sustainability

MDPI

Article

Multiple Intelligence Informed Resources for Addressing Sustainable Development Goals in Management Engineering

Begoña Etxebarria [1], Francisco Sánchez [1], Naiara Rojo [2] and Astrid Barona [3,]*

[1] Department of Business Administration, Faculty of Engineering of Bilbao, University of the Basque Country UPV/EHU, Torres Quevedo 1, 48013 Bilbao, Spain; mariabegona.echevarriar@ehu.eus (B.E.); francisco.sanchez@ehu.eus (F.S.)
[2] Department of Chemical and Environmental Engineering, Faculty of Engineering of Vitoria-Gasteiz, University of the Basque Country UPV/EHU, Nieves Cano 12, 01006 Vitoria-Gasteiz, Spain; naiara.rojo@ehu.eus
[3] Department of Chemical and Environmental Engineering, Faculty of Engineering of Bilbao, University of the Basque Country UPV/EHU, Torres Quevedo 1, 48013 Bilbao, Spain
* Correspondence: astrid.barona@ehu.eus

Abstract: The competence-based model focuses on acquiring skills and abilities, yet each student's individual circumstances condition the way in which they learn, develop, and implement them. Accordingly, there is a growing interest in defining learning activities that consider the diverse range of intelligences, abilities, and prevailing mindsets in each individual in order to promote inclusive education and sustainable development. This article seeks to design a methodology for the teaching–learning resources associated with the nature of the prevailing intelligence in the competence-based model. Thus, the "competence-intelligence-resource triangle" was proposed for promoting inclusive education in the degree in Management Engineering at the University of the Basque Country (UPV/EHU). A total of 99 teaching–learning resources, 11 competences, and 9 types of intelligence were combined. As far as the multiple intelligence approach is concerned, the 50 students surveyed prioritized logical–mathematical, interpersonal, intrapersonal, linguistic, and spatial intelligences. As a conclusion, the use of teaching–learning resources designed for promoting different types of intelligence in the competence-based model constitutes an adaptive strategy for the students to successfully acquire competences.

Keywords: multiple intelligences; competence; teaching–learning resources; engineering; inclusive education; sustainable development goal

check for updates

Citation: Etxebarria, B.; Sánchez, F.; Rojo, N.; Barona, A. Multiple Intelligence Informed Resources for Addressing Sustainable Development Goals in Management Engineering. *Sustainability* **2022**, *14*, 8439. https://doi.org/10.3390/su14148439

Academic Editor: Antonis A. Zorpas

Received: 30 May 2022
Accepted: 8 July 2022
Published: 10 July 2022

1. Introduction

The path to sustainable development involves the introduction of innovative initiatives at societal, environmental, political, and financial levels in order to reduce the heterogeneous sustainability performance in different countries [1]. The UNESCO 2030 agenda for sustainable development reinforces the importance of inclusive education through Sustainable Development Goal 4 (SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all) [2].

All education and instruction (from primary school through to the labor market) should include the sustainability perspective by reinforcing behavioral changes [3]. Higher education institutions (HEIs) are beginning to make more systemic changes towards sustainability by re-orienting their education, research, publications, synergies, operations, and community outreach activities, either simultaneously or, which is more often the case, as a subset thereof [4,5]. Higher education is uniquely placed to play a leading role in the attainment of sustainable development, but if it is to be transformative, it clearly needs to transform itself first, including in its teaching–learning practices [6].

Traditional practices, such as a one-off exam to assess the acquisition of knowledge or the primacy of knowledge over know-how, have now been discredited, and new inclusive alternatives are being developed worldwide [7]. Thus, knowledge has been structured into related concepts known as semantic networks, with new information constantly being added. Depending on how this connection is made, new information can be used to solve problems or recognize situations, redefining the concept of learning as a process and not simply as the reception and accumulation of knowledge [8–10]. New technologies now play a crucial role for sustainable development, and young people use digital technology and gather information much faster than ever before [11–13]. In particular, the global COVID-19 pandemic has boosted the widespread use of digital technologies in education [14]. Thus, learning models need to be modified accordingly.

The widely accepted competence-based learning (CBL) model was prompted by the 1999 Bologna Declaration, when for the first time ever ministers of education from 29 European countries agreed to adopt a system of readily understandable and comparable degrees with a common structure for undergraduate and graduate cycles across higher education. This sea change emphasized the need to assess students using quantifiable competences. It therefore meant that competence-based education (CBE) became a leading paradigm in educational reform [15–17], as the essence of 21st-century skills involves focusing on what students can do with knowledge, rather than on the units of knowledge they can memorize [18].

Competence can be defined as the visible elements (knowledge and technical skills) and underlying features (attitudes, traits, and motives) that boost job performance [19]. The classification into subject-specific and generic competences refers to the particular skills required for any given purpose. Specific competences are those connected with the technical aspects of improving knowledge; they play a crucial role in preparing students for their profession. Generic ones, also called core, key, soft, transferable, employability or life competences, are related to personal interaction and identify the mainstream attributes that are common to many degrees [20–24]. In fact, a modified definition of soft skills as a dynamic combination of cognitive and meta-cognitive, interpersonal, intellectual, and practical skills has been proposed [25]. According to that definition, soft skills help people to adapt and behave positively so that they can deal effectively with the challenges of their professional and daily lives. Some authors [26,27] have analyzed the particular skills that facilitate new graduates' success in the workplace, concluding that the "ability and willingness to learn", "teamwork and cooperation", "hard-working and willingness to take on extra work", "self-control", and "analytical thinking" are the main ones.

Some of the challenges of transitioning from a lecture-based approach to experiential learning require specific skills, such as those needed for self-awareness, integrity and ethical decision making, interpersonal relations, communication, problem solving, project management, teamwork and team development, conflict resolution, planning, organization and strategy formulation, coaching and mentoring, time management and prioritization, and cultural awareness and global agility [28]. Companies and HEIs need to work together not only to increase students' awareness of the importance of soft skills, but also to guide them in taking individual responsibility for acquiring and developing these essential skills [25]. Similarly, emphasis has been placed on the importance of active mentoring to enhance students' confidence, competence, and even psychological support, as necessary elements for thriving in an environment of volatility, uncertainty, complexity, and ambiguity (VUCA), such as that generated by the COVID-19 pandemic or climate change [29].

The development of meta-cognitive skills promotes a better and more effective learning process. This involves honing the skills that allow students to judge the difficulty of problems, to decide whether they understand the text, to identify the alternative strategies for digesting the documentation, to conduct a peer review of their classmates' work, and to assess their own progress in knowledge acquisition [30–32]. During this process, students work with their peers and constantly discuss and evaluate what they have learned. Active methodologies use strategies to support this process. The literature has proposed a set of teaching and learning strategies that will enable students to acquire these skills, such as the case method, creative thinking tools, problem-based learning, multi-criteria decision-making tools in stepwise benchmarking, and project-based learning [33,34]. CBL is becoming more widely used in engineering education, and there is evidence to support its effectiveness in improving learning outcomes, meeting the needs of diverse student populations, and responding to industry's demand for competent engineers [35]. Nevertheless, HEIs differ in the extent to which they adopt a CBE approach, and there are many hurdles to overcome before they actually implement it in their curricula [36].

All these methodologies stress that instruction should involve real-world problems and professional practice, catering for situations that reflect the students' future professional settings as closely as possible. The contextualization of oriented teaching promotes a positive inclusive attitude, which is essential for ensuring learning by understanding with equal opportunities [37]. It also enables students to deal with real-life problems with a similar level of difficulty and complexity to those they will encounter in their working lives, despite the present VUCA environment.

This study proposes a new methodology based on the design of learning–teaching resources that respond to the unique nature of each student to guide them towards the acquisition of competences in engineering studies. Considering the different types of intelligence involved in the overall learning process, this methodology seeks to improve the acquisition of competences in HEIs using resources connected with the types of intelligences and competences.

Thus, this study comprises a literature review, the selection of the model degree for the subsequent describing of the methodology, and two questionnaires that have been designed to identify the most relevant intelligences for competence acquisition, according to the respondents' own experience.

2. Literature Review

Competences respond to a context of rapid social and economic transition. There has been a palpable change in the productive model over the past 50 years, moving from an industrial society with a serial production model targeting stable markets and with a business sector based on large organizations, to the present one of flexible, highly competitive, and deregulated production (Figure 1). Today's society and its economic sectors are living in a VUCA environment that is evolving at a vertiginous and digitalized pace [29].

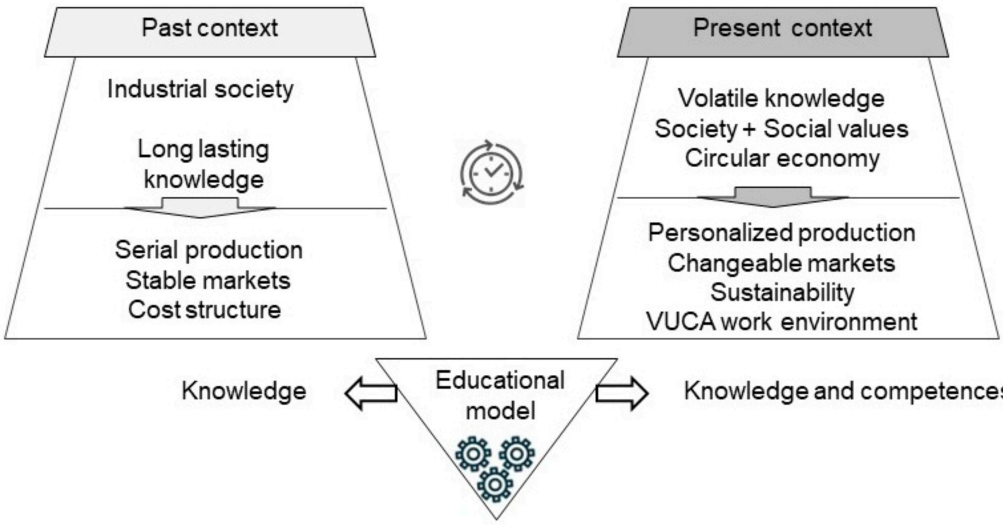

Figure 1. Past and present context for the educational model.

These changes entail new skills rather than knowledge-related professional needs; in other words, if knowledge is the mainstay enabling managers to carry out their role in a traditional organizational structure (some plan and others execute orders), knowledge now has to be complemented by such competences as the skills required for teamwork, better group management, and engagement with the organization. Similarly, the need for sustainable development and social transformation is becoming increasingly important, and social learning processes are being required to contribute to a real change, which is why the Agenda 2030 and the World Action Program have reiterated the importance of inclusive education and flagged it as one of their priorities [38].

Demographic, socio-economic, and technological evolution has a major impact on the higher education model, and it calls for a paradigm shift in teaching and learning, as higher education is responsible for graduates' ultimate preparation for the job market [33,39]. Education provides lasting knowledge, but this is now volatile, and the ability to find, discriminate, apply, and update it is essential in a highly dynamic environment [40].

One of the aspects on which university teaching reforms have placed particular emphasis is the detailed description of the competences that students need to acquire as future knowledge workers. Regardless of the significance of the competences, their accurate identification and classification are crucial for fulfilling their objectives [41]. This task has already been carried out in recent years and has led to a catalogue of competences that is under continuous review. Nevertheless, this catalogue has been criticized for placing too much emphasis on the technical competences derived from business needs rather than on those that stimulate critical thinking; a balance therefore needs to be struck between pragmatism and reflection. It is noteworthy that the CBL model is dynamic and reviewable, as it needs to adjust to changes in society and business over time (Figure 2). For example, the COVID-19 pandemic has triggered the largest ever disruption of education systems and has prompted changes and innovation within the education sector. Distance learning and digital skills solutions have been quickly developed and applied, and one of the lessons learnt from the pandemic, therefore, is that digital competences will have to be reviewed and strengthened in the future.

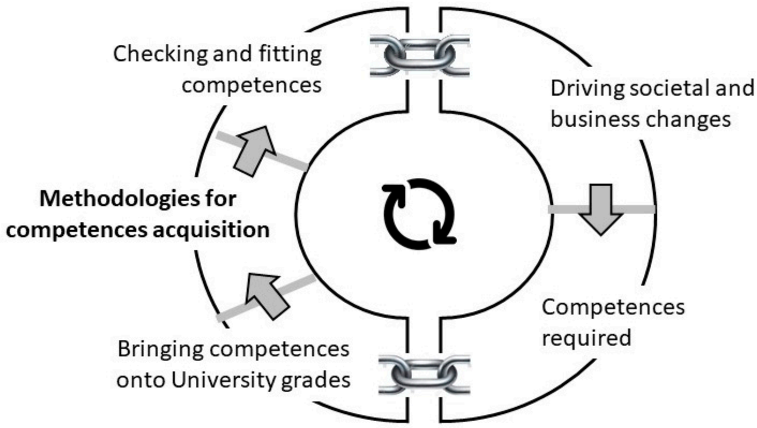

Figure 2. The dynamic process for identifying competences and their subsequent implementation in HEIs.

2.1. Multiple Intelligences

The current CBE model focuses on active methodologies, although they have unfortunately been designed and applied without considering the variety of student profiles, and therefore make knowledge acquisition less effective. This teaching approach does not adapt the content and formats to the wide range of students in the classroom in terms of level of knowledge and learning ability. There is therefore a need to adapt inclusive instructional practices and assessment methods that are both consistent with the teaching strategies at HEIs and sensitive to students' idiosyncrasies [42].

With each individual's particular profile in mind, in 1983 Howard Gardner proposed a new concept whereby each human being has a "unique combination of intelligences" [43]. This author stated that the traditional vision of intelligence and the single measurement of the intelligence quotient (IQ) did not take into account each individual's entire skills' set. This theory has become known as the theory of Multiple Intelligences (MI), which initially defined seven components of intelligence, as described below.

(1) Logical/Mathematical Intelligence: The ability to construct solutions and resolve problems involving numbers and reasoning. This intelligence can be attributed to scientists. For many years, it has been considered the highest expression of human intelligence. Nevertheless, the psychological study of intelligence has steadily evolved, resulting in the proposal of more open options. Thus, together with the development of the MI theory, the development of intelligence can be understood by analyzing its relationship to three aspects, namely the individual's internal world (what happens in our brain when we think rationally), personal experience (how intelligence affects that type of experience), and the external world (how an individual's interaction with society affects their intelligence, and vice versa) [44].

(2) Linguistic Intelligence: The ability to manage and structure the meanings and functions of words and language, as attributed to writers, poets, proficient editors, and public speakers.

(3) Spatial Intelligence: The ability to form and imagine drawings in two and three dimensions, and the ability to understand, handle, and modify the configurations of broad and defined space. This is the intelligence of architects, pilots, sailors, chess players, surgeons, artists, painters, graphic artists, and sculptors.

(4) Musical Intelligence: The ability to perceive, distinguish, transform, and express musical forms. It includes sensitivity to rhythm, tone, and timbre. It is attributed to musicians, including composers, singers, instrumentalists, and dancers.

(5) Bodily/Kinesthetic Intelligence: The ability to use one's body to express and transmit skills, ideas, and feelings. This is the intelligence of athletes, artisans, surgeons, and dancers.

(6) Intrapersonal Intelligence: The ability to understand one's own emotions and feelings. In other words, a person's ability to construct an accurate perception of themselves and use this knowledge to organize and direct their own lives [45]. This is the intelligence of theologians, teachers, psychologists, and counsellors.

(7) Interpersonal Intelligence: The ability to understand others and communicate with them, taking into account their different personalities, temperaments, motivations, and skills. This is the intelligence of teachers, therapists, counselors, politicians, salespeople, and leaders.

Subsequent to his first proposal, Gardner added the additional components of naturalist and existential intelligence for completing the concept:

(8) Naturalist Intelligence: The ability to communicate with nature, understand our natural environment, and make scientific observations. This is the intelligence directly developed by biologists, geologists, and astronomers.

(9) Existential intelligence: The ability to place oneself in relation to the cosmos. It is the intelligence inherent to abstract thinkers and philosophers.

Other scientists have proposed additional components of intelligence, suggesting that, amongst others, spiritual intelligence, attention, and particularly digital intelligence should also be included [46,47]. Although the literature on the MI theory is becoming more extensive, it also has numerous detractors, especially those who claim that this theory lacks empirical evidence [48,49].

2.2. The Concept of Intelligence in an Educational Context

For many years, IQ tests were used to label a person as more or less intelligent, with these tests determining logical/mathematical skills as the driving force behind any type of success. Nevertheless, a high IQ or a personal history of recognized academic success does not necessarily guarantee the successful achievement of future objectives. Similarly, the human brain can change its structure based on experiences, which means students´ brains make new connections every time they learn, whereby their intelligence can increase (or change) as a result of their experience, interest, and efforts.

Although each person´s intelligence is dynamic and malleable, the classical "educational paradigm" enforces and overestimates the first two types of intelligence described by Gardner (logical/mathematical and linguistic) to the detriment of the others. The direct consequences of this approach are that students with lower percentages for these types of intelligence record a lack of motivation as they are unable to achieve the level required and to adapt to the traditional concept of intelligence. Additionally, considering that knowledge and competences are designed to be assimilated according to these types of intelligence, those students whose learning flow is based on components of intelligence other than logical/mathematical and linguistic intelligence are liable to feel frustrated.

Recognition of the existence of different intelligences means that alternative resources should be found for the teaching–learning process. Thus, it has been postulated that different paths should be followed depending on the predominant type of intelligence in each individual [50].

The interest in adapting teaching–learning resources according to the nine types of intelligences has prompted us to propose the methodology presented here.

3. Materials and Methods

The university degree in Management Engineering (or Industrial Organization Engineering) taught in the Faculty of Engineering of Bilbao at the UPV-EHU was selected for presenting the methodology, as a tool for reinforcing the competences of any degree by proposing teaching–learning resources focused on the predominant intelligence of one or more students. Thus, the competences considered secondary for many traditional engineering degrees can be prioritized.

Future management engineers (like many other engineers) will be engaged in activities involving team management and the successful acquisition of generic skills that are particularly relevant in this degree. In fact, today´s managers need numerous abilities and skills, such as: (1) a broad vision and understanding of the market context, its dynamics and driving forces; (2) a mastery of tools to improve the quality of human resources and to work with personnel fully while considering different values and models of communication, the organization of innovative processes, and teamwork; (3) entrepreneurial initiative; and (4) the ability to quickly implement innovative business models and various changes [51]. Additionally, the ability to implement proactive management is also necessary to tackle unexpected changes and situations, such as the ones generated by the COVID-19 pandemic or climate change (proactive management can be defined as a set of technical, organizational, and economic measures and resources implemented at all levels of an industry or of a business, which are aimed at preventing the negative impact of internal and external factors threatening sustainability, functionality, competitiveness, and economic and environmental efficiency) [51].

The first step in the preparation of the methodology was to identify the particular competences to be acquired by graduates in Management Engineering at UPV/EHU. Those competences were established by Spain's National Agency for Quality Assessment and Accreditation (ANECA), and they were based on previous studies, evaluation reports, and feedback from academics, industrialists, researchers, and entrepreneurs [52]. In the particular case of Management Engineering, the following ones were established:

(1) Analyze and evaluate the social and environmental impact of technical solutions.
(2) Organize and plan tasks in a company setting, as well as in other institutions and organizations.
(3) Solve problems with initiative, creativity, and critical reasoning, and communicate and transmit knowledge, skills, and abilities in the field of Management Engineering.
(4) Work in a multilingual and multidisciplinary environment.
(5) Apply quality principles and methods.
(6) Comply with statutory specifications, regulations, and guidelines.

(7) Manage the particular activities involved in projects in the field of Management Engineering.
(8) Draft, sign, and implement projects and reports in Management Engineering.
(9) Master the basic and technological aspects necessary to learn new methods and theories for tackling new situations.
(10) Understand and apply legislation related to activities in Management Engineering.
(11) Carry out measurements, calculations, assessments, expert work, studies, reports, working plans, and other similar tasks.

The second step entails gathering all the teaching–learning resources available for the successful acquisition of the aforementioned competences. Teaching–learning resources are considered to be those materials and activities and/or procedures for the development of competences in an educational context. The next step involves selecting and grouping the teaching–learning resources of greatest use in helping students to acquire a particular competence. This selection has been specifically made on the basis of the preferential type of intelligence required. Figure 3 shows the three features of the methodology proposed: the target competence, the selection of the teaching–learning resources, and the preferential type of intelligence related to each resource. It is called the "competence-intelligence-resource triangle".

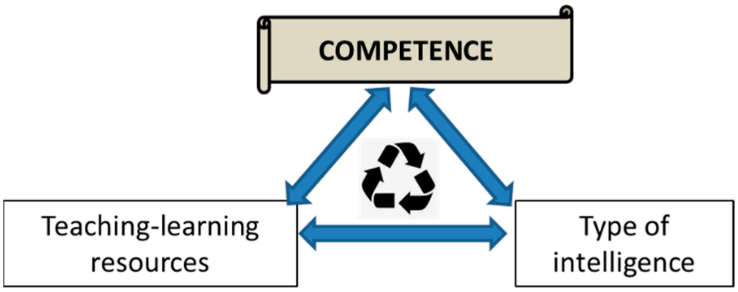

Figure 3. Outline of the process proposed in the methodology (competence–intelligence–resource triangle).

Additionally, the students in their final year in Management Engineering were asked to complete a first questionnaire in order to determine whether they were aware of the theory of MI. They were also asked to prioritize the nine intelligences, according to their experience in the degree.

Based on the results, a second questionnaire was designed for assessing the most relevant intelligences according to the number of competences that were prioritized. Each item presented a target objective and six possible resources (or activities) for fulfilling the objective. Each target objective was related to a competence, and the possible resources or activities were linked to the types of intelligence, but the respondents were not informed about these relationships (blind questionnaire).

Fifty students were surveyed, aged between 20 and 25. They all answered both questionnaires, and their responses were collected online and anonymously.

4. Results

The methodology based on the "competence-intelligence-resource triangle" has been applied to the eleven competences in the selected degree, with Tables 1–11 providing a detailed description of the teaching–learning resources proposed for each type of intelligence. In short, each competence could be mastered by applying the selected resources or activities that have been grouped according to each type of intelligence.

Tables 1–11 detail the 99 teaching–learning resources proposed; note that all of them are equally useful for acquiring a particular competence depending on the type of intelligence or student´s particularities. Thus, the teacher only has to define the competence to be acquired, select the type of intelligence in the competence corresponding table, and put into practice the proposed teaching–learning resource, so that the competence–intelligence–resource triangle is completed.

As far as the questionnaires are concerned, the first one revealed that 95% of the respondents had some knowledge about the theory of MI because it was included in their syllabus. The respondents intuitively prioritized logical–mathematical, interpersonal, intrapersonal, linguistic, and spatial intelligences, although the other four intelligences (naturalist, existential, musical, and bodily/kinesthetic) were not wholly disregarded (Figure 4).

Table 1. Teaching–learning resources selected for Competence 1: analyzing and evaluating the social and environmental impact of technical solutions.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To analyze a product's environmental impact on its life cycle.
Linguistic	To read reports about the environmental impact of selected cases.
Spatial	To identify technical building solutions for creating communicative social spaces.
Musical	To analyze the acoustic impact of everyday products.
Bodily/kinesthetic	To eliminate obstacles for people with reduced mobility.
Intrapersonal	To discuss the inconsistency of prioritizing profit over a highly negative environmental impact.
Interpersonal	To discuss the overrun arising from solutions with a high environmental impact.
Naturalist	To analyze environmental mishaps caused by inadequate technical solutions.
Existential	To propose zero-impact technical solutions.

Table 2. Teaching–learning resources selected for Competence 2: organizing and planning in a company setting, as well as in other institutions and organizations.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To identify planning algorithms.
Linguistic	To analyze visual planning methods (the visual factory).
Spatial	To comply with planning boards.
Musical	To organize structures according to sounds in nature.
Bodily/kinesthetic	To organize different group dynamics in the classroom.
Intrapersonal	To consider the need for organization in the company's business.
Interpersonal	To discuss planning versus adapting to the client´s needs.
Naturalist	To identify organizational models in nature and consider their implementation in the company.
Existential	To search for alternatives according to chaos management.

Table 3. Teaching–learning resources selected for Competence 3: solving problems with initiative, creativity, and critical reasoning and communicating and transmitting knowledge, skills, and abilities in the field of Management Engineering.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To prepare weighted matrices for making business decisions.
Linguistic	To draft technical reports.
Spatial	To design spaces to enhance interpersonal communication.
Musical	To experiment with intonation when transmitting orders to subordinates.
Bodily/kinesthetic	To analyze the effects of using facial expressions on people's work dynamics.
Intrapersonal	To consider personal skills and abilities.
Interpersonal	To develop critical thinking through discussions.
Naturalist	To develop creativity dynamics by applying biomimetics.
Existential	To propose an ideal system without communication channels for conveying information.

Table 4. Teaching–learning resources selected for Competence 4: working in a multilingual and multidisciplinary environment.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To define connections across disciplines when dealing with a topic.
Linguistic	To draft reports on different topics in several languages.
Spatial	To take on the role of international partners for discussing problems.
Musical	To associate word sounds in different languages with the communication process.
Bodily/kinesthetic	To identify jobs in a company and empathize with staff.
Intrapersonal	To consider the influence of employees' language and attitude.
Interpersonal	To generate dynamics among people with different roles in different languages.
Naturalist	To identify animal-related roles for discussing the complexity of communication in interdisciplinary environments.
Existential	To analyze the reasons "Esperanto" failed as a universal language.

Table 5. Teaching–learning resources selected for Competence 5: applying quality principles and methods.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To perform a statistical analysis for default sampling.
Linguistic	To design effective communication channels and messages for disseminating the concept of quality.
Spatial	To produce a company's 3D Process Map.
Musical	To associate the concept of "orchestra" with the coordination required for teamwork.
Bodily/kinesthetic	To simulate dynamics with students playing the roles of manager and subordinates in quality matters.
Intrapersonal	To consider the differences between two companies with only one of the applicable quality methods.
Interpersonal	To discuss the advantages and disadvantages of procedural systems.
Naturalist	To identify organized systems in nature.
Existential	Quality methods: are they a handicap for innovation today?

Table 6. Teaching–learning resources selected for Competence 6: managing statutory specifications, regulations, and guidelines.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To classify new regulations according to disciplines.
Linguistic	To modify regulations according to other ones in force.
Spatial	To draw up flowcharts for summarizing regulations.
Musical	To create rhythms involving the concept of regulation.
Bodily/kinesthetic	To play the role of user when complying with regulations.
Intrapersonal	To consider the pros and cons of current regulations.
Interpersonal	To discuss regulations.
Naturalist	To analyze the consequences of approving certain regulations.
Existential	To imagine a rule-free company.

The five main intelligences emerging from the first questionnaire were selected for designing the second questionnaire, where the students were asked to choose the more suitable resources or activities (related to the five types of intelligences) for dealing with a particular target objective (related to a competence). It should be noted that the respondents were not aware of the relationship between the resource or activity and the intelligence type or the relationship between the target objective and the competence (blind questionnaire).

The intelligences (resources in the questionnaire) selected for each competence (target objective in the questionnaire) were grouped into three categories: highly relevant, relevant, and slightly relevant. Table 12 shows the assessment of each intelligence for achieving the eleven competences in Management Engineering. Thus, logical–mathematical intelligence was rated as highly relevant for six competences and as relevant for five.

Table 7. Teaching–learning resources selected for Competence 7: managing the particular activities involved in projects in the field of Management Engineering.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To make decisions according to quantitative methods.
Linguistic	To propose cases for solving management problems.
Spatial	To define the barriers to project management by using 3D tools.
Musical	To listen to music in association with different prevailing styles.
Bodily/kinesthetic	To play the roles of manager and subordinates through body languages.
Intrapersonal	To consider the role of a subordinate being managed by an incompetent superior.
Interpersonal	To discuss the behavior of superiors with different management policies.
Naturalist	To identify animal management systems in nature.
Existential	To define business self-management systems in which the managerial role is redundant.

Table 8. Teaching–learning resources selected for Competence 8: drafting, signing, and implementing projects and reports.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To identify different report types and styles and analyze their features and peculiarities.
Linguistic	To write a report on the discipline of Management Engineering.
Spatial	To define projects in which levels have to be defined according to established criteria.
Musical	To link the structure of certain reports to the structure of a symphony.
Bodily/kinesthetic	To write a report as if it were a scripted play.
Intrapersonal	To consider the abilities required for writing effective reports.
Interpersonal	To discuss the responsibility underlying the signing of a project.
Naturalist	To identify the ethical consequences of carrying out non-respectful or non-sustainable projects.
Existential	To identify new technologies that assist in drafting reports with no writing requirements.

Table 9. Teaching–learning resources selected for Competence 9: mastering the basic and technological aspects necessary for learning new methods and theories for tackling new situations.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To gather information for developing new methodologies.
Linguistic	To analyze related theories and analyze their consequences.
Spatial	To integrate within changing scenarios by applying initial knowledge.
Musical	To establish musical sequences and prompt changes accordingly.
Bodily/kinesthetic	To visit facilities and integrate within different contexts.
Intrapersonal	To consider the learning basis of new methods.
Interpersonal	To share technological knowledge with peers.
Naturalist	To study the ability living organisms have to adapt to hostile ecosystems.
Existential	To develop new methods based on other previous methods.

In sum, the logical–mathematical and linguistic competences were rated as highly relevant and relevant for the 11 competences, with the spatial and interpersonal ones appearing within those two categories for nine competences. Intrapersonal intelligence did not record a clear categorization.

Table 10. Teaching–learning resources selected for Competence 10: understanding and applying legislation related to professional activities in Management Engineering.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To discuss the convenience of complying with regulations.
Linguistic	To propose cases for locating related legislation.
Spatial	To summarize regulations in the form of flowcharts.
Musical	To link sounds to particular legislation.
Bodily/kinesthetic	To relate body movements to legislative steps.
Intrapersonal	To consider the need for bespoke legislation for certain situations.
Interpersonal	To discuss the convenience of certain regulations.
Naturalist	To identify organizations in nature and analyze their rules.
Existential	To analyze the consequences of non-compliance with regulations.

Table 11. Teaching–learning resources selected for Competence 11: undertaking measurements, calculations, assessments, expert work, studies, reports, working plans, and other similar duties.

Type of Intelligence	Teaching–Learning Resource
Logical/Mathematical	To search for knowledge repositories in order to perform calculations.
Linguistic	To draft project reports.
Spatial	To calculate 3D structures when forces are applied.
Musical	To measure sounds.
Bodily/kinesthetic	To assess body expressions.
Intrapersonal	To consider and classify the knowledge required for expert reports.
Interpersonal	To compare students´ strategies with a view to learning from peer experiences.
Naturalist	To analyze the structures in nature and their fundamentals.
Existential	To relate valuations to people´s knowledge.

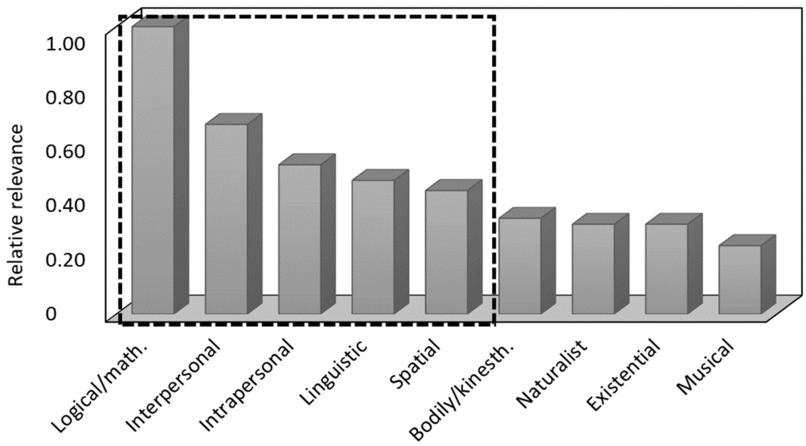

Figure 4. Relative relevance attributed to each type of intelligence in the Management Engineering degree.

Table 12. Assessment of the type of intelligence according to the number of competences.

	Number of Competences (Out of 11)		
Type of Intelligence	**Highly Relevant**	**Relevant**	**Slightly Relevant**
Logical/Mathematical	6	5	0
Linguistic	4	7	0
Spatial	5	4	2
Interpersonal	4	5	2
Intrapersonal	4	3	4

5. Discussion

5.1. Resources Assignment

Bearing in mind that it is imperative for instructors to have a good command of innovative teaching–learning strategies, the detailed lists of resources in Tables 1–11 show the specific activities (although not the only ones) that a teacher may select according to the type of intelligence to be developed or strengthened. To the best of the authors´ knowledge, this is the first time that such a detailed proposal has been reported for inclusive engineering education. It comprises a total of 99 activities, with each intelligence being reinforced by 11 alternatives according to the target competence.

This methodology creates a flexible link between competence, teaching–learning resources, and type of intelligence, and seeks to successfully instruct future professionals in the VUCA world, with an emphasis on sustainable development. It is obviously not a closed proposal but is instead an open tool that all teachers/lecturers should adapt to each degree´s peculiarities, such as particular competences, the syllabus, and the HEI's structure, among others.

It is worth mentioning the growing interest in manifesting the social value of research in all disciplines, particularly in the European Union (EU) [53]. Thus, the methodology described here can also be assessed as far as its future impact on society is concerned. Considering that this impact in academia corresponds to the outcomes and consequences of education for non-academic stakeholders, the long-term impact involves the development of a tool for contributing to the inclusive education and social integration of highly qualified professionals/engineers working for sustainable development.

5.2. Intelligence Assessment

The questionnaire's respondents clearly prioritized logical–mathematical intelligence over the other ones, as shown in Figure 4. This result is consistent with Salehi and Gerami [54], although this intelligence was not necessarily the best predictor for the engineering students´ final achievements. Engineering is traditionally associated with the development of industrial skills, knowledge, and expertise on business and management techniques, strategies and tasks, and this intelligence is considered to be engineers´ strength, although it is not the only driving force for selecting engineering instruction.

Surprisingly, the relative relevance of the linguistic, interpersonal, and intrapersonal intelligences ranged from 0.47 to 0.66, which reveals that the engineer profile has shifted to knowledge sharing rather than simply transmission. Despite the common belief that engineering students may succeed by relying solely on their logical–mathematical intelligence, the need for other types of intelligences has also been acknowledged by the students surveyed. Interestingly, the literature has reported the differences in the MI profiles among first-year engineering students (107 females and 214 males) recruited in seven academic programs (including Engineering Management) [42]. Surprisingly, the students in the study had a more developed interpersonal intelligence than expected. Large differences were also reported in some intelligence profiles according to the program (civil engineering, computer science engineering . . .).

As far as the relevance of the preselected five intelligences is concerned, the logical–mathematical and the linguistic ones were assessed as "highly relevant or relevant" for the acquisition of all the competences. The other two, spatial and interpersonal, recorded a slightly lower rating, being prioritized for 9 competences out of 11. These results may be classified as "traditional" and "expected" and might reflect the students´ conventional instruction bias towards lecturing or visual presentations.

Looking to the labor market, the World Economic Forum [55] predicted that critical thinking and problem-solving skills will be the ones most highly valued by employers over the next five years, and MI theory precisely encourages creative and inclusive thinking by supporting different strategies for learning and applying knowledge. In fact, this theory has not only been promoted in elementary schools, high schools, and HEIs, but it has also been successfully applied in high-tech industries. Teaching with multiple intelligences and with more personal practice and participation has enabled 314 employees in a high-tech industry in Taiwan to engage with learning, rather than simply accumulate knowledge [56].

5.3. Limitations

The detractors of MI theory argue that it suffers from a lack of empirical evidence and that it is difficult to isolate intelligence in the way that Gardner's theory suggests, as our brain works as a whole to generate a "global intelligence" [57,58]. Despite the use of specific questionnaires, they seem to be insufficient to measure the development of intelligences [59]. Nevertheless, it is reasonable to claim that different situations (and learning objectives) require the use of different sets of intelligences.

As far as future research is concerned, two objectives are pursued. First, mindful of the need for evidence, the proposed methodology needs to be put into practice so that an accurate assessment of its efficiency would determine whether it is performing better than traditional education models and whether it is applicable to other degrees. Second, a bigger sample size is needed for statistically tracking the evolution of this assessment in forthcoming years. Other engineering programs and universities should also be included. Education is expected to rapidly adapt to the new state of reality and teachers having an understanding of creative methods will be required urgently.

6. Conclusions

In view of the obvious need for regularly adjusting competences in HEIs for complying with sustainable development goals, dynamic teaching–learning methodologies are called for, although unfortunately most of them do not consider the variety of student profiles or types of intelligence. Therefore, those students whose learning flow is based on components other than logical/mathematical and linguistic intelligence underperform.

The interest in adapting teaching–learning resources for improving competence acquisition according to each student's individual nature (intelligence) has led us to propose the methodology presented here. Thus, the novelty of this methodology lies in two main particularities. It applies a psychology-developed theory to the CBE model within the engineering framework, and it proposes the "competence-intelligence-resource triangle" as a strategy to be applied in engineering degrees.

As far as the methodology is concerned, the first step entails the identification of the mainstream competences to be acquired by the students; the second step involves gathering all the teaching–learning resources available for successfully acquiring those competences; and the final step involves identifying and grouping the teaching–learning resources of greater use for helping students to acquire each competence according to their preferential type of intelligence. Thus, the "competence-intelligence-resource triangle" can be used as a teaching–learning tool that promotes all the intelligences.

In order to illustrate one application in an HEI, the degree in Management Engineering was selected, and 99 learning–teaching resources for 11 competences and 9 intelligences were detailed.

As far as the intelligence priority in that degree is concerned, the students interviewed intuitively prioritized five out of nine intelligences (logical–mathematical, interpersonal, intrapersonal, linguistic, and spatial). Despite the common belief that engineering students can succeed by relying solely on their logical–mathematical intelligence, the need for other types of intelligences has also been acknowledged by the students surveyed.

This methodology can be applied to any engineering degree by following the three proposed steps adapted to each context, and it contributes to the inclusive education that considers the way in which each individual learns, develops, and puts the competences and knowledge into practice.

Author Contributions: Conceptualization, F.S. and B.E.; methodology, F.S., B.E., N.R. and A.B.; formal analysis, N.R.; investigation, F.S., B.E., A.B. and N.R.; resources, A.B., B.E. and N.R.; writing—original draft preparation, B.E., A.B. and N.R.; writing—review and editing, A.B.; visualization, F.S., B.E. and N.R.; supervision, A.B., F.S., B.E. and N.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors would like to sincerely thank the participation of the students in completing the questionnaires.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. D´Adamo, I.; Gastaldi, M.; Imbriani, C.; Morone, P. Assessing Regional Performance for the Sustainable Development Goals in Italy. *Sci. Rep.* **2021**, *11*, 24117. [CrossRef] [PubMed]
2. UNESCO. UNESCO Moving Forward the 2030 Agenda for Sustainable Development. 2017. Available online: https://en.unesco.org/creativity/sites/creativity/files/247785en.pdf (accessed on 30 May 2022).
3. Zorpas, A.; Voukkali, I.; Loizia, P. Effectiveness of Waste Prevention Program in Primary Students´Schools. *Environ. Sci. Pollut. Res.* **2017**, *24*, 14304–14311. [CrossRef] [PubMed]
4. Wals, A.E.J. Sustainability in higher education in the context of the UN DESD: A review of learning and institutionalization processes. *J. Clean. Prod.* **2013**, *62*, 37. [CrossRef]
5. Machado, C.F.; Davim, J.P. Higher Education for Sustainability: A Bibliometric Approach-What, Where and Who Is Doing Research in This Subject? *Sustainability* **2022**, *14*, 4482. [CrossRef]
6. Tilbury, D. Higher Education for Sustainability: A Global Overview of Commitment and Progress. In *Higher Education in the World 4. Higher Education's Commitment to Sustainability: From Understanding to Action*; GUNI, Palgrave: Barcelona, Spain, 2011; pp. 18–28.
7. Larsen, S.N. Blindness in Seeing: A Philosophical Critique of the Visible Learning Paradigm in Education. *Educ. Sci.* **2019**, *9*, 47. [CrossRef]
8. Adams, B.; Jorgensen, S.; Arce-Trigatti, A.; Arce, P. Innovative Curriculum Design for Enhancing Learning in Engineering Education: The Strategies, Principles and Challenges of an Inquiry-Guided Laboratory. In Proceedings of the 14th International Technology, Education and Development Conference, Valencia, Spain, 2–4 March 2020.
9. Maya, J.; Maraver, J. Teaching-Learning Processes: Application of Educational Psychodrama in the University Setting. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3922. [CrossRef]
10. Tremblay-Wragg, E.; Raby, C.; Menard, L.; Plante, I. The Use of Diversified Teaching Strategies by Four University Teachers: What Contribution to Their Students´ Learning Motivation? *Teach. High. Educ.* **2021**, *26*, 97–114. [CrossRef]
11. Hajhashemi, K.; Anderson, N.; Jackson, C.; Caltabiano, N. Online Learning: Increasing Learning Opportunities. *IJAEDU-International E-J. Adv. Educ.* **2017**, *3*, 184–189. [CrossRef]
12. Lazarenko, N.; Kolomiets, A.; Klymenko, A. Symbiosis of Methodological Approaches to the Development of Education in the Information Society. *Sci. Educ.* **2017**, *4*, 107–112. [CrossRef]
13. Kuzina, I.V.; Mironycheva, V.F. Role of Digital Technologies in the Process of Future Teachers´ Professional Development. In Proceedings of the VI Virtual International Forum on Teacher Education, Kazan, Russia, 12 October 2020.
14. Teräs, M.; Suoranta, J.; Teräs, H.; Curcher, M. Post-Covid-19 Education and Education Technology 'Solutionism': A Seller's Market. *Postdigit. Sci. Educ.* **2020**, *2*, 863–878. [CrossRef]
15. Sturing, L.; Biemans, H.J.A.; Mulder, M.; De Bruijn, E. The Nature of Study Programs in Vocational Education: Evaluation of the Model for Comprehensive Competence-Based Vocational Education in The Netherlands. *Vocat. Learn.* **2011**, *4*, 191–210. [CrossRef]
16. Chernysh, V.V.; Zadorina, O.; Melnyk, K.; Khromova, I.O.; Danyliuk, M.M. Development of Professional Competence of Present and Future Teachers under the Conditions of Transformational Processes in Education. *J. Educ. Teach. Train.* **2020**, *11*, 56–67.
17. Brauer, S. Towards Competence-oriented Higher Education: A Systematic Literature Review of the Different Perspectives on Successful Exit Profiles. *Educ.+Train.* **2021**, *63*, 1376–1390. [CrossRef]
18. Bender, D.M. The Role of Reflection in Design Studio Education. In Proceedings of the 13th International, Technology, Education and Development Conference, Valencia, Spain, 2–4 March 2019.
19. Kulik, A.A.; Lazareva, P.V.; Ippolitova, N.V.; Egorova, A.E.; Nedorezova, O.Y. Competency-Based Approach and Competencies in Higher Education: A Theoretical Review. *Propósitos Y Represent.* **2020**, *8*, 645. [CrossRef]
20. Robles, M.M. Executive Perceptions of The Top 10 Soft Skills Needed in Today's Workplace. *Bus. Commun. Q.* **2012**, *75*, 453–465. [CrossRef]

21. Cronin, L.; Allen, J.; Ellison, P.; Marchant, D.; Levy, A.; Harwood, C. Development and Initial Validation of the Life Skills Ability Scale for Higher Education Students. *Stud. High. Educ.* **2019**, *46*, 1011–1024. [CrossRef]
22. Bennett, D.; Knight, E.; Bell, K. Graduate Employability and the Career Thinking of University STEMM Students. *Teach. High. Educ.* **2020**, *25*, 750–765. [CrossRef]
23. Elmi, C. Integrating Social Emotional Learning Strategies in Higher Education. *Eur. J. Investig. Health Psychol. Educ.* **2020**, *10*, 848–858. [CrossRef]
24. Olivares, S.; Torres, E.; Treviño, I.; Cabrera, M.; Turrubiates, M. Action Learning: Challenges that Impact Employability Skills. *High. Educ. Ski. Work-Based Learn.* **2020**, *10*, 203–216. [CrossRef]
25. Succi, C.; Canovi, M. Soft skills to Enhance Graduate Employability: Comparing Students and Employers' Perceptions. *Stud. High. Educ.* **2020**, *45*, 1834–1847. [CrossRef]
26. Pang, E.; Wong, M.; Leung, C.H.; Coombes, J. Competencies for Fresh Graduates' Success at Work: Perspectives of Employers. *Ind. High. Educ.* **2019**, *33*, 55–65. [CrossRef]
27. Habets, O.; Stoffers, J.; Van der Heijden, B.; Peters, P. Am I Fit for Tomorrow's Labor Market? The Effect of Graduates' Skills Development during Higher Education for the 21st Century's Labor Market? *Sustainability* **2020**, *12*, 7746. [CrossRef]
28. Warnick, G.; Schmidt, J.; Bowden, A.E. An Experiential Learning Approach to Develop Leadership Competencies in Engineering and Technology Students. In Proceedings of the 121st ASEE Annual Conference & Exposition, Indianapolis, IN, USA, 15–18 June 2014.
29. Seow, P.S.; Pan, G.; Koh, G. Examining an Experimental Learning Approach to Prepare Students for the Volatile, Uncertain, Complex and Ambiguous (VUCA) Work Environment. *Int. J. Manag. Educ.* **2019**, *17*, 62–76. [CrossRef]
30. Cicchinelli, A.; Veas, E.; Pardo, A.; Pammer-Schindler, V.; Fessl, A.; Barreiros, C.; Lindstädt, S. Finding Traces of Self-Regulated Learning in Activity Streams. In Proceedings of the 8th International Conference on learning analytics and knowledge, New York, NY, USA, 5 March 2018.
31. Grokholskyi, V.L.; Kaida, N.L.; Albul, S.V.; Ryzhkov, E.V.; Trehub, S.Y. Cognitive and Metacognitive Aspects of the Development of Lifelong Learning Competencies in Law Students. *Int. J. Cogn. Res. IJCRSEE* **2020**, *8*, 1–14. [CrossRef]
32. Mora, H.; Signes-Pont, M.T.; Fuster-Guilló, A.; Pertegal-Felices, M.L. A Collaborative Working Model for Enhancing the Learning Process of Science & Engineering Students. *Comput. Hum. Behav.* **2020**, *103*, 140–150.
33. Aleryani, A.Y.; AlMunifi, A.A. A Roadmap to the Development of Key Competencies of Engineering and Technology Graduates. *Int. J. Eng. Pedagogy* **2019**, *9*, 75–88. [CrossRef]
34. Lazarevic, I. Using the ELECTRE MLO Multi-Criteria Decision-Making Method in Stepwise Benchmarking-Application in Higher Education. *Oper. Res. Eng. Sci. Theory Appl.* **2019**, *2*, 77–91. [CrossRef]
35. Henri, M.; Johnson, M.D.; Nepal, B. A Review of Competency-Based Learning: Tools, Assessments, and Recommendations. *J. Eng. Educ.* **2017**, *106*, 607–638. [CrossRef]
36. Borte, K.; Nesje, K.; Lillejord, S. Barriers to Student Active Learning in Higher Education. *Teach. High. Educ.* **2020**, *1356*, 1–19. [CrossRef]
37. Nasri, N.; Rahimi, N.M.; Nasri, N.M.; Talib, M.A.A. A Comparison Study between Universal Design for Learning-Multiple Intelligence (UDL-MI) Oriented STEM Program and Traditional STEM Program for Inclusive Education. *Sustainability* **2021**, *13*, 554. [CrossRef]
38. Bürgener, L.; Barth, M. Sustainability Competencies in Teacher Education Count in Every Day School Practice. *J. Clean. Prod.* **2018**, *174*, 821–826. [CrossRef]
39. Pašalić, S.; Mastilo, Z.; Đurić, A.; Marković, D. Demographic Trends and the Educational System of the Republic of Srpska. *ECONOMICS-Innov. Econ. Res.* **2020**, *8*, 93–113. [CrossRef]
40. Bauman, Z. Education in Liquid Modernity Review of Education. *Pedagog. Cult. Stud.* **2005**, *27*, 303–317. [CrossRef]
41. Soeiro, A.; Nørgaard, B.; Schrey-Niemenmaa, K.; Sjoer, E.; Kalman, A.; Jones, M. Engineering Students' Expectations about Skills and Competences for Jobs versus What Is Expected by Companies and Organizations. What Is the Need for Continuing Education after Graduation (an European Overview)? In Proceedings of the 16th World Conference on Continuing Engineering Education, Monterrey, Mexico, 22–25 May 2018.
42. Chavarria-Garza, W.X.; Santos-Guevara, A.; Morones-Ibarra, J.R.; Aquines-Gutierrez, O. Assessment of Multiple Intelligences in First-Year Engineering Students in Northeast Mexico. *Sustainability* **2022**, *14*, 4631. [CrossRef]
43. Gardner, H. *Frames of Mind: The Theory of Multiple Intelligences*; Basic Books: New York, NY, USA, 1983.
44. Sternberg, R.J. *Beyond IQ: A Triarchic Theory of Human Intelligence*; Cambridge University Press: Cambridge, UK, 1985.
45. Campbell, L.; Campbell, B.; Dickinson, D. *Inteligencias Múltiples, Usos Prácticos de Enseñanza y Aprendizaje*; Troquel: Barcelona, Spain, 2000.
46. Posner, M. Neural Systems and Individual Differences: A Commentary on Frames of Mind: The Theory on Multiple Intelligences. *Teach. Coll. Rec.* **2004**, *106*, 24–30. [CrossRef]
47. Battro, A.M. Digital Intelligence: The Evolution of a New Human Capacity. Scientific Insights into the Evolution of the Universe and Life. *Pontif. Acad. Sci. Acta* **2009**, *20*, 539–549.
48. Waterhouse, L. Inadequate Evidence for Multiple Intelligences, Mozart Effect, and Emotional Intelligence Theories. *Educ. Psychol.* **2006**, *41*, 247–255. [CrossRef]

49. Waterhouse, L. Multiple Intelligences, the Mozart Effect, and Emotional Intelligence. A Critical Review. *Educ. Psychol.* **2006**, *41*, 207–225. [CrossRef]
50. Gardner, H. *Intelligence Reframed: Multiple Intelligences for the 21st Century*; Basic Books: New York, NY, USA, 1999.
51. Gitelman, L.; Kozhevnikov, M.; Ryzhuk, O. Advanced Management Education for Power-Engineering and Industry of the Future. *Sustainability* **2019**, *11*, 5930. [CrossRef]
52. ANECA (Agencia Nacional de Evaluación de la Calidad y Acreditación). Libro Blanco de Titulaciones de Grado de Ingeniería de la Rama Industrial. Chapter, V. Management Engineering. 2004. Available online: http://www.aneca.es/Documentos-y-publicaciones/Libros-Blancos/Libro-Blanco-de-Titulaciones-de-Grado-de-Ingenieria-de-la-Rama-Industrial (accessed on 16 March 2022).
53. Horizon Europe. Horizon Europe. Widening Participation and Strengthening the European Research Area. 2022. Available online: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2021-2022_en.pdf (accessed on 25 May 2022).
54. Salehi, M.; Gerami, S. On the relationship between multiple intelligences and achievement among engineering students. *Engl. Specif. Purp. World* **2012**, *35*, 1–19.
55. World Economy Forum. The Future of Jobs Report 2020. Available online: https://www.weforum.org/reports/the-future-of-jobs-report-2020/ (accessed on 26 May 2022).
56. Lei, D.Y.; Cheng, J.H.; Chen, C.M.; Huang, K.P.; Chou, C.J. Discussion of Teaching with Multiple Intelligences to Corporate Employees´ Learning Achievement and Learning Motivation. *Front. Psychol.* **2021**, *12*, 770473. [CrossRef] [PubMed]
57. Armstrong, T. *Multiple Intelligences in the Classroom*, 4th ed.; ASCD: Alexandria, VA, USA, 2009.
58. White, A.L. Is the Multiple Intelligences Theory a Research–Based Theory or a Story with Positive Message? *Southeast. Asian Math. Educ. J.* **2019**, *9*, 57–60. [CrossRef]
59. Winarti, A.; Yuanita, L.; Nur, M. The effectiveness of Multiple Intelligences based teaching strategy in enhancing the multiple intelligences and science progress skills of junior high school students. *J. Tech. Sci. Edu.* **2019**, *9*, 2.