilizing youth, and accelerating local level action.

This paper hypothesizes that the IB Economics program and its newest guide, which includes Circular Economy teaching, is aligned with the second and fourth areas of work of



the UNESCO in the Education for Sustainable Development, through the use of the ecoCEO game. Transforming learning environments is one of the areas of work, its purpose is to encourage students to become agents with the knowledge, means, willingness and courage to take transformative action for sustainable development. It calls for learners who live what they learn. On the other hand, empowering and mobilizing youth is the other area of work in which this study is going to focus. The actual generations have to create creative and ingenious solutions, since they are an important consumer group and their consumption patterns have a huge impact on sustainability; therefore, empowering and mobilizing young people is crucial for ESD (UNESCO, 2020).

Furthermore, ESD focuses on experiential learning, it emphasizes the need to move from reductionist approaches towards an interdisciplinary education, where students are involved in their learning process and are encouraged to “shape their world”. Moreover, it is crucial to find real life problems and actual experiences as learning situations. This approach avoids the reductionist solutions that have been used since the Industrial Revolution, and learners move from an external and distanced point to an internal and personal one, where they develop personal character and integrity (Dawe, et. al., 2005), empowering and inquiry based learning. According to Hermes and Rimanoczy (2018) experiential learning leads to two thinking dimensions, when combined a “sustainability mindset” results. On one hand, the systemic and innovative thinking dimension includes the student's thought, the lenses through which they interpret data and facts. On the other hand, the being dimension encompasses the student's personal values, purposes, life mission, sense of transcendence and making a difference. What is more, learning has an emotional pathway, it is a social process that occurs in oneself, it is an active and reflective construction development, this is why learning can't be considered just as a cognitive process. In this sense, a deep learning occurs when the student grasps the relationship between concepts and their own behaviors, preferences, and experiences.

Teachers are called to achieve this deep learning using systems-thinking, where they create learning experiences that are closer to the students' own experiences, allowing them to integrate their whole being in learning. Systems-thinking refers to the process where learners analyze information, seek patterns and systemic interconnections. Hermes and Rimanoczy (2018) suggest that systems-thinking connected with emotions and values can create a

powerful transformation of the world, leading to thoughtful and compassionate behaviors. In addition, systems-thinking helps students to consider the trade-offs, interdependencies, casualties, and different perspectives of stakeholders about sustainable development, and consider the aspects of scarcity, choice, and opportunity cost. When students view the world with a system thinking, they see the cause, the consequence, and the solution for environmental, social, and economic aspects with a holistic view (Roba et.al., 2021).

#### **d. Experiential learning – Game based learning**

In order to answer the call of the UNESCO and face the challenge of cultivate an Education for Sustainable Development, meaning to develop a systems-thinking language, programs such as the IB come up with a new curriculum that equips students with tools that allow them to change the traditional mindset which deconstructs systems and analyzes its parts, to think in systems terms and comprehend its behavior. In this section a deep explanation of experiential learning is going to be developed, as well as its relationship with the types of knowledge, sustainable development, and the DP program of the IB.

Behavioral theories of learning and rationalist / cognitive theories are commonly found in the educational literature. Nevertheless, Kolb (1984) suggests that learning is not only related with the acquisition, manipulation and recall of abstract symbols, nor the denial of the role of consciousness and subjective experiences that are involved in the learning process. He proposes that experiential learning theory is a holistic theory that integrates experience, perception, cognition, and behavior; where ideas are not fixed and immutable but are formed and reformed through experience.

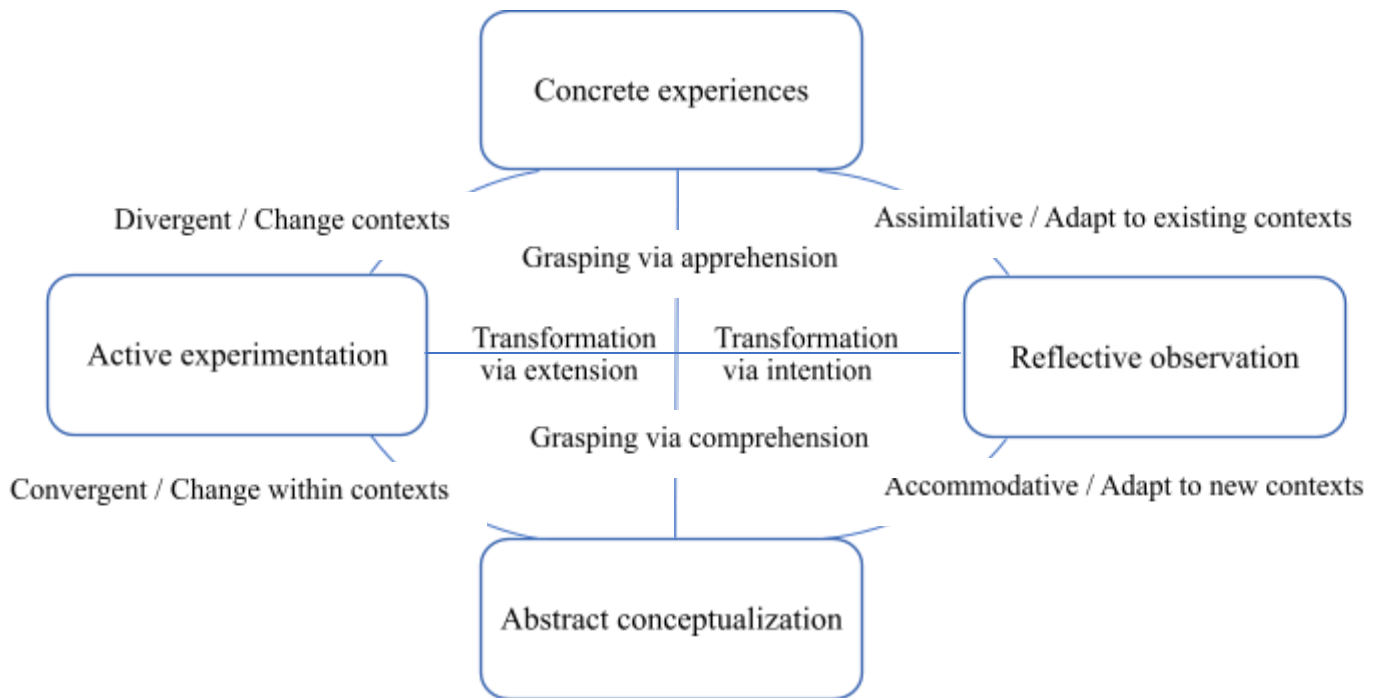
Kolb (1984) defines learning as a process of combination of grasping experience, meaning the understanding and observation of any circumstance under study, and transforming it, denoting the importance of doing something, such as testing or applying in order to achieve a desired result. Dieleman and Huisingh (2006) enhance the explanation of Kolb's theory; the authors point out that grasping might be distinguished between apprehension and comprehension. First, "experience grasped through apprehension relies on the tangible and felt qualities of the immediate experiences" (Dieleman and Huisingh, 2006). This type of learning process occurs on the left side of the brain, it goes through the five senses: seeing, touching, smelling, tasting, and hearing; and relies on intuition, feeling, and

emotion. Second, “experience grasped through comprehension relies on conceptual interpretation and symbolic representation” (Dieleman and Huisingsh, 2006). Comprehension occurs on the right side of the brain, is rational and analytical.

On the other hand, the learning process of transforming might be distinguished between intention and extension. First, intention is liable to the internal reflection, it touches the emotions and recreates the image one has of oneself. Second, extension means that the learning process is under the control of the external world, when an object is transformed, therefore, the external world also changes. Dieleman and Huisingsh (2006) reported that Kolb makes another distinction in terms of knowledge saying that there are four types of it: assimilative knowledge, the one that helps the learner to understand and adapt to existing contexts and situations; accommodative knowledge, which helps to understand and adapt to new contexts and situations; divergent knowledge, which helps to accomplish changes within given situations and contexts; and convergent knowledge, which helps to change situations and contexts. With these distinctions in mind, Dieleman and Huisingsh (2006) explains Kolb’s experiential learning four-stage cycle:

<b>Learning process</b>	<b>Type of knowledge</b>	<b>Change process</b>
Apprehension/intention	Assimilative – think and watch	Adapt to existing contexts
Comprehension/intention	Accommodative – feel and do	Adapt to different contexts
Comprehension/extension	Convergent – think and do	Change within contexts
Apprehension/extension	Divergent – feel and watch	Changes contexts

*Table 1. Kolb's experiential learning cycle – Dieleman and Huisingsh (2006) adaptation*



*Figure 7. Kolb's experiential learning cycle – Dieleman and Huisinigh (2006) adaptation*

The starting point in learning occurs in concrete experiences, on the grasping of experience through apprehension. “Children first start to apprehend experiences and learn to know reality *as it is*” (Dieleman and Huisinigh, 2006). Later they start to experience the richness and complexity of reality that goes beyond our capacity to grasp with models and theories. Secondly, reflective observation centralizes on accommodative knowledge, in this stage the knowledge and skills that enables the learner to become better in performing known tasks within more or less given contexts takes place. Thirdly, abstract conceptualization refers to the comprehension through conceptual interpretation, here the importance of obtaining understanding from information is highlighted. In this phase the development of skills for converting information into knowledge occurs since it is based on theories and philosophies. Finally, active experimentation seeks learners who become active participants of a group, in order to put into practice the knowledge that has been acquired to change the outside world.

Furthermore, McDonald (2020) assures that there is a closed relationship between Kolb's learning cycle and the four regions of the brain; the sensory cortex is responsible of collecting information (concrete experiences – gathering); the back integrative cortex of making meaning of the information received (reflective observation – analyzing); the front integrative cortex of formulating new ideas (abstract conceptualization – creating); and the motor cortex of performing on the ideas (active experimentation – acting). Therefore, experiential learning warrants all four regions of the brain are used, allowing students to have a more holistic experience.

In addition to Kolb's categorization of knowledge, Gardner's Multiple Intelligences theory remarks seven learning styles: visual or spatial; aural or musical; verbal or linguistic; physical or kinesthetic; logical or mathematical; social or interpersonal; solitary or intrapersonal. All these categorizations, including the fact that students have different cultures, gender, language, motivation, personal challenges, experiences, interests, life circumstances, socioeconomic levels, etc. allows us to realize that each "learner grasps concepts in different ways at different rates... Therefore, to improve teaching and learning through experiential learning it is imperative that learners are exposed to the appropriate kinds of experiences that best match their holistic profiles" (McDonald, 2020).

Experiential learning entails learners taking an active role in the teaching/learning process, in order to nurture collaboration, discovery, service to community, hands-on participation, deeper understanding and commitment to lifelong learning; in order to achieve personal growth, emotional well-being, personal responsibility, maturity, sense of purpose, etc. For this to happen, the teacher becomes a guide and the student an active learner. Experiential learning is considered the oldest form of learning, we can refer to the controversy that Aristotle had with Plato about attempting to separate knowledge from experience, in the following centuries different educational experts such as Dewey, Montessori, Piaget, Kolb, etc. gradually put all their effort to demonstrate that experiential learning can be the bedrock to transform learning into a more real life application, they brought to light the fact that all subjects areas occurs in the real world (McDonald, 2020).

There is a natural propensity to learn in all human beings, according to McDonald (2020), Rogers (1969) assures that experiential learning is equivalent to personal change and

growth since significant learning can be achieved when the personal interests are aligned with the subject. Moreover, McDonald (2020) exposes the experiential learning principles, it is important to build a background of this approach in order to emphasize the importance of its suitability to the DP in order to achieve a sustainable development mindset. There are eight principles of good practice for experiential learning according to the National Society for Experiential Learning Education: intention, which refers to the purposefulness that enables experience to become knowledge; preparedness and planning evoke the importance to ensure that the student has the sufficient foundation to support a successful experience. Authenticity, the experience should be designed according to a real-world context; the reflective process is essential for adjusting the experience and measure the outcomes; orientation and training refers to the fact that a baseline of knowledge must be addressed to give the context and the skills requirements for the experience. Monitoring and continuous improvement refers to the formative evaluation, teachers have the responsibility to ensure that the experience provides the richest learning possible while affirming the learner, flexibility is important in this principle. Assessment as a means to develop and refine specific learning goals and objectives during the experience and evaluation provides comprehensive data about the experiential process as a whole. Finally, acknowledgment refers to the recognition of learning through a reflective process of reporting, documentation and sharing of accomplishments, it is important that everyone participates in order for the experience to be sustainable in the future.

According to Kolb, the relationship between the ways of learning and the types of knowledge are important for ESD because sustainable development requires that learners develop systems-thinking in order to focus on the whole and not just on the parts. As stated before, knowledge is a continuous process derived from experiences, students' minds are not a blank paper where a professor can write conclusions. What is more, ESD requires a focus on the contribution to change paradigms, contexts, and behaviors. For this reason, ESD must be based on a balanced mix of their four types of learning (Dieleman and Huisingsh, 2006). When we want to make a change, certain levels of emotion are essential, this is why apprehension and comprehension must be integrated in teaching. Furthermore, ESD requires collaboration between teachers and students in order to become co-learners and make the appropriate connections between what the professor teaches and the application in real life

situations. We can achieve this through games “because the student becomes an active learner, is part of the problem, lives the problem and the consequences without the real consequences” (Andrews, 2015).

The literature about experiential learning provides the conceptual framework to explain why this method was selected to apply an inquiry-based teaching approach in this report. As it can be seen, experiential learning leads teachers to accomplish the key values and principles of the IB pedagogy, in other words, students are allowed to develop (IBO, 2020) (Verbatim from the original source):

- Thinking skills. Critical thinking, creative thinking and ethical thinking.
- Communication skills. Written and oral communication, effective listening, and formulating arguments.
- Self-management skills. Organizational skills (time and task management), affective skills (managing state of mind and motivation).
- Research skills. Comparing, contrasting, validating, and prioritizing information skills.
- Social skills. Forming and maintaining positive relationships, listening skills, and conflict resolution.

### **Games in the context of experiential learning and sustainable development.**

Game-based learning, commonly named serious games, describes the situation where knowledge and skills acquisition are enhanced by game content and game play, and where players (students) are required to solve problems and challenges with a sense of achievement (Qian & Clark, 2016). According to De la Torre et al. (2021) the main purpose of serious games relies on the acquisition of knowledge and skills, as well as achieving a behavior change. Serious games have received attention for experiential learning as they provide a safe place for students to experiment the reality in a dynamic and interactive system (Whalen, et. al, 2018). Also because they provide a positive experience which allows young learners to focus on education rather than on entertainment (Krath, Schürmann, & Von Korfflesch, 2021); they seek high levels of realism without jeopardizing the capacity to understand, follow and by all means enjoy the game (De la Torre, et al. 2021). Serious games assure that students develop critical thinking skills, as they plan, evaluate, analyze, and seek

to connect the game to reality – key skill for ESD. Additionally, according to the literature these skills indicate a higher level of thinking according to Bloom’s taxonomy of cognitive abilities (Whalen, et. al, 2018). As it can be seen, the inquiry-based teaching approach is applied.

“Games simulate and create realities, with certain mutually accepted rules, roles, conditions and assumptions” (Dieleman and Huisingsh, 2006). Games provide the optimal scenario where students can take a specific role, this provides the opportunity to develop an emotional understanding (apprehension) of the reason why others act as they do. Additionally, as it was mentioned before, students learn by doing and failing without the real consequences of their actions. De la Torre et al. (2021) specify that serious games allows the players to take into consideration, in a holistic way, the complex interactions that exist between the different actors and factors of a society, helping them to elaborate a multifaceted knowledge.

Dieleman and Huisingsh (2006) describe seven functions of games: they provide learning experiences (learn by doing); the foundation of shared experiences (of problems and solutions); create shared experiences – used as a reference point to facilitate mutual understanding; provides a sense of belonging – facilitate communication and collaboration; contributes to the knowledge of oneself – helps to understand and feel the limitations and possibilities to change the system; helps to test solutions in the safety of the simulation; and provides the opportunity to develop creativity, innovation and adventure – essential for ESD.

In order to stimulate inquiry and skills through games and to apprehend diverse facets of reality in new and more comprehensive ways, the game must be well prepared, well executed and well evaluated. Dieleman and Huisingsh (2006) proposes three generic rules that games must follow: contextualization and preparation – games should represent the reality of the participants; introduction and instruction – explain the game in an appropriate way is fundamental to their success and impact; evaluation and reflection are fundamental in order to gauge the perceptions, emotions, and learning. On the other hand, Roba, et al. (2021) itemize eight quality criteria: clear goals, focus on the characterizing goal, indispensability of the characterizing goal, correctness of the domain expert content, appropriate feedback on progress, appropriate rewards, proof of effectiveness and use of



game awards or ratings; as well as high level of realism. Finally, De la Torre et al. (2021) indicate that it is suitable to give an introduction to the main topics of the theme of study, in this case, about Circular Economy. After an appropriate introduction, the same authors recommend to apply a reflection process in order to assure that “the message underpinning the game are efficiently conveyed”.

Nowadays, educational games are being used more and more in classrooms. They are gaining teachers’ attention as they are an attractive and effective tool to transcend the purpose of entertainment, to provide a change in behavior, to develop skills and to create awareness towards sustainability. Educational games can create an “authentic, meaningful, and rich learning environment” (Roba, et al., 2021) as they demand students to adapt to the different situations that can arise during the game, triggering reflection and critical thinking from an ethical perspective since games imply an emotional implication (De la Torre, et al. 2021); they also motivate students to use their problem-solving skills. Serious games require students to decide what to do, when to do it, what are the goals, and stimulate them to become change agents for a more sustainable society; in this way, games act as a stimulus for active learning, a fundamental component of experiential learning - IB inquiry-based teaching approach.

Qian & Clark (2016) remark that traditional education tends to hinder creativity because it focuses only on one correct answer, favoring conformity and standardization. While game-based learning positively influences the development of the 21<sup>st</sup> century learning and innovative skills, defined as: critical thinking, creativity, collaboration and communication. Critical thinking includes reason effectively and uses systems thinking (analyze how parts as a whole interact with each other to produce overall outcomes in complex systems; synthesize and make connections between information and arguments, interpret information, evaluate, infer, self-regulate and draw conclusions). Creativity includes thinking creatively (create new ideas; elaborate, refine, analyze and evaluate them), work creatively with others, and implement innovations. Collaboration refers to the interaction with others in an effective and respectful way, being flexible and assuming responsibility. Communication encompasses the ability to articulate thoughts in diverse ways, communicate them for a range of purposes and in diverse formats (Binkley et al.,

2012). It is worth mentioning that the aforementioned learning objectives are difficult to implement from a theoretical point of view.

Crocco et al. (2016) come up with six key learning functions offered by game-based learning: games activate prior knowledge; teach players the relationship between knowledge and context; provide a rich feedback and assessment of the game actions; foster an environment that encourages the application of previously gained knowledge; accommodate experiential learners; and, because they are inherently social, they foster the sharing of knowledge. As it can be appreciated, the literature affirms the relationship between games and the inquiry-based teaching approach. Additionally, authors such as De la Torre et al. (2021) point out that educational institutions are key agents in the process of fighting against unsustainable practices “since they are the ones that can educate citizens in a series of methodologies, skills, and capacities that will lead our societies towards a more environmentally friendly and socially sustainable future”.

### **Limitations**

For the sake of a successful implementation of experiential learning, some salient issues must be discussed. Authors such as Kirschner et al. (2004) underlines that “minimally-guided learning does not enhance student achievement”, the writers use the analogy of throwing a non-swimmer into a pool without a lifeguard, arguing that it is the best way for them to learn to swim. What is more, “in order to improve the learning experience, the teacher must reach to the learner’s prior knowledge and awareness and connect this with new knowledge” (McDonald, 2020). But in the case of novice learners, who lack the proper background to integrate new knowledge with previous one, a free exploration of complex environments “may generate a heavy working memory load that is detrimental to learning” (Kirschner et al. 2004). This is why games must be integrated with specific themes and outcomes, in order for Game Based Learning to reach its full potential, professors should promote an alignment between the game design and the instructional goals (Crocco et al., 2016). This is why a guided inquiry is going to be proposed in this report, by using serious games.

On the other hand, according to McDonald (2020) there are lots of expectations regarding experiential learning, so it can be challenging to define whether an activity can be

an experiential activity or not. “The experiential methodology is not linear, cyclical or even patterned. It is a series of working principles, all of which are equally important, and must be present to varying degrees at some time during experiential learning” (Chapman, McPhee, & Proudman, 1992). These authors come up with ten characteristics of experiential learning to bring expectations into reality:

1. Mixture of content and process: balance between the experiential activities and the content or theory.
2. Absence of excessive teacher judgment: within the teacher-defined boundaries, students should have full run of premises. Professors must recognize the effects of conditioning in order to allow students to have their own experiences minus teacher judgment.
3. Engaged in Purposeful Endeavors: the teacher is challenged to recognize the student as a self-teacher, who has personal needs. With this in mind, the activities must be personally relevant to the student.
4. Encouraging a Big Picture Perspective: the activities must provide the learner the opportunity to make connections between what they are learning and the world, the activities should build in students the ability to see relationships in complex systems and find the way to work with them.
5. Teaching with multiple Learning Styles: Kolb’s learning cycle stresses that for a person to learn experientially, a teaching routine must include all four learning styles (concrete experience, reflective observation, abstract conceptualization, and active experimentation). Experiential learning is not simply a physical activity with some discussion at the end.
6. The role of reflection: teachers must mix experience with content and guided reflection in order the learner can have the tools to bring theory to life.
7. Creating emotional investment: students must be fully immersed in the experience, not just doing what they feel is required. The teacher is required to create an environment where learners are valued and appreciated in order to engage in their learning experiences.
8. The re-experimentation of values: creating opportunities for personal growth is a hallmark of meaningful experiential education.

9. The presence of meaningful relationships: learning that takes place without reference to relationship is not experiential as it does not allow learners an opportunity to see how they fit into the bigger picture.

10. Learning outside of one's perceived comfort zone (not just the physical environment but also the social one): it is fundamental that students take responsibility for their actions.

Roberts (2018) established that “bringing experiential learning into the formal curriculum remains a pedagogical and structural challenge”. Policy makers must evaluate the quality and nature of teaching and learning experiences, studying their impact and effectiveness rather than emphasizing on simplistic activities. In this way schools are going to be able to find the balance between “traditional classroom experiences” (seminars, lectures) and experiential ones (games, collaborative research, project work). Given that more research on experiential learning is needed, another purpose of this paper is to apply the ecoCEO game in a classroom and evaluate its effectiveness, in order to contribute to the literature in future studies.

### **3. PART III**

#### **a. Case Study: EcoCEO Game for circular economy**

Few educational games for circular economy teaching have been developed, in this paper one example is going to be proposed as part of the IB curriculum for teaching circular economy. ecoCEO is a serious game created for 16 – 18-year-olds, its purpose is “to increase awareness and transfer knowledge about circular economy strategies and sustainable entrepreneurship to students in upper secondary education” (Roba, et. al., 2021). Based on Bloom's taxonomy for educational learning, it can be said that the game mechanics are highly related with high thinking skills. The ecoCEO game requires students to plan a business strategy in order to create logical investment combinations – which are rewarded. This allows students to develop the creating thinking skills of Bloom's taxonomy. Students play in clockwise turns, in each one they must make valuable decisions. With this in mind, the evaluating thinking skill is developed when students place a worker wisely to the available activities, when choosing the best action (invest, assign workers or sell products), when use the scarce resources in the best possible way to manufacture a product, and when

act cunningly before an event card emerges, disrupting the flow of the game. Learners are required to enhance analyzing skills when they receive feedback on the business strategies applied. Applying skills are developed when students have to choose whether to use the mining activity as a resource or as an investment; and when they receive victory points due to investments, awards and revenues. Finally, players are in the shoes of the CEO of an electronics company – role play – demanding students to develop understanding skills.

#### **i. The course of play**

EcoCEO is a multiplayer and competitive game, it can be played with 3 or 4 players or in teams of two players. A game session takes 90 to 100 minutes, including introduction, rules explanation, game setup and debriefing. The game can be downloaded from the vito – ecoCEO website<sup>1</sup>. Players are going to run an electronics company which produces microchips, smartphones, and e-bikes; with the mission “to develop a thriving business” (Roba, et. al., 2021). During the game they need to make decisions about investments, worker allocation and materials management. Students can diversify their product portfolio by combining different investments, or maximize the company’s performance and profitability when improving their production efficiency and try new business models. As in real life, day-to-day business is interrupted by different external events such as regulatory charges and market challenges (government taxes, bans on toxic materials, changes in market prices).

Players have two scenarios, during stage 1 students “learn about the production and sales process in a linear economy, based on the traditional take-make-sell-dispose pattern” (Roba, et. al., 2021). They realize how to optimize this system through efficiency and resource substitution strategies. Roba, et. al. (2021) design a table to show how the linear economy principles were integrated in the ecoCEO game:

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<sup>1</sup> URL: <https://ecoceo.vito.be/en/ecoceo-its-your-business>. <Last view: April 28<sup>th</sup>, 2023>

<b>Linear economy principles</b>	<b>Representation in the game</b>
Mining of virgin resources	Drawing resource cards from the central raw materials pile
Production	Producing microchips/ smartphones/ e-bikes with the resource cards at hand
Product sales	Selling microchips/smartphones/e-bikes to the central market for money
Resource efficiency	Producing microchips/ smartphones/ e-bikes with one resource less
Resource substitution	Replacing one resource from another when producing a microchips/ smartphones/e-bike

In stage 2 new circular business models arise to help overcome resource constraints. Roba, et. al. (2021) design a second table to show how circular economy principles were represented in the ecoCEO game:

<b>Circular economy principles</b>	<b>Representation in the game</b>
Waste recycling	Reclaiming resource cards from the central waste pile as an alternative for mining virgin resources
Take back and sell for scrap	Taking back microchips/ smartphones/e-bikes from the central market and selling it to the central waste pile for a credit

Microchip reuse	Reusing microchip from products taken back from the central market in new products
Renting service	Renting out products instead of selling them, in exchange for a recurrent rental fee
Design for repair	Allowing rented out products to be repaired so they continue to yield credits

At the end of the game the company's success is measured in victory points, which can be gained over strategic investments, awards and the accumulation of revenues; and the player or team with the most victory points wins. The teacher shall prepare a debriefing session where students reflect about the impact of sustainable business strategies, consumption patterns, resource scarcity and waste management on the financial performance and resilience of a company; through the understanding of the principles behind both the linear and circular economies.

## **ii. Evaluation**

In the case study conducted by Roba, et. al. (2021), a short debriefing session (5 to 10 minutes) was conducted after the playing to discuss with the class the challenges they had, the strategies they used and the choices they had to make to run a business. After one week, teachers ask students to write an individual reflection report (two pages) about the content of the game and their personal experiences and learnings. The authors used an evaluation rubric with 5 criteria and reach the following results:

<b>Evaluation criteria</b>	<b>Result</b>
EcoCEO illustrates the concepts of linear and circular economy	The majority the students explicitly mentioned the circular economy in their reflection report and also the linear economy was often mentioned
EcoCEO explains the basic concepts and strategies of a circular economy, such as recycling, reuse, design for repair, product service systems	<p>The following strategies of circular economy were discussed by the students:</p> <ul style="list-style-type: none"> <li>● Recycling (15 students)</li> <li>● Reusing (13 students)</li> <li>● Renting service (7 students)</li> <li>● Design for repair (2 students)</li> </ul>
EcoCEO illustrates the impact of the scarcity of raw materials and other real-life external events on doing business	Almost half of the statements discussed scarcity of raw materials. Some statements referred to external events such as fluctuating market prices and government intervention
EcoCEO provides an impression of the role of a (sustainable) entrepreneur	Almost half of the students wrote about the role of an entrepreneur and some of them also mentioned the responsibilities that come along with this job
EcoCEO is a pleasant manner to learn about the circular economy	The majority declared they had fun playing EcoCEO. The difficulty level of the game and the explanation in English were often mentioned as the most important hurdles, although most students stated that after a while the gameplay went more smoothly



### **iii. Instructions of the game**

The game should start with an introduction, where students are asked about the destiny of worldwide products such as smartphones. Some questions that can be included are:

- Do you know the lifespan of your smartphone?
- Do you know the destiny of your old smartphone? Or your parents'?
- Do you know how smartphones are recycled?
- Do you know how many raw materials are used to produce a smartphone?
- Any prior knowledge about circular economy.

It is expected that the majority of students are not familiar with the concept of circular economy, and during the game they are expected to deduce the principles of this economic theory. The introduction will be followed by an explanation of the game rules, the materials provided by the vito – ecoCEO website are going to be used (see appendix 1).

### **b. Unit planner**

In previous sections we have explained the theory behind inquiry-based learning, experiential learning, and the use of games for its application as well as the operation of ecoCEO. We now turn to the development of a didactic proposal. It was decided to implement the ecoCEO game as an introduction of part 2.7 “Role of government in microeconomics”, enclosed in Unit 2 Microeconomics of the IB economics program. Although the game can be used to introduce students to the circular economy, it has been decided to implement it in this part of Unit 2 because the IB economics guide does not include a specific section on the subject in Microeconomics, however, the diploma program invites teachers to refer to circular economy throughout the curriculum. Even though the IB proposes extra activities and units about circularity, this paper seeks to provide an extra resource for IB economics teachers.

At the end of the real-world issue 1 “How do consumers and producers make choices in trying to meet their economic objectives?” students acquire knowledge about supply, demand, competitive equilibrium and elasticities. The skills acquired in this first stage of

inquiry will help students to take advantage of the game in a better way, because as will be explained later, when playing the game with two future teachers, it was concluded that although previous knowledge of circular economy is not necessary, knowledge and skills on decision making, investment, supply, demand and competitive equilibrium may be required. On the other hand, in the real-world issue 2 “When are markets unable to satisfy important economic objectives - and does government intervention help?” The inquiry questions include topics such as the role of the government in microeconomics and market failures - more specifically, externalities and public goods in Standard Level. Since the game includes events such as regulatory charges and market challenges (government taxes, bans on toxic materials, changes in market prices), it is a great way to first: refresh students' knowledge about the circular economy and introduce them to the new topic, 2.7 Role of government in microeconomics. Furthermore, it is an excellent opportunity to delve into the advantages and limitations of the circular economy and its effect on externalities - market failures, which are the later topics.

For the preparation of the unit, the planning template provided by the IB was used, as well as the 2024 economics guide. As mentioned before, the inquiry question of the unit, which the Unit Planner revolves around, is: How a country’s economy could thrive without depending on the overuse of finite resources and still meet people’s needs?

At the end of the game, students are going to be asked to do a written reflection, which is going to be assessed using a modified internal assessment criteria in order to prepare learners for their internal assessment commentary, allowing them to develop the necessary skills for the task. The original criteria evaluate: diagrams, terminology, application and analysis, key concept, and evaluation. The criteria that will be used is going to be as follows:

- Terminology: economic terminology is used appropriately throughout the reflection.
- Application and analysis: throughout the reflection, relevant economic theory is applied, with effective economic analysis.
- Key concept: a key concept is identified and a full explanation of why it was chosen is included.

The evaluation criteria proposed by Roba, et. al. (2021) is also going to be taken into account, in this way the teacher can be sure that the purpose of the game is achieved:

- EcoCEO illustrates the concepts of linear and circular economy.
- EcoCEO explains the basic concepts and strategies of a circular economy, such as recycling, reuse, design for repair, product service systems.
- EcoCEO illustrates the impact of the scarcity of raw materials and other real-life external events on doing business.
- EcoCEO provides an impression of the role of a (sustainable) entrepreneur.
- EcoCEO is a pleasant manner to learn about the circular economy.

## DP unit planner

<b>Teacher(s)</b>	Dayana Vaca	<b>Subject group and course</b>	<b>Individuals and societies: Economics</b>		
<b>Course part and topic</b>	<b>Unit 2: Microeconomics</b> <b>Part of 2.7 Role of government in microeconomics</b>	<b>SL or HL/Year 1 or 2</b>	<b>SL/Year 1</b>	<b>Dates</b>	
<b>Unit description and texts</b>		<b>DP assessment(s) for unit</b>			
<p>In this guided inquiry, students will analyze, explain and evaluate how a country's economy could thrive without depending on the overuse of finite resources and still meet people's needs.</p> <p>Students will deepen their understanding of the Circular Economy principles and its implications in the market outcomes, through the serious game ecoCEO. Students will evaluate how households, stakeholders, and the environment can be benefited from circularity as well as the relative strengths and limitations of it.</p>		Paper 1: Extended response; potential for internal assessment commentary			

### ***INQUIRY: establishing the purpose of the unit***

<p><b>Transfer goals</b></p> <p><i>List here one to three big, overarching, long-term goals for this unit. Transfer goals are the major goals that ask students to “transfer” or apply, their knowledge, skills, and concepts at the end of the unit under new/different circumstances, and on their own without scaffolding from the teacher.</i></p>
<p>The market mechanism may result in socially undesirable outcomes that do not achieve <b>efficiency</b>, environmental <b>sustainability</b> and/or <b>equity</b>. Resource overuse, resulting in challenges to environmental <b>sustainability</b>.</p>

***ACTION: teaching and learning through inquiry***

Content/skills/concepts—essential understandings	Learning process
<p><b>Prior learning that will be activated is as follows.</b></p> <ul style="list-style-type: none"> <li>● Students will already be confident with the workings of the market mechanism under free market conditions.</li> <li>● They will have extensive knowledge about the centrality of efficient resource allocation in economics.</li> <li>● Students will already be familiar with the problem of scarcity, opportunity cost, and sustainability.</li> <li>● The concepts of sustainability, efficiency, and equity will be linked to the idea that free market outcomes are not always consistent with sustainability.</li> </ul> <p><b>Students will know the following content</b> (see subject guide for content details).</p> <ul style="list-style-type: none"> <li>● Students will be able to <b>analyse, apply</b> and <b>evaluate</b> the principles behind the linear and circular economy.</li> <li>● Students will be able to <b>discuss</b> how households, stakeholders, and the environment can be benefited from circular economy as well as the relative strengths and limitations of it.</li> <li>● Students will be able to <b>examine</b> and <b>evaluate</b> the objectives for government intervention in markets.</li> <li>● Students will be able to explain and <b>evaluate</b> the main mechanisms of government intervention in markets.</li> <li>● Students will be able to <b>discuss</b> the consequences of government intervention for markets and stakeholders; as well as for the environment.</li> </ul> <p><b>Students will develop their ability to:</b></p> <ul style="list-style-type: none"> <li>● apply economic concepts and theories to real-world situations</li> <li>● engage with economic reasoning</li> <li>● make informed decisions and take individual and collective action to change society and care for the planet.</li> <li>● demonstrate the extent to which economic information is used effectively in particular contexts.</li> </ul> <p><b>Students will grasp the following concepts:</b></p> <ul style="list-style-type: none"> <li>● efficiency</li> <li>● equity</li> </ul>	<p><b>Learning experiences and strategies/planning for self-supporting learning</b></p> <ul style="list-style-type: none"> <li>● Mini lecture</li> <li>● Mini lesson</li> <li>● Socratic seminar</li> <li>● Small group work – game</li> <li>● Genial.ly lecture/notes</li> <li>● PowerPoint / Rules and game set-up</li> <li>● Individual reflection</li> </ul> <p><b>Details</b>            EcoCEO – <a href="#">Game Rules</a> (Appendix 1)  <a href="#">ecoCEO Teachers guide</a>  <a href="#">Rules &amp; Game set-up</a></p> <ul style="list-style-type: none"> <li>● Lessons and Socratic seminars could be provided at strategic points.</li> </ul> <p><b>Formative assessment</b></p> <ul style="list-style-type: none"> <li>● Debriefing session to reflect with the class group – discuss which challenges the students confronted with, which strategies they used, and which choices they made when running a business.</li> <li>● To ensure accountability, students will upload their written reflection document to a shared folder in Google Drive so that oversight can be provided at a distance and students have easy access to one another’s work.</li> </ul>

<ul style="list-style-type: none"> <li>● sustainability.</li> </ul>	<p><b>Summative assessment</b>  <b>Paper 1: Extended response</b> – Potential for internal assessment commentary  Written reflection document assessed using modified internal assessment criteria as well as the following evaluation criteria:</p> <ul style="list-style-type: none"> <li>● EcoCEO illustrates the concepts of linear and circular economy.</li> <li>● EcoCEO explains the basic concepts and strategies of a circular economy, such as recycling, reuse, design for repair, product service systems.</li> <li>● EcoCEO illustrates the impact of the scarcity of raw materials and other real-life external events on doing business.</li> <li>● EcoCEO provides an impression of the role of a (sustainable) entrepreneur.</li> <li>● EcoCEO is a pleasant manner to learn about the circular economy.</li> </ul>
<p><b>Approaches to learning (ATL)</b></p>	
<p>All ATL skill categories will be engaged with: Thinking, communication, social, and self-management.</p>	

EE connections	TOK connections	CAS connections
<p>How could an experience of this type be transformed into something suitable for the extended essay?</p>	<p>How reliable is our knowledge regarding sustainable development?  How have technological advances affected the nature and practices of economics?  What are the implications of accepting that knowledge in economics changes over time?</p>	<p>What actions could students, as individuals, take to promote environmental sustainability?</p>

**Resources**

1. Roba, J., Kuppens, T., Janssens, L., Smeets, A., Manshoven, S. and Struyven, K. (2021). *Serious Games in Secondary Education to Introduce Circular Economy: Experiences With the Game EcoCEO*. *Frontiers in Sustainability*. 2:690232. doi: 10.3389/frsus.2021.690232
2. Blink J, Dorton I. (2020). *IB Economics Course Companion*. Oxford: Oxford Unit Press
3. *Genial.ly presentation*
4. <https://ecoceo.vito.be/en/ecoceo-its-your-business>

***REFLECTION: considering the planning, process and impact of the inquiry***

<b>What worked well</b>	<b>What didn't work well</b>	<b>Notes/changes/suggestions:</b>
<i>List the portions of the unit (content, assessment, planning) that were successful</i>	<i>List the portions of the unit (content, assessment, planning) that were not as successful as hoped</i>	<i>List any notes, suggestions, or considerations for the future teaching of this unit</i>

### **c. Simulation of the ecoCEO game**

In the following section the conclusions of the simulation carried out on February 14<sup>th</sup> and 21<sup>st</sup>, 2023 of the ecoCEO game are going to be exposed. The game was carried out with two students from the master's degree in teaching and myself. It was decided to execute this first simulation with the aim of familiarizing myself with the game and be sure that the game will provide the richest learning possible, as well as requesting the evaluation of two professionals in education about it. This feedback allowed me to make the necessary adjustments to perform the game in a classroom.

The simulation enables to evaluate if the principles of good practice for experiential learning are followed: make sure that the activity enables experience to become knowledge; ensure that the students have the sufficient foundation to support a successful experience; verify that the experience encompasses a real-world context; prepare a reflective process for adjusting the experience and measure the outcomes; provide the appropriate orientation and training to give the context and the skills requirements for the experience. It was also useful to prepare the correct evaluation to provide comprehensive first-hand feedback about the experiential process as a whole, and be able to guide the students through a reflective process of reporting documentation and sharing new knowledge.

This section will describe my observations and those of the other two teachers who played. As it was stated before, in order to stimulate inquiry and skills through games and to apprehend diverse facets of reality in new and more comprehensive ways, they must be well prepared, well executed and well evaluated. To achieve it is essential that the professor plays it previously in order to capture the essence of the game. In the first instance, although the game provides the proper instructions in different formats (written, videos, PowerPoint presentations, and instructions for the teacher) these are not clear enough in a first contact with the game. When the teacher grasps the essence of the game, he or she can accomplish the three generic rules for games proposed by Dieleman and Huisinigh (2006), which are: present the game in a contextualized environment, explain the game in an appropriate way so it can be successful and obtain the desired impact, in order to carry out the evaluation and reflection. Additionally, the instructor will have the complete insight of the game and



provide the student the right feedback about their conclusions and guide a correct class discussion. All of this in order to develop the IB approaches to learning:

- Thinking skills. Critical thinking, creative thinking and ethical thinking.
- Communication skills. Written and oral communication, effective listening, and formulating arguments.
- Self-management skills. Organizational skills (time and task management), affective skills (managing state of mind and motivation).
- Research skills. Comparing, contrasting, validating, and prioritizing information skills.
- Social skills. Forming and maintaining positive relationships, listening skills, and conflict resolution.

Furthermore, the simulation took longer than expected, a total of 120 minutes. It is expected that to apply it in class it will take approximately 100 minutes, since once the teacher is familiar with the game it is much easier to explain it and answer the questions of the students.

On the other hand, with the aim of obtaining the appreciation of the game from the other future teachers and analyze to what extent the Circular Economy principles were assimilated, a google form (appendix 2) was created with the following questions:

- Write a word or term that describes your experience during the game
- What aspect was new, most surprising or interesting to you and why?
- Do you think that previous knowledge is needed to play the ecoCEO game? If your answer is yes, describe in a few words what you would need to know.
- After your experience, could you describe in a few words what is the Circular Economy?
- Please write any additional comments or recommendations.

The responses of the participants are exposed below:

- Write a word or term that describes your experience during the game
  - Learning (Participant 1)
  - Challenge (Participant 2)

- What aspect was new, most surprising or interesting to you and why?
  - The aspect that caught my attention the most was the idea of learning about economics through a game. I never thought that this was possible, in fact I thought that the economy was very complex but as I played, I began to understand certain concepts better that I didn't understand before. (Participant 1)
  - It was very accurate to reality: you had to plan your actions well, adjust to unforeseen events and understand the concepts. (Participant 2)
- Do you think that previous knowledge is needed to play the ecoCEO game? If your answer is yes, describe in a few words what you would need to know.
  - I believe that prior knowledge is needed to get the most out of the game, knowledge for investment for example. (Participant 1)
  - They are not required, but are recommended. The more you know about the concepts, the more chances of winning you have. (Participant 2)
- After your experience, could you describe in a few words what is the Circular Economy?
  - It is the economy that revolves around the product, seeking not to waste, but to reuse, repair and thus give the product a longer useful life. (Participant 1)
  - The circular economy is a stream of economic activity that seeks to reuse materials so they are not wasted. On the other hand, with the linear economy, it is more sustainable since it tends to prevent the scarcity of natural and human resources thanks to innovations that allow it to reuse its products and resources. (Participant 2)
- Please write any additional comments or recommendations.
  - I really liked the game; I would like to have been taught economics like this at school. I suggest in future investigations to adapt it to Spanish. (Participant 1)
  - It's fun and educational, but it's very challenging. I think it would be nice to watch a video or read a case study of the circular economy and linear economy in companies to better understand this challenge. (Participant 2)

It is possible to conclude that although the game does not require prior knowledge about the circular economy, it does require prior knowledge about economic concepts such as: scarcity, choice, efficiency, equity, economic well-being, sustainability, change, interdependence and intervention, as well as investment and closed looped production. In order to play the game, and make the most of it, students must have had an introduction to key IB concepts as well as the economic principles of supply and demand.

It is considered that the game, in addition to promoting critical thinking and an approach to the circular economy, is an excellent way to encourage students to deepen the key concepts of the subject, so that they are familiar to them and can include them in their vocabulary and economic thought, and be ready to apply them in the internal assessment, where they are asked to include one key concept to their work.

Moreover, it was interesting to play the game with two teachers, it was possible to observe that although the game is made for high school learners, it implied a challenge to be able to understand the dynamics of the game and make the right decisions to earn victory points. Undoubtedly, the highest categories of the bloom taxonomy are worked on.

#### **d. Summary, Conclusions, and Recommendations**

##### **i. Summary and conclusions**

The present work presents a teaching tool that allows IB economics teachers to deepen their teaching about the benefits, complexity, and importance of Circular Economy. The author proposes a Unit Planner based on serious game for Unit 2. Microeconomics, point 2.7 Role of government in microeconomics as a complement of the IB economics program. The Unit Planner is based on the following inquiry question: How a country's economy could thrive without depending on the overuse of finite resources and still meet people's needs? And it also provides an explanation of how the students can be assessed, it has to be mentioned that the assessment provides an excellent opportunity to prepare students for the Internal Assessment.

To sum up, it has been decided to propose a Unit Planner using the serious game ecoCEO, due to the fact that not all students are engaged with sustainability issues. Since serious games provide the opportunity to transcend the purpose of entertainment leading to a

change in the behavior in order that scholars develop skills and create awareness towards sustainability. This happens because serious games require students to take a specific role without the real consequences of their actions; nevertheless, they are motivated to use their problem-solving skills and decide what to do, when to do it, what are the goals they are pursuing in order to become change agents for a more sustainable society.

What is more, according to the literature, learning about Circular Economy means that education for sustainability is implicit; when there is a change in the curriculum in terms of design thinking and practice, the knowledge and the ability to apply the principles of Circular Economy are integrated (Andrews, 2015). This means that instead of imposing a particular type of change, Education for Sustainable Development leads to a change in the individual behavior, developing responsibility, passion, and interest; and a social change is achieved. It is also important to mention that the objectives of the IB program are achieved through the proposed Unit Planner since it proposes an inquiry-based activity, allowing students to learn with enthusiasm, being engaged with local and global issues, analyze and take responsible actions, act with integrity and honesty, learning to communicate and listen to others by evaluating a range point of view. The Unit Planner also seeks that scholars develop empathy, compassion, and respect to the environment and the societies; being resilient in front of constant changes, as well as being able to recognize the interdependence between the different actors of the society and the environment.

It is also concluded that the Unit Planner is aligned with the areas of work of the UNESCO in the Education for Sustainable Development, as well as the 27th Conference of the Parties of the UNFCCC (COP27), ACE, which supports the thesis that climate change start with education. It is crucial that young learners are empowered to make informed decisions and take individual and collective actions that change society and care for the planet (UNESCO, 2022). The author proposes the implementation of ecoCEO game due to the fact that through experiential learning students are involved in their learning process and this encourages them to “shape their world” with integrity; allowing them to grasp the relationship between concepts, their behavior, preferences and experiences. In summary, it is crucial that 21<sup>st</sup> century schools find the balance between a between “traditional classroom experiences” (seminars, lectures) and experiential ones (games, collaborative research, project work).

Finally, it is worth mentioning some of the limitations that the author found during the development of the present study. The main issue was that I wasn't able to implement the game in a classroom and evaluate the outcomes of the game in a real scenario. It will be extremely interesting to appraise and confirm the literature proposed about experiential and game-based learning methodology. As well as weight the degree of development of the different skills mentioned before on the students. Nevertheless, it is planned to implement the Unit Planner developed in the near future, when its creator actually has her own class.

## **ii. Recommendations**

In this final section some recommendations are going to be considered for future research work. First of all, it is highly recommended to implement the game in a real economic classroom. Based on the experience of the simulation it is suggested to do so at the end of Unit 2. Microeconomics, real-world issue 1 "How do consumers and producers make choices in trying to meet their economic objectives?". This is because at the end of this part of the IB curriculum, students are familiar with economic principles as well as with the key concepts proposed by the IB organization. As mentioned before, the skills acquired in this first stage of inquiry will help students to take advantage of the game in a better way. By doing so, it will be possible to analyze and evaluate to what extent the objectives set by UNESCO and the IB learner profile are met, referring to content as well as skills and abilities, and of course to the development of a sustainable mentality.

On the other hand, taking into consideration that games must be integrated with specific themes and outcomes, in order for Game Based Learning to reach its full potential, and that professors should promote an alignment between the game design and the instructional goals (Crocco et al., 2016), it proposed that teachers who would like to use ecoCEO game in their classes should play the game before applying it. And once they are familiar with the game and after taking into account the necessities of their students, professors can apply the ecoCEO game and guide the students to delve into the Circular Economy. It is also recommended to apply the game with different class generations and evaluate over time if a sustainable mentality is really achieved. In this way instructors can verify that they are actually applying an experiential methodology, which according with Chapman, McPhee, & Proudman (1992), this approach is not linear, cyclical or even

patterned; but series of working principles that must be present to varying degrees at some time during the experience. This can be achieved through an evaluation process of repeated playing. It is hoped that the author of this study can apply these recommendations and be able to make a deeper contribution to the field of education, sustainable education and, of course, provide a better tool that enriches the IB curriculum.

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## 5. Appendices

### a. Appendix 1 – Game Rules

The rules are available online, teachers are allowed to download all the materials for free at the following link: <https://ecoceo.vito.be/en/teaching-activities>

#### WELCOME TO BUSINESS LIFE!

You have been appointed CEO of a small company producing electronic microchips. Make clever decisions and smart investments to outdo your industry competitors. But beware! To produce you will need resources such as fossil fuels, rare earths and metals, which are finite raw materials that will soon be exhausted if global production and consumption patterns don't change.

Try to build and run a profitable company that is able to withstand sudden price rises, technological and economic changes, and establish a production process and business model that withstand the challenges of resource scarcity and production waste.

Come out on top against competing microchip producers and earn the title of ecocEO, the most successful and resource-responsible entrepreneur.

It's your business! What are you waiting for?

#### GAME SET-UP

**The companies**  
Play with 3 or 4 companies, either individually or in teams of 2 players. Every player or team receives a company board ('linear economy') with a starting portfolio consisting of a mining site, a microchip factory, 2 employees, 4 resource cards, 1 actions card and a starting capital of 8 credits.

**The public facilities**  
The market, the waste depot and the remaining credits (bank) are placed in the centre of the table.

**The resource deposit**  
Separate the resource cards into stack A (blue cards) and stack B (green and yellow cards). Add 2 random event cards (purple cards) to each stack and shuffle both stacks individually. Put Megawent-stage 1 on top of stack A and Megawent-stage 2 at the bottom of stack A. Put the prepared stack A in the middle of the table as a resource deposit. Put stack B and Megawent-stage 3 to the side; they will only come in later in the game. Put the prepared resource depot in the middle of the table, next to the public facilities.

#### RESOURCE CARDS

Resource cards have 2 separate features that are independent from each other. A resource card can be used as a resource for production OR as an investment to extend your company.

There are 3 different resource types, depicted in the upper left corner of each card (1), and 8 different investment options, indicated in the centre of the card (2).

These investments can be subdivided into 2 different types:

- Business activities** can be recognised by the worker space. These investments expand your company with new actions to which you can allocate an employee.
- Upgrades** can be recognised by the coloured ribbon at the right side of the card. They can be added to business activities of the same colour to improve their performance. The benefits of the upgrade investment only become active when the corresponding business activity is also in place. Upgrades only affect the business activity they are connected to; they cannot be shifted towards other activities during the game.

#### EVENTS

Day-to-day business can be interrupted by events. While performing the 'mining' activity, a player may draw an event card. When this happens, the player finishes his/her mining action and reads the information on the event card out loud. Events affect all players. Players must fulfil the indicated action to the best of their ability. Players who cannot or can only partially execute the event-related action must skip their next turn. After the event has taken place, the player can finish the remainder of his/her turn. The event card counts as a mined card; it cannot be replaced by drawing a new resource card.

#### BUSINESS ACTIONS AND INVESTMENTS IN STAGE I

The business activities initially available in Stage I are mining and production, and each of them requires an employee to operate it.

**MINING**  
Allocating an employee to mining allows you to draw 2 new resource cards from the central resource pile to add to your hand. Hand Limit: You can have a maximum of 7 resource cards at the end of your turn. Any surplus cards (of your choice) are lost to the waste depot.

**PRODUCTION**  
To produce a microchip, you need to allocate an employee to the factory and supply the 3 resources indicated on the card. 1 of the supplied resource cards (arbitrarily) is placed face-down on the microchip factory to symbolise the finished product. The remaining resources are regarded as production waste and are placed face-down on the waste depot. The microchip can be sold to the market for 2 credits.

**There are 2 investment cards for new business activities in Stage I:**

**A mobile phone factory**  
You can extend your product portfolio by producing mobile phones. To produce a mobile phone, you need to allocate an employee to the factory and supply 1 finished microchip and an additional resource of the indicated colour. When producing you move the microchip to the mobile phone factory to represent the finished phone, while the additional resource is discarded as production waste to the waste depot. The mobile phone can be sold to the market for a higher revenue of 5 credits.

#### QUICKSTART? CHECK OUT THE VIDEO TUTORIALS ON OUR WEBSITE

**INTRODUCTION**   **STAGE I**   **STAGE II**

#### YOUR MISSION

Your mission as an entrepreneur is to develop a thriving business.

Make smart investments to strengthen your company. Safeguard your resource supply, diversify your product portfolio, improve your production process, respond to global challenges and try new business models to maximise your profits.

Your success is measured in victory points. Gain them through investments, awards and the remuneration of financial capital.

#### GAME PLAY

Agree on a starting player and take turns in a clockwise direction.

#### ACTIONS

A turn consists of the following actions in a set order. None of the actions are obligatory.

- Invest** in 1 of the business activities/upgrades indicated on the resource cards in your hand. An investment is made by paying the one-time investment fee (indicated on the card) to the bank and placing the card in the designated spot on your company board. A new investment can be operated in the same turn by assigning an employee to it. Investments remain available throughout the rest of the gameplay. They cannot be removed or exchanged.
- Allocate your employees to business activities.** Place your employees on the available business activities. Each employee can only perform one activity per turn, but you can place both employees on the same activity. Once both employees have been assigned, the chosen activities may be performed in any order you wish.
- Sell finished products to the market.** Revenues depend on the product type and are indicated on the central market. When selling, you put your finished products on the market and receive the number of credits indicated. You can sell any number of products at the same time.

**Feeling stuck? During your turn you can trade resource cards and credits with other players.**

#### STAGES OF THE GAME

The game consists of 2 stages:

**Stage I** is played on the linear economy company board. Players learn about the production and sales processes in a linear economy, including efficiency measures and resource substitution strategies.

**Stage II** introduces the concept of a circular economy, including recycling, take-back systems, reuse, repair and product-service systems. In this phase the circular economy company board comes into play, as well as a new set of investment cards and possible business activities.

#### AN e-bike factory

This is operated in the same way as mobile phone factory but requires 1 microchip and 2 additional resources. The e-bike can be sold to the market for a higher revenue of 7 credits.

**Sell or store?** Finished products can be sold to the market straight away or stored on the factory card for further processing (you can always sell a stored product later on).

**There are 2 investment cards for factory upgrades in Stage I:**

**Resource efficiency:** allows you to produce the same product with 1 resource (of your choice) less.

**Resource substitution:** allows you to swap 1 resource for another resource when producing.

These upgrades can be used for all factories, but only one upgrade card can be added per factory. An upgrade only applies to the factory it is attached to. Upgrades cannot be switched between factories during the game; they remain attached to the factory they were originally assigned to.

**AWARD: Efficient production**  
If you succeeded in filling all the investment gaps on the linear economy company board by the end of the game, you will be rewarded with the EFFICIENT PRODUCTION AWARD and will receive 3 victory points for your efforts towards a more resource-efficient production process.

**Mega event I announces the start of Stage II.**  
Linear production processes put a strain on the world's resource deposits and raw materials are running out fast. Producers need to look for new methods to recycle production waste, reuse parts and repair broken products. Investing in circular economy measures is the only way to secure the survival of their company and prevent a global raw materials crisis.

**Following Mega event I:**  
Take all cards from the waste depot and mix them with stack B which was kept aside. Next, put Mega event II approximately in the middle of the card stack.

Each player receives an additional company board 'circular economy', which is put next to the 'linear economy' board.

#### BUSINESS ACTIONS AND INVESTMENTS IN STAGE II

In Stage II, all Stage I cards remain active, but 5 new business activities:

**Waste recycling:** this business activity allows you to reclaim resource cards from the waste depot as an alternative for primary mining. For every employee you assign to waste recycling, you can draw 4 cards from the waste depot and choose 2 to keep. The other 2 are placed back at the bottom of the waste pile, face down.

**Take back & sell for scrap:** this investment allows you to take back a product from the market and sell it to the waste depot for credit.

**Renting service:** this business activity allows you to rent out the mobile phone or e-bike you produced for a fee, instead of selling it. By allocating an employee, you can introduce an unlimited number of products into the renting system (set use phase), while the products already present in the renting system from earlier rounds are all 'serviced' and move clockwise to their next use phase. For each product that is rented out, the player receives a renting fee, regardless of the use phase it is in (3 credits for a mobile phone, 4 for an e-bike). Products in the 3rd use phase move to the waste depot upon the following clockwise turn.

**In Stage II, there are 2 new upgrade investments:**

**Microchip reuse:** this investment is an upgrade to the take-back & sell as scrap business activity. It allows players to reuse any take-back product from the market as a microchip. The chip can either be used in a mobile phone/e-bike factory or sold back to the market for the full price.

#### Design for repair:

This investment is an upgrade to the 'renting service'. It allows players to repair products that are end-of-life, which prevents them from moving to the waste depot after their 3rd use. By adding the resource depicted on the investment card (i.e. it is put in the waste depot) for the repair process, the product returns to the 1st use phase again and continues to yield revenue.

**Events**  
More events will occur in Phase II, including Mega event II, introducing material scarcity. Material scarcity has become a serious problem for companies. From now on, the mining activity will only yield one resource card instead of two. Waste recycling is not affected by this event.

**AWARD: Closed loops**  
During Stage II the focus is on circular economy measures and establishing closed loops. Take-back & sell for scrap in combination with microchip reuse creates a closed loop for microchips, which is worth 3 victory points at the end of the game. A renting service with design for remanufacturing creates a closed loop for products (mobile phones or e-bikes), which yields 4 victory points at the end of the game.

#### END OF THE GAME & END SCORE

The game ends when:  
the resource pile runs out;  
the game ends immediately.

a player has made all 8 investments;  
after the 8th investment has been made, the player completes his/her turn and all other players can take a final turn.

after 60 minutes of play;  
the final round is announced.

The strength of your company is measured in victory points. Count the victory points on your investment cards and on the awards you have earned. Additionally, your financial capital is converted into victory points (every 5 credits = 1 VP).

The entrepreneur with the most victory points wins the game and earns the title of ecocEO. In case of a draw, the player with the most assets (then investments, then credits) is the winner.

# ECO CEO

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**vito**   **Wuppertal Institut**

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## b. Appendix 2 - Simulation Game

### STAGE I





STAGE II



c. Appendix 3 – Google forms

Participant 1.

## Evaluación ecoCEO game

Gracias por jugar conmigo ecoCEO game!

Nombre \*

\_Andrea Tisalema\_

Escribe una palabra o término que describa tu experiencia durante el juego juego \*

\_Aprendizaje\_

¿Qué aspecto fue nuevo, más sorprendente o interesante para ti y por qué? \*

El aspecto que mas me llamo la atención fue la idea de aprender sobre economía a través de un juego. Jamás pensé que eso fuera posible, de hecho pensaba que la economía era muy compleja pero al jugar iba  
\_comprendiendo mejor ciertos conceptos que antes no los comprendía\_

¿Crees que se necesitan conocimientos previos para jugar ecoCEO game? Si tu respuesta es \*  
sí, describe en pocas palabras qué necesitarías saber.

Considero que si se necesitan conocimientos previos para sacar mayor provecho al juego, conocimientos  
\_de inversiones\_

Después de tu experiencia, podrías describir en pocas palabras ¿qué es la economía circular? \*

Es la economía que gira entorno al producto, busca no desperdiciar, reutilizarlo, reparar y así dar mas  
\_ tiempo de vida útil al producto. ....

Por favor, escribe cualquier comentario adicional o recomendación.

Muchas gracias por tu ayuda.

Me gusto mucho el juego, me hubiera gustado que me enseñaran economía así en el colegio. Sugiero en  
\_ próximas investigaciones adaptarlo al español. ....

Este formulario se creó en  
Universidad de Navarra.

GoogleFormularios

Participant 2.

## Evaluación ecoCEO game

Gracias por jugar conmigo ecoCEO game!

Nombre \*

\_Adeliya.....

Escribe una palabra o término que describa tu experiencia durante el juego juego \*

\_reto.....

¿Qué aspecto fue nuevo, más sorprendente o interesante para ti y por qué? \*

Era muy ajustado a la realidad: habia que planear bien las acciones, ajustarse a los eventos imprevistos y  
\_entender los conceptos.....

¿Crees que se necesitan conocimientos previos para jugar ecoCEO game? Si tu respuesta es \*  
sí, describe en pocas palabras qué necesitarías saber.

No son necesarios, pero son recomendados. Cuanto más sabes sobre los conceptos, más oportunidad de  
\_ganar tienes.....



Después de tu experiencia, podrías describir en pocas palabras ¿qué es la economía circular? \*

La economía circular es un flujo de actividad económica que busca volver a utilizar los materiales para que no se desperdician. En cambio con la economía lineal, es más sostenible ya que tiende a prevenir la escasez de recursos naturales y humanos gracias a las innovaciones que le permiten volver a utilizar sus productos y recursos.

Por favor, escribe cualquier comentario adicional o recomendación.

Muchas gracias por tu ayuda.

Es divertido y educativo, pero plantea mucho reto. Creo que estaría bien ver un vídeo o leer un caso de la economía circular y economía lineal en las empresas para entender mejor de este reto.

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