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Sustainability Teaching Tools in the Digital Age

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Abstract: The increasing presence and relevance of Information and Communications Technology (ICT) in learning scenarios has imposed new demands on teachers, who must be able to design new learning situations while relying on the growing supply of available digital resources. One of the fields that more urgently needs to utilize the potential benefits of ICT to transform learning is sustainability, and more precisely the development of sustainability competences (SCs). Indeed, wider societal changes are needed that ensure a balance between economic growth, respect for the environment, and social justice, and these changes must start with individual action, knowledge, and the capacity and willingness to act (i.e., the definition of "competence"). However, although there is a wide consensus on the fact that education should ensure the acquisition of competences for life, making this a reality may be more problematic. This difficulty stems, partly, from a lack of a definition of the intervening elements (knowledge, skills, values, attitudes) that enables the integration of competences into specific learning sequences and activities. Taking into account all the above and the difficulties that teachers face in choosing relevant resources and incorporating competences into their planning, we propose a series of indicators that serve to characterize the four dimensions of scientific competence: contents of science, contents about science, the value of science, and the utility of science in educational materials. Although primarily intended for filtering multimedia resources in an educational platform, this instrument (as well as the indicators therein) can be extrapolated to the selection and management of a variety of resources and activities, eventually selecting those that are more useful for the acquisition of the scientific competence. They can also provide learning-managers with a common ground to work on by sharing the objectives and indicators related to the acquisition of competences.

Keywords: scientific competence; competence-based education; educational planning; Education for Sustainable Development; evaluation of digital resources

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1. Introduction

1.1. Integration of ICT in Education: Teachers Facing New Challenges

Today, every educational process—including the delivery of competences—is mediated by Information and Communications Technology ICT. Whether used as tools for teaching, learning, work, or management in general, ICT is a sine qua non component of a new paradigm of society: the society of information, knowledge, and learning.

Educational institutions have made important steps towards digitalization by having put major effort into the improvement of telecommunications infrastructure and electronic administration, as well as through connection services, network usage, and so on [1]. The next step is to rethink the academic organization of classrooms and teaching processes in general, and to put Educational Technologies in the service of learning. In other words, it is crucial to move the focus from the mere presence of ICT to ensuring its impact on knowledge acquisition.

Using ICT at any level from compulsory education levels to higher education favors more flexible learning—anytime, anywhere, and more interactive—that is centered around students and both synchronous and asynchronous communication [2]. At present it is almost inconceivable to teach without technology, or without reference to methodologies such as gamification, flipped classrooms, or bring your own device (BYOD) [3], which can contribute to creating new scenarios that facilitate and promote different processes inside the classroom, and which connect and help transfer knowledge to the outside world [4,5]. In this new era, informal learning that takes place outside of formal educational institutions is steadily gaining importance [6], making learning a source of personal, institutional, and social growth.

In turn, these new scenarios are urging teachers to become designers of learning in technology-rich environments, and, to that end, to consider and manage a constantly increasing number of tools and resources. Indeed, online resources have become more and more abundant with the commercial interest of developers, increasing compromises of institutions, and an expanding culture of collaborative professional development networks [7]. Materials are made available via teacher networks or specific platforms held by public institutions (i.e., www.golabz.es) or private companies (e.g., PBS Learning Media), which act as repositories of teaching materials and didactical resources, and these materials can include videos or other multimedia materials, classroom activities, full lesson plans, games, or educational animations or simulations [8].

In summary, transforming conventional teaching into new models mediated by ICT (blended learning or mobile learning) has a two-fold implication for teachers: on the one hand it requires practical knowledge to create communities of active learners [3]; on the other hand, it relies on the ability to search and curate adequate contents to support the learning process inside or outside the classroom.

This task is complicated because it implies a series of competences that teachers do not possess either because they are not familiar with them, or because they have not been adequately trained [9]. Indeed, among the dimensions of teacher digital competence, teachers have received a lower score in Resource Creation and Problem Solving [10], which includes selecting the best available tools or resources for a given purpose. Moreover, teachers often find it difficult to agree on basic aspects such as the cognitive demands of activities and examination items [11], as well as in formulating indicators of competence [12] when applying competence-based assessment. All in all, teachers face relevant challenges when trying to select resources that support the development of competences. Furthermore, the necessity of developing a reliable method to choose the most suitable resource is exacerbated by the growing availability of digital resources.

1.2. ICT at the Service of Today's Themes: Educating for Sustainable Development

As already noted, ICT should not be considered as an end per se, but as a means of achieving enhanced learning outcomes. As such, the potential impact of ICT in education must be put at the service of themes that are relevant to our time.

One of the most salient themes today could be climatic emergency and environmental degradation. The current ecological crisis is one of the major challenges facing our world, to an extent that unsustainable patterns can compromise the future of current and future generations [13]. In order to guarantee our survival as a species, we need to commit to a joint strategy with concrete actions and compromises, and revert to a more bearable, equitable, and viable way of life [14–16]. This is the aim of the Sustainable Development Goals (SDG) [17].

In this context, education appears as one of the priority strategies for involving new generations and enacting personal actions that bring wider societal changes that ultimately contribute to balancing economic growth, respecting the environment, and achieving social justice [18,19]. It is with good reason that we say "there is no more powerful transformative force than education—to promote human rights and dignity, to eradicate poverty and deepen sustainability, to build a better future for all, founded on equal rights and social justice, respect for cultural diversity, and international solidarity and shared responsibility, all of which are fundamental aspects of our common humanity" (I. Bokova, cited in [20]).

In that sense, universities and higher education institutions around the world are trying to incorporate sustainable development into their programs, as a way of contributing to increasing public awareness, empowering individuals to make informed decisions regarding environmental issues [21], enabling people to reflect on their behaviors from a global perspective of responsibility [6], and, ultimately, building societies that are based on the values of equity, social justice, and sustainability [22]. ICT may play a fundamental role here by fostering learning outside school, and creating the conditions for autonomous, life-long learning.

There are more and more banks of online resources, offered by public institutions ("la main à la pâte": https://www.fondation-lamap.org; SUSTAIN: https://www.fondation-lamap.org/en/sustain), or private consortia (National Geographic Education: https://www.nationalgeographic.org/education/; https://www.pbslearningmedia.org/subjects/science/), that contain specific resources for science teaching.

However, most of the resources available in these repositories deal mainly with conceptual or procedural content, while we know that, to solve wicked sustainability problems, use-inspired knowledge must be linked to transformative action [23]. It is not a question of modifying behaviors, but rather creating capacity and critical thinking [24]. In other words, taking an active part in sustainability issues as citizens implies developing not only knowledge, but also emotions, values, skills, and attitudes; the interactions among which have the potential to shape individual environmentally responsible behaviors [25]. As Sipos et al. [25] put it, Transformative Sustainability Learning (TSL) requires mobilization of the cognitive (head), psychomotor (hands), and affective (heart) domains of learning, to foster profound changes in skills, knowledge, and attitudes.

This aligns with the claim of the European Commission, in the words of Jacques Delors, of an education that is able to "foster a deeper and more harmonious form of human development and thereby to reduce poverty, exclusion, ignorance, repression and war" [26]; in other words, an education that provides individuals with the necessary resources to lead an overall successful and responsible life and face present and future challenges [27]. This perceived need, together with the notion that decontextualized learning provokes very weak learning outcomes and has a limited effect on real life, has created the breeding grounds for the emergence of the concept of "competence", which has pervaded the educational discourse since.

1.3. The Definition of (Sustainability) Competences: A Wicked Problem

The introduction of the term "competence" into the conceptual universe of education has been a major step forward in the ongoing shift of the educational paradigm: leaders and teachers have begun to question the traditionally dominant role of conceptual knowledge, as they placed more emphasis on other aspects, such as the development of abilities, skills, values and attitudes.

Although there is a wide consensus that education should promote the development of competences for daily life, putting this discourse into practice entails certain difficulties. In fact, one of the obstacles to pursuing competence-based teaching is that the concept can be approached from multiple perspectives: as a measure of human capital, a predictor of individual productivity in the labor market, or the ability to transform knowledge into power or social action [28].

Be that as it may, there is no doubt that developing competence requires, first of all, knowledge ("know" or "know-what"). Complex thinking skills (metacognitive and strategic ones) that arise from this knowledge enable a competent learner to act in conscious, coordinated, integrated, effective, fast, and creative [28] ways. However, acquiring competences is hardly comparable with learning as an acquisition of knowledge. Competences are learnable but not teachable [6], and this leads to the question of whether and how they may be acquired through formative programs (Weiner, 2001, in [6]): the cognitive structure that makes somebody competent is developed through training and experience ("know-how"), contributing to a progressive and endless process of constant updating that can only be achieved through action. As a result, competences are only demonstrable in action [29,30]. In addition to this, the development of competence is linked to personality, a series of characteristics that are intrinsic to a person, including motivation, self-concept, abilities, and so on. In turn, "desire to do" and the "know how to be" derive from these personality factors. The overall process of competence development enables learners to efficiently play certain roles by solving problematic questions in complex situations and within given contexts with autonomy and flexibility [30–32].

This apparent agreement in the general definition of competence and its dimensions fades when translating it into concrete learning objectives. In other words, one of the problems for making this new paradigm real is the fact that professionals have difficulty reaching an agreement on which specific knowledge, skills, attitudes or values citizens need to possess to participate effectively in the different areas of their lives [33].

As for sustainability competences (SCs), there have been many works that have sought to define this minimum endowment. In recent years, numerous articles and reports have made a significant contribution to conceptualizing SCs [23]. Education for Sustainable Development (ESD) requires fostering life-long skills such as creative and critical thinking, communication, collaboration and cooperation, conflict management, decision-making, problem-solving and planning, using appropriate ICT, and practical citizenship [6]. These skills represent a series of key competences that are expected to enable active, reflective, and cooperative participation towards Sustainable Development (SD). Furthermore, transformative social learning is required to deconstruct existing ways of knowing and understanding, and to critically reflect on the values, beliefs, and worldviews that underpin these traditional process, and to co-construct new shared meanings that can contribute to sustainability [22]. There are 8 to 12 key competences according to different authors, which include the following: competency in foresighted thinking and envisioning new scenarios; dealing with complexity; interdisciplinary work and establishing dialogues between disciplines; and cosmopolitan perceptions and contextualization, transcultural understandings, and co-operation; participatory skills: deciding and acting for change; planning and implementation; capacity for empathy, compassion and solidarity, managing emotions and concerns; self-motivation and motivating others; distanced reflection on individual and cultural models; thinking critically; clarifying values [22,34].

Despite notable advances in the conceptualization of ESD and SCs, holistic embedding into the curriculum remains to be carried out [22]. However, for the time being, there is a great deal of terminological ambiguity that associates "competences" with skills, abilities, capacities, capabilities or other concepts [31], making it more difficult to elucidate the complex (and not linear) interconnection among all these elements [35].

Furthermore, SCs, which have become an objective of many higher education institutions, might be difficult to implement between primary to high school, where the focus is on basic competences [36]. The closest areas to sustainability competences in compulsory education, in the European context, would be mathematical competence and basic competences in science and technology [37]. This posits that science education should aim to produce scientifically literate individuals who can jointly understand science, technology, and society, while also using this knowledge in everyday decision-making [38,39] when responding to ecological and societal challenges. There is considerable consensus regarding certain aspects of a desirable scientific education, and, indeed, it overlaps to a good extent with what has been said for sustainability competences (SCs). As such, the dimensions of scientific competence identified by Blanco-López et al. [33], which are in broad agreement with eight relevant previous reports, include a critical attitude/thinking, individual responsibility, the ability to process information, the ability to reason concerning scientific phenomena, and the ability to work as a part of a team (compare with [22,34]). It must be noted that scientific literacy [40] differs here from what would be expected from a scientist, and places an emphasis on enabling young people to engage with real-life contexts in contemporary society.

Many authors consider scientific literacy to be a very broad and shifting concept [41], for which a clear operational definition has yet to be produced [42]. On the other hand, teachers are responsible for executing educational policies in the classroom. Every act of educational planning (also competence-based planning), responds to different levels of curricular application. What to teach, how to teach, and when to teach are defined in three nested levels (Figure 1): public administrations (educational policies), schools (Educational Centre Plans, according to particular agendas), and classrooms (planning suited to the particular needs and features of a group).

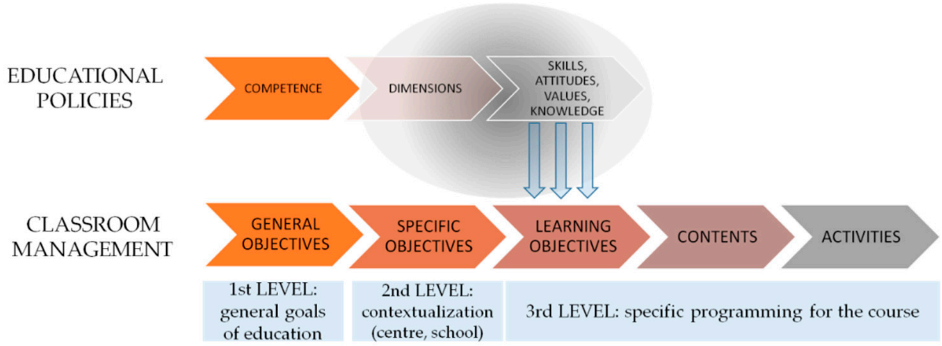

Figure 1. The two levels of educational planning—general policies and specific classroom arrangements—have difficulties working in concert to realize competence-based teaching (source: own work).

However, these two spheres—educational policies aimed at raising competences and curriculums designed for the classroom—are difficult to reconcile in practice (Figure 1). On the one hand, competence is most often used as a (rather bold) declaration of intent, which is only expressed in general terms without a specific definition of the intervening elements (knowledge, skills, values, attitudes) (Arnold, 1997, in [6]), associated with a vague definition of methodological notes and didactical notions. On the other hand, teachers (as designers of learning situations and architects of the teaching–learning process) require tangible or concrete entities on which to base the processes. As such, the open definition of competences in curricular design is a barrier to their practical implementation.

In particular, planning for the classroom starts with defining learning objectives (Figure 1), also known as "learning outcomes" or "intended learning outcomes" (ILOs). Learning objectives are brief and clear statements of what students should know or be able to do at the end of the course that they could not do before. Learning objectives may refer to knowledge, skills, or attitudes, and must define or describe an action, be measurable (regarding time, space, amount, and frequency), and be differentiated (i.e., specify levels of achievement). According to competence-based schemes, learning objectives should refer to competences in such a way that the sum of learning objectives enables the creation of a profile of each competence. In other words, competences must be translated into specific LOs to become operational (i.e., for curriculum development [6]).

Once more, the main difficulty here is that practitioners wishing to incorporate competences may encounter a lack of definition among the different frameworks. For example, the PISA and Socioscientific Issue (SSI) approaches are seemingly well aligned when considering the general aims of scientific competence. Both approaches emphasize the preparation of students for life and citizenship, complex reasoning, and reflective practices, as well as robust understandings of the nature of science, particularly as it is practiced in society. However, as the focus of comparison moves from the conceptual to the more-specific, connections between PISA and the SSI movement become more tenuous [43]. In absence of specific indicators to develop general frameworks, basic competences are, in practice, identified with curricular areas and substantially reduced to the "know" and "know-how" dimensions of competence, or are used simply within the context of a non-specific discourse about teaching innovation that justifies and accompanies outbursts of active methodologies.

In other words, effectively incorporating competences into learning and teaching involves, inexcusably, finding common ground between curriculums and policy design (top-down direction), and between curriculums and teachers (bottom-up approaches) (Figure 1).

Taking into account all the above, we are proposing the development of an instrument or evaluation scheme that includes specific indicators for each dimension of scientific competence. This instrument will enable teachers to analyze the contributions of specific digital educational resources used to develop scientific competence. Lastly, it will allow teachers to develop practical proficiency in selecting online materials that contribute to the development of students' competence. This would, ultimately, guide not only teachers but also families and students in following specific formative itineraries and sharing the objectives and data behind the acquisition of competences, thus strengthening the potential impacts of informal learning.

2. Material and Methods

The necessity of creating this system of indicators, or scheme for evaluation, arose from the development of the educational platform Zapatoons (www.zapatoons.info), which provides teachers with a practical resource to support teaching–learning processes during early childhood and primary education.

In particular, this system of tags has been developed to filter and select videos related to natural and social sciences, promoting the development of scientific competence and, ultimately, providing a basis for sustainable behaviors. Nonetheless, the instrument has characteristics that make it applicable for a variety of resources and formats, and thus could be applied in a wide range of educational situations.

2.1. Structure of the Tag System

The first step will be to thoroughly characterize "scientific literacy" in a way that can be translated to other areas of competence. For the definition of this conceptual umbrella, we opt for an understanding of competence as literacy (i.e., thorough knowledgeability) of situations related to science that students are likely to encounter as citizens [39].

This vision goes beyond purely technical approaches that are focused on the promotion of scientific concepts and processes, the development of robust understandings of scientific findings and formalisms, and the skills and processes used within the sciences. Instead, we defend an approach focused on understanding and using science in situations involving personal decision-making related to contextually embedded issues [43] that may result in individual actions leading to more sustainable action patterns. This includes the internalization of values and other non-cognitive components [6]. In other words, it relates to situations that provide individuals with opportunities for using scientific ideas, processes, and reasoning, and are thus closer to a holistic view of competence understood as knowledge put into action that encompasses the four dimensions ("know", "know-how", "know how to be", "know to live together") [26].

Accordingly, the indicators (or tags) are developed as belonging to the four main categories, which recall the definitions that PISA [44] has used for "scientific literacy" concerning an individual's:

- Scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues (contents OF science);
- Understanding the characteristics of science as a form of human knowledge and inquiry (contents ABOUT science);
- Awareness of how science and technology shape our material, intellectual, and cultural environments (CONTEXTS of science);
- Willingness to engage with science-related issues, and with the ideas of science as a reflective citizen (INTEREST in science).

Each of the dimensions needs to be further developed into a series of concepts, processes (verbs of action), and contextual factors, to allow them to establish links with the learning objectives and the way teaching–learning processes are designed, put into practice, and evaluated (Table 1).

Table 1. Indicators per dimension of scientific competence, theme, type of word and examples.

Dimension	Type of Knowledge	Indicator	Type of Word *Examples*
CONTENTS OF SCIENCE To know science/to do science	Know Know-how	**Science contents** as defined by the relevant curriculum or document of standards. **Scientific skills** (simple and complex).	Nouns *pulleys, living beings* Verbs of action *compare, classify, pose a hypothesis*
CONTENTS ABOUT SCIENCE To know about science	Know Know-how Know to be	**Nature of Science**, or epistemology,	Adjectives, adjectival phrases *science is verifiable*
CONTEXTS OF SCIENCE To be aware of the importance of science	Know to be Know to live together	Personal **attitudes, beliefs, and values**. Ethical references guide scientific practices.	Short phrases *engage in sustainable behavior*
INTEREST IN SCIENCE To value science			

Another constraint to be considered is that the indicators must be gradable, or likely to be ordered to adjust to a progression. Competences are developed through a gradual process that starts in elementary school and continues both within and outside the school through elementary and secondary school and even beyond. Thus, the architecture of the system must ensure that it fits successive levels of complexity.

2.2. Development of the Indicators (tag)

For each of the dimensions, relevant authors or policies were selected (Table 2). As for the "contents of science", the chosen norm (RD 126/2014 [45]) contained the perceptive curriculum for Spain, the region the platform is being developed and used in. This is obviously intended only for a local application, but it does not hamper the broader applicability of the rest of the dimensions.

Table 2. Specific themes and authors or policies taken as reference for the list of indicators per dimension.

	Theme	Referent Authors or Policies
Science Contents	Knowledge progression Scientific contents	RD 126/2014 [45] Next Generation Science Standards [38]
Science Practices	Science process skills Science processes Scientific practices	M.J. Padilla [46] Science and engineering practices—NSTA [47]
Nature of Science	Nature of science Epistemology of science	N.G. Lederman [48,49]
Attitudes, Beliefs and Values	Attitudes science Utility science	Earth Charter [50] UN's Sustainable Development Goals [17]

For the other dimensions, authors or policies around which a broad consensus exist were taken as the reference.

Selected references and sources were then combined and critically reviewed to produce a comprehensive list of indicators that were designed to reflect the consensus definition of the dimension.

3. Results

As a result of the theoretical conceptualization described above, we produced an evaluation form (see Supplementary Materials) and a series of support documents that teachers can use for evaluating the videos in the platform. It is to be noted that, as stated elsewhere, this practical evaluation scheme can be applied to categorize any other digital or multimedia educational resource.

3.1. Dimension I: Content Progression

We produced a map of the official perceptive curriculum for the region [45]. The map followed a hierarchical structure, progressing from broader encompassing concepts to more specific terms. At the same time, a progression across courses/grades (grades 1–6) was suggested, to allow the algorithm to propose coherent thematic progressions following coherent strands of increasing sophistication, or to suggest diverse routes within thematic blocks (Figure 2).

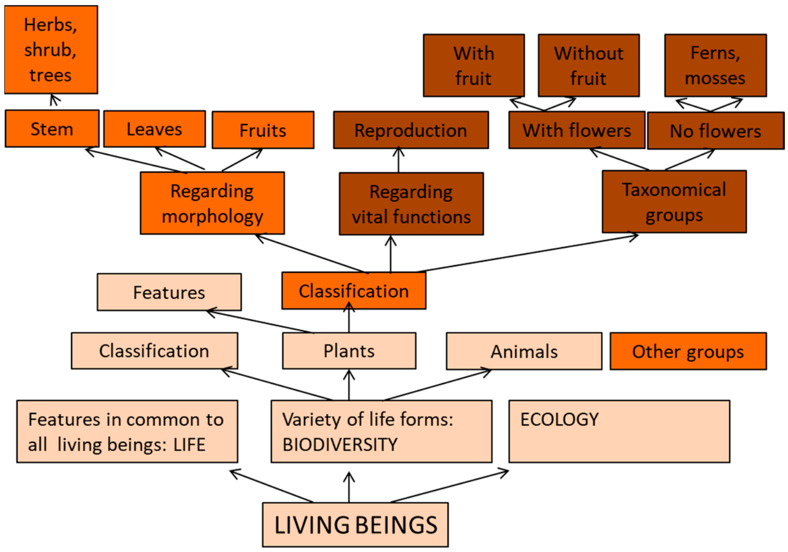

Figure 2. A nested hierarchy of factual concepts (contents of science; knowledge progression). An example of the classification of plants. Colors by grade: grades 1–2 (light); grades 3–4 (medium); grades 5–6 (dark orange).

The proposed final progression included a total of 551 terminal nodes nested in seven levels.

3.2. Dimension II: Progression in Skills or Processes

The proposed progression combined the Science and Engineering Practices of the National Science Teachers Assocation (NSTA) (also voiced by Bybee [38]) with the traditional division by Padilla [46] into basic and integrated process skills (Table 3).

Table 3. A nested hierarchy of science and technology practices. An example including one basic and one complex science process skill.

1	2	3	4	5
Basic practices	Measuring	Estimating Measuring (with metric units) Comparing measures		
Complex practices	Communicating	Communicating information	Communicating information in written formats Communicating information orally	Expressing ideas in texts Combining text and graphic formats Expressing ideas orally Making oral presentations

The tags are not inherently gradable, but the arrangement into successively inclusive levels facilitates designing ordered progressions (i.e., a suggestion about the order in which the progressions should be introduced for a smooth acquisition).

3.3. Dimension III: Nature of Science

A detailed analysis of Norman Lederman's work [48,49]—including 35 years of academic production on the nature of science and scientific practices, and summaries of the documents of the NSTA [51]—was used as the source of indicators in order to describe the nature of science and scientific practices (Table 4):

Table 4. Statements about the nature of science.

Scientific investigations use a variety of methods
Scientific knowledge is based on empirical evidence
Scientific knowledge is open to revision in light of new evidence
Scientific models, laws, nechanisms, and theories explain natural phenomena
Science is a way of knowing
Scientific knowledge assumes an order and consistency in natural systems
Science is a human endeavor
Science addresses questions about the natural and material world

3.4. Dimension IV: Values, Beliefs and Attitudes

As stated above, scientific literacy entails the capacity and will to transform the world through action. In this sense, science should not be understood as an end in itself, but rather a means. The document "Earth Charter", echoing part of the UN Sustainable Development Goals [17], proposes certain ethical prompts that may help frame today's scientific education to make it closer to sustainable approaches (Table 5). Earth Charter encourages individuals and nations to "join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and future generations" [50].

Table 5. Attitudes, beliefs, and values inherent to science education.

Knowledge as a value	Science satiates our thirst for knowledge Scientific knowledge makes us free to opt and be responsible for our actions Critical thinking allows us to adopt ethical positions Science leads humanity to excellence through knowledge
Science useful for transforming the world	Science helps us cover basic needs (health and wellbeing) Science may ensure equitable distribution of richness Science can improve living conditions for all and ensure pacific cohabitation Science helps us anticipate problems and adopt the best available solutions to achieve sustainability
Ethical framework in which science education must inscribe	
Respect and Care for the Community of Life	Believe in the inherent dignity of all human beings and the intellectual, artistic, ethical, and spiritual potentials of humanity Ensure human rights and fundamental rights Recognize the value of every form of life, regardless of its worth to human beings Bear in mind the need for future generations to experience Earth's bounty and beauty
Ecological Integrity	Stimulate reduction, reuse, and recycling of materials Work towards increasing reliance on renewable energy sources Behave to avoid severe or very severe environmental damage Preserve natural heritage
Social and Economic Justice	Strengthen technical cooperation to advance sustainability Contribute to developing social and economic justice Ensure the active participation of women in all aspects of public life Value the equitable distribution of wealth
Democracy, Nonviolence, and Peace	Promote a culture of tolerance, non-violence, and peace Make solidarity and cooperation possible among nations Engage in the resolution of conflicts among people and with the environment Understand the world and act from a "glocal" perspective

In this vein, the document we have chosen as a reference for the indicators in this dimension considers the intrinsic value of science together with implications that connect it with the three pillars of sustainability (i.e., environmental preservation, social equity and bearable economic development) [52].

4. Discussion

In this study, we developed an instrument intended to help teachers evaluate digital educational resources or, more specifically, the contribution of specific digital educational resources to the development of scientific competence and sustainable behavior. The evaluation scheme included a series of indicators in four categories: contents of science (contents and skills), contents about science (nature of science), contexts of science, and attitudes towards science (personal values and beliefs). These indicators were gathered from literature, after having selected the most relevant authors or policies in each of the dimensions.

The necessity to consider and provide explicit accounts of all the remaining dimensions stems from a recognition that the selection of resources based on thematic content is only insufficient if we want to provoke something more than factual learning. Being scientifically literate and displaying (un)sustainable behaviors are not only the results of rational decision-making processes based on specific moral cognitions; on the contrary, emotions of different categories can further account for individual conducts [53]. In other words, science education must help individuals from the very beginning of school life to understand the world around them and how that world works [54], while also providing an idea of how science education should work and how to remediate it by intervening with resources at their disposal. On top of this, science education should make individuals inclined and eager to take action. That is to say that rational knowledge requires know-how, capability, and the desire to act. In this sense, the proposed system of indicators provides concrete statements or items belonging to the three domains of competence (cognitive, affective, psychomotor [25])—or, put in more familiar words, it includes knowledge, skills, values, and attitudes [9].

This kind of rubric or evaluation scheme becomes especially relevant given the growing availability of digital educational resources or multimedia materials that can be used for educational purposes. We must acknowledge that there are some relevant banks of resources or initiatives offering outstanding materials that, far from focusing on sustainability as a theoretical concept, also seek to foster sustainability competences—that is to say, to enable and encourage learners to engage in transformative practices [8,25] (e.g., the SUSTAIN project (https://www.fondation-lamap.org/en/sustain) or the National Geographic Education (https://www.nationalgeographic.org/education/)). However, the otherwise scarce availability of remarkable materials that go beyond pure factual learning illustrates how difficult it is to move further down the road from discourse to action. Furthermore, this scarcity reinforces the necessity to provide teachers with scaffolds that allow them to make informed choices using resources from an increasingly wide repository with no formal curation [55]. Like Pepin, Gueudet, and Trouche [56], we argue that, now more than ever, the design and selection of digital curricular resources has become a crucial aspect of teachers' work, and that this is one of the areas of digital competence where teachers (both pre-service [10] and in-service [56]) encounter difficulties. However, most of the indicators developed to date have related to technical or design aspects [57,58], neglecting or missing pedagogical criteria for selection [59]. The proposal introduced in the current study can fill in this gap and incorporate the perspective of competence-based teaching.

Unfortunately, legal measures and provisions alone do not guarantee any real impact on learners unless the community of educators adopts these directions. It is at this point where it becomes necessary to establish a broad consensus among educators and develop the tools that will put these ideas into practice, and to generate practical strategies that teachers can use to share reflections, resources, and debates over common grounds. This scaffold should include practical support in the forms of: (1) clear formative objectives with clear indicators; (2) guidance on how to integrate these objectives through practice; and (3) orientations to evaluate them. This is what our proposal aimed to do.

5. Conclusions and Further Directions

Teaching in the digital age requires teachers to be capable of interacting with digital resources in a curriculum [56], and to select the ones that can enhance their teaching or expand it beyond the limits of the classroom. At the same time, the desire to raise competent students to be capable, professional citizens or individuals has pervaded the objectives of education systems all over the world. Integrating these competences in educational planning is not straightforward, but providing teachers with clear entities (actions, values, contents) they can use for crafting their intended learning outcomes (ILOs) could support them in this task.

It has become clear that if we understand competence as the capacity and eagerness to act, we need to consider not only conceptual understandings but also skills, values, beliefs, and attitudes. This is especially true in the case of Education for Sustainable Development, whose focus is on transformative learning.

Taking all this into account, it can be said that the major contribution of this proposal is to provide a detailed account of the specific contents, actions, understandings, and values that integrate each of the dimensions of scientific competence, with reference to a an explicit higher-order conceptual framework. This would facilitate the integration of competences in class- or curriculum-level educational planning, if need be.

The main limitations of this study could be related to the lack of theoretical references on which to substantiate a precise definition of the elements integrating the competences we are proposing. As many authors have pointed out, these elements are often vaguely defined, hampering integration in curricula [23]. As such, the way forward in research on the topic involves a three-step validation process: (1) validation by experts, to check agreement with structuring concepts (big ideas) in science and scientific skills; (2) pilot application to the videos in the platform, to check accuracy (completeness and differentiation); (3) validation with users (teachers) to check comprehensibility and specificity.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/8/3366/s1.

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