# Education in the Knowledge Society

# 21st-Century Education or the Awakening of the Sleeping Beauties: A Systematic Literature Review

## La educación del siglo XXI y el despertar de las bellas durmientes: una revisión sistemática de la literatura

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## ARTICLE INFO

## ABSTRACT

Although 21st-century education has been widely debated and presented in the literature, the reality of today's schools, especially in developing countries, shows a very distant image of what should be a flexible, personalized, soft skills-oriented education, based on the use of Information and Communication Technologies (ICT). To address this situation should be the first step in order to understand it and provide concrete work elements for teachers, school principals and policymakers, especially for those who work in adverse educational contexts. This article presents a systematic literature review focused on the identification of critical ideas about 21st-century education as possible factors of a transformation of the current school. The review included 780 research reports on 21st-century education, which were coded and processed through text mining. A selection of 101 reports was read in-depth and qualitatively analyzed. The results revealed that although most of the critical ideas related to 21st-century education are not brand new, they are flourishing, like sleeping beauties, with new possibilities of implementation due to the evolution of current technological development. Some of the educational sleeping beauties to highlight are personal learning paths, research-based teaching, open, flexible and digitally supported curriculum, and lifelong learning.

## RESUMEN

Aunque la educación del siglo XXI ha sido ampliamente debatida y presentada en la literatura, la realidad de las escuelas actuales, especialmente en los países en desarrollo, muestra una imagen muy alejada de lo que debería ser una educación flexible, personalizada, orientada al desarrollo de habilidades blandas y basada en el uso de Tecnologías de la Información y la Comunicación (TIC). Abordar esta situación en detalle sería el primer paso para comprenderla y proporcionar elementos de trabajo concretos para los docentes, los directores escolares y los responsables de la política educativa, especialmente para aquellos que trabajan en contextos educativos adversos. Este artículo presenta una revisión sistemática de literatura centrada en la identificación de ideas clave sobre la educación del siglo XXI como posibles factores de transformación de la actual escuela. La revisión incluyó 780 informes de investigación sobre la educación del siglo XXI, 101 de los cuales fueron leídos en profundidad y analizados cualitativamente. Los resultados revelaron que, si bien la mayoría de las ideas clave relacionadas con la educación del siglo XXI no son completamente nuevas, están floreciendo, como bellas durmientes, con nuevas posibilidades

de implementación debido a la evolución del desarrollo tecnológico actual. Algunas de las bellas durmientes educativas a destacar son: las rutas personales de aprendizaje, la enseñanza basada en la investigación, el currículo abierto, flexible y apoyado digitalmente y el aprendizaje a lo largo de la vida.

## 1. Introduction

One of the most noticeable social changes in the last two decades is the fluctuating nature of labor markets that today's students will be part of. About this, Bell (2010) points out that now, more than ever, students who become workers will be evaluated based not only on their performance but on collaboration, negotiation, planning, and organization skills.

Furthermore, the labor market is becoming more complex every day because of emerging "hybrid" jobs. As Aoun (2016) states: "[...] in addition to such familiar jobs such as engineer, consultant or financial analyst, we're increasingly seeing new job titles emerge: forensic technologist, digital storyteller, and marketing automation manager" (p. 1). Additionally, jobs are changing from the manufacturing sector to the services sector, which implies a decreasing need of mechanical-routine workers and an increasing need for more autonomous, flexible, creative workers who are able to solve problems (Marzano & Heflebower, 2012).

Finally, the Partnership for 21st-Century Skills (2008) posits major changes regarding what companies are expecting from their new employees and indicates that "advanced economies, innovative industries and firms, and high-growth jobs require more educated workers with the ability to respond flexibly to complex problems, communicate effectively, manage information, work in teams and produce new knowledge" (p. 6). This statements raises a major concern about the capacity of current schools to fulfill this kind of social need and implies that schools should emphasize skills development such as critical thinking, computational thinking, open-ended complex problem solving, communicating and collaborating with teams conformed by people across cultural, geographic and language boundaries (García-Peñalvo, 2018; García-Peñalvo & Mendes, 2018; Villalba-Condori, García-Peñalvo, Lavonen, & Zapata-Ros, 2018). This perspective suggests that students should be involved in projects in which their creativity and innovation are promoted; also, teachers must create the right balance between learning general facts and principles and coming up with interesting new solutions to problems and creative answers to questions they really care about (de Paula, Burn, Noss, & Valente, 2018).

A final element to be considered in the discussion of changes affecting and outdistancing education in the 21st-century is technology, which is addressed by Bates (2015) when mentions:

> In a digital age, we are surrounded, indeed, immersed, in technology. Furthermore, the rate of technological change shows no sign of slowing down. Technology is leading to massive changes in the economy, in the way we communicate and relate to each other, and increasingly in the way we learn. Yet our educational institutions were built largely for another age, based around an industrial rather than a digital era. (p. 13)

However, what has been discussed so far seems to gather the general elements that characterize the expectations of the academic community about an education aligned with the nature of our times. However, the educational reality of developing countries not only does not seems to reflect such expectations but also broadly deploys teaching and assessment strategies that go in opposite directions to the social and technological transformation of the Information and Knowledge Society (Lockheed, 2012). Given this situation, this study has focused on the detailed identification of key ideas associated with 21st-century education that have been published in high impact peer-reviewed journals, which would indicate the educational research perspective on this matter. The results of this review would allow us to identify in more detail the elements that have fed this discussion, from which it would be possible to undertake school transformation processes in adverse educational contexts, widely presented in developing countries.

## 2. Method

According to Gough, Olive and Thomas (2012), a systematic literature review is a type of documentary research that is characterized by its methodological rigor. In this regard they indicate that:

[...] is a review of research literature using systematic and explicit, accountable methods [...] and systematically involves three key activities: identifying and describing the relevant research ("mapping" the research), critically appraising research reports in a systematic manner and bringing together the findings into a coherent statement, known as synthesis. (p. 2-5)

The present review was carried out by applying two parallel and complementary protocols: first, an in-depth reading-based review and second, a data mining-based review as a triangulation process.

### 2.1. In-Depth Reading-Based Review Protocol

The systematic review addresses specialized literature following a rigorous protocol in order to provide clarity to allow its reproduction or use by other researchers (Booth, Sutton, & Papaioannou, 2016). Regarding this, the first review protocol was designed taking into consideration the phases proposed by López, Méndez, Paz & Arboleda (2016), which are detailed and shown in Figure 1:
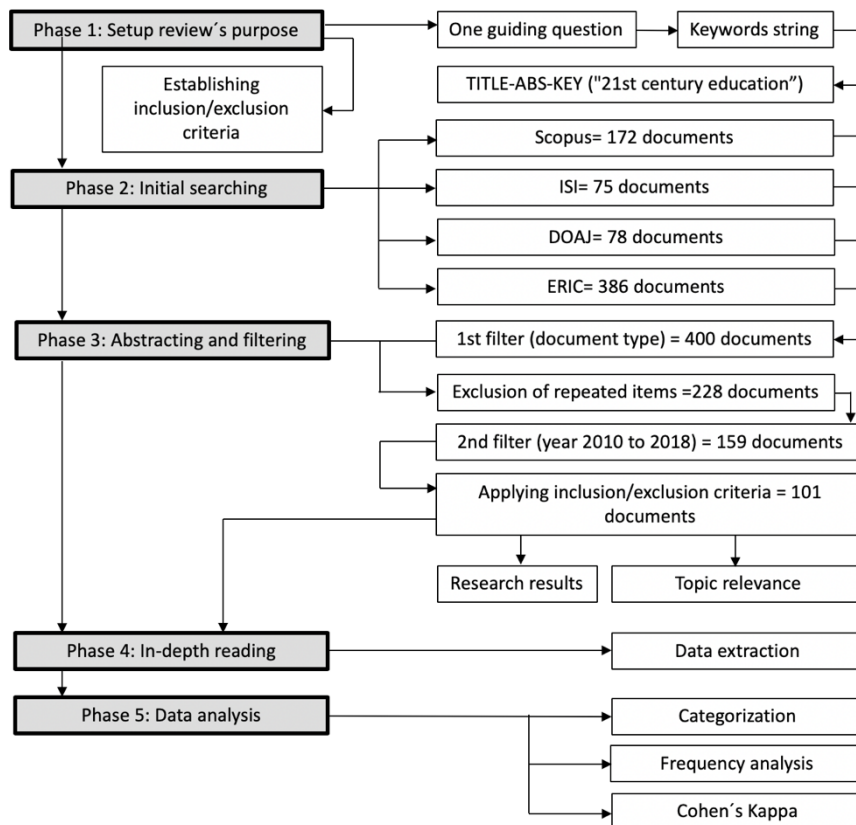


Figure 1. In-Depth Reading Review Protocol. Source: own elaboration.

### 2.1.1. Setup the Review's Purpose

This step included the definition of study´s object and the identification of relevant issues. A reflection on this, allowed to establish that the purpose of the review was to identify what researchers consider to be of particular relevance when referring to "21st-century education".

To address this objective, a guiding question was defined: According to educational researchers, what are the most remarkable characteristics of 21st-century education?

Then, both searching, and inclusion/exclusion criteria were defined in order to determine eligibility of the initial corpus of articles. The criteria taken into consideration were:

– The information sources must come from major peer-reviewed journal databases (SCOPUS, ISI, DOAJ, and ERIC).

- Searching was limited to social sciences, arts and humanities, psychology and computer science, as there was greater interest in education both in school and higher education. This criteria component allowed to exclude many results in other fields, different from education which were not pertinent to the review question.
- Initially, no date restriction was applied in order to get a sense of the chronological results, but due to the notorious increase in growth in publications, it was considered pertinent to limit the review from 2010 to 2018. Before that date the production of research on "21st-century education" was minimal (average of 2 papers and maximum of 6 articles published per year). As of 2010, a substantial increase in research production began, reaching 82 papers published per year in 2018.
- Articles would be pre-selected only if "21st-century education" appeared textually or was clearly associated to the title or in abstract, and if research results were presented.

The final step in this phase was to determine the appropriate search descriptors, which result in the follow keywords string: TITLE-ABS-KEY ("21st-century education").

## 2.1.2. Initial Searching

The preliminary search yielded 711 articles related to 21st-century education distributed in the four consulted databases as follows: Scopus (172 documents), ISI (75 documents), DOAJ (78 documents) and ERIC (386 documents).

## 2.1.3. Abstracting and Filtering

After the initial search, a first filtering by type of document was applied to its results (n=400), selecting only articles, articles in press and conference papers. Then, through the reading of abstracts and titles, a process of exclusion of the articles that were found repeated in more than one database was carried out, which limited the corpus of documents to 228 items.

Subsequently, a second filter was applied per year of publication (2010 to 2018), further reducing the set of documents (n=159).

Of these, through a final abstracting, the last of the inclusion/exclusion criteria was applied, ensuring the thematic relevance and the presentation of research results, which generated a final set of 101 articles for further in-depth reading and data extraction.

## 2.1.4. In-Depth Reading

The data was extracted following the recommendations of Barnett-Page & Thomas (2009) and Gough (2012) as an adaptation of their synthesizing process in two different steps.

The first step was establishing the general characteristics of each study as summarized in Table 1.

| Item | Characteristic |
|------|----------------|
| Journals in which the articles are published | Very disperse information. Articles published in a total of 72 journals |
| Affiliation of authors | 84% written by university-level researchers, individually or with others. |
| Context in which the research was carried out | 41.9% do not specify the context 20.9% in North America 15.1% in Asia 9.3% in Europe 7.0% in multiple contexts Only 1 in South America |
| Type of study reported | 52.3% correspond to reports of empirical research 47.7% correspond to research reviews |

Table 1. Summary of the Characteristics of Reviewed Articles. Source: own elaboration.

The second step was extracting key ideas from selected articles through an in-depth reading process that was conducted in order to identify main concepts associated to "21st-century education". The entire set of selected articles was divided among four different researchers who identified key ideas and placed them in the same shared information-gathering instrument.

### 2.1.5. Data Analysis.

Once the reading process was completed, these concepts were compared, standardized, unified, and categorized into a list of key ideas, which was subjected to an interpretation process. The list of key ideas was analyzed separately by two members of the research team, who verified the consistency of each one of the key ideas extracted. The reliability of this process was confirmed by the application of a Cohen´s Kappa coefficient (k = 0.613), which according to (Sim & Wright, 2005) corresponds to an acceptable inter-rater process.

In order to analyze the results, a simple descriptive statistical approach was conducted in which processes of frequency analysis and co-occurrences were carried out and the most prominent concepts were identified within the global set of results. The interpretation of the results was generated in accordance with the guiding question. Also, a more qualitative process was undertaken based on the comparison of text segments extracted from the selected articles, in which repeated ideas and issues associated with such ideas or patterns were detected as relevant to the purpose of the review.

### 2.1.6. Text Mining Process Protocol

The purpose of running a text mining analysis on the final set of articles was both to provide a separate instrumental analysis for triangulation, and to help the research team in discovering additional information. In that sense, text mining helps reveal aspects of scholarly literature that might otherwise remain obscured after or during manual codification (McDonald & Kelly, 2012).

Text analyses or "text mining" processes are defined by Shapiro & Markoff (1998), as "any systematic reduction of a flow of text (or other symbols) to a standard set of statistically manipulable symbols representing the presence, the intensity, or the frequency of some characteristics relevant to social science" (p. 18). This definition includes both the quantitative and qualitative aspects of the process, and points out that it is not exclusively computational.

The text mining protocol used to triangulate the in-depth reading-based review is shown in Figure 2.
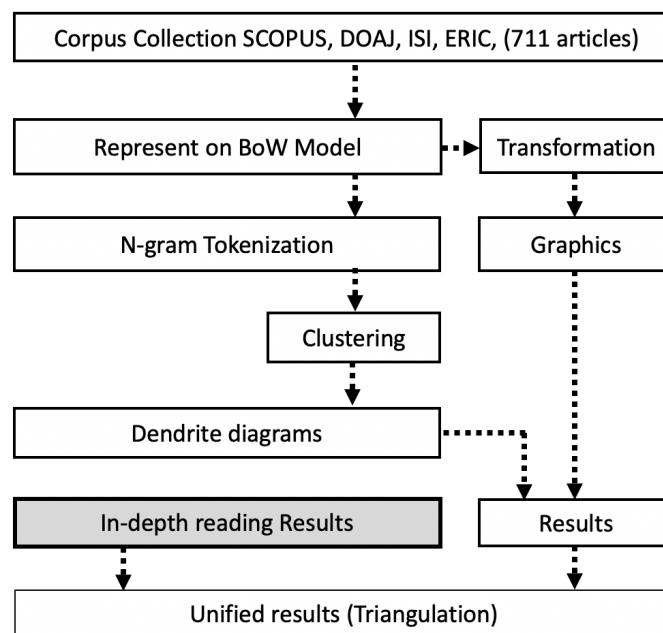


Figure 2. Text Mining Review Protocol. Source: own elaboration.

The text mining process involved several stages: text retrieval, preprocessing, tokenization (process of discarding non-essential or useless elements), transformation and clustering. From a human perspective, text creation is a 'natural' way to register perceptions and understandings; however, from a computerized perspective, texts are rather unstructured data —long strings of characters. A transformation is necessary in order to be able to make a useful handling of the data; organizing the language into a structured data matrix of words or groups along with their adjusted frequencies of occurrence (Meyer, Hornik, & Feinerer, 2008).

The document corpus were analyzed using R as the computational environment, which is a widely-used Open Source statistical language and platform (Gentleman et al., 2004). The workflow followed the path recommended by Feldman & Sanger (2008) and Zhao & Cen (2014), including a preprocessing phase in which all PDF documents were properly converted to text via OCR and then subjected to punctuation, whitespace, number and stop word removal using the mapping functions of the {tm} R package. At that stage, the research team decided not to remove additional stop words function in order to keep possible combinations for further processing.

Next, a stemming process was carried out using the {SnowballC} package (Hofmann & Chisholm, 2015), an implementation of Porter's algorithm, which conflates word families into common roots. Finally, 1-, 2-, 3-, and 4-gram tokenizations were completed in order to process N-grams using a bag-of-words language model, an analysis that uses the N-gram frequency as the main variable.

## 3. Results

The results obtained after the categorization process were organized into 6 clustered data sets which are shown in Figure 3 as a comparative perspective of both manual and text mining analysis on this matter.
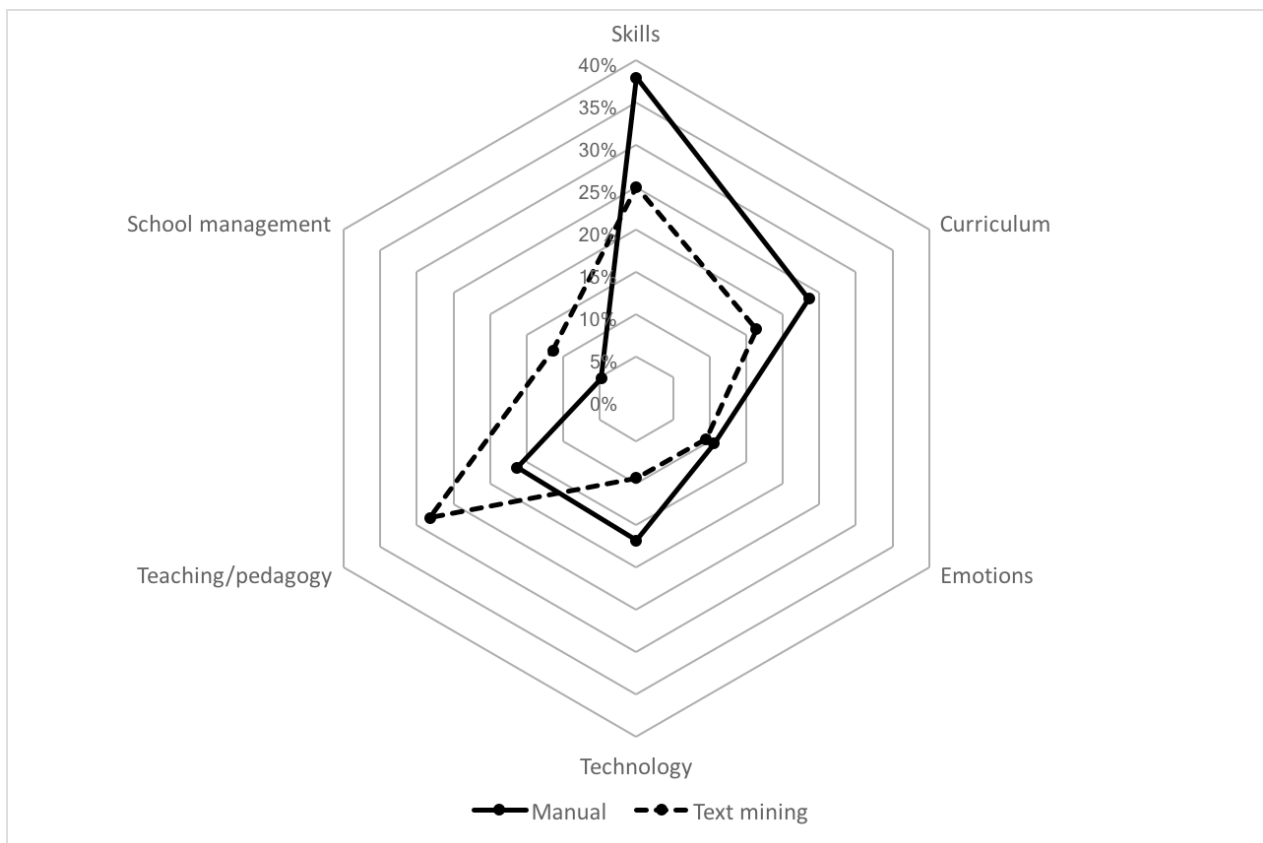


Figure 3. Results Organized by Categories. Source: own elaboration.

Next, Table 2 shows the detail of the key ideas related to each of the raised categories.

| Category | Key-ideas | % frequency |
|---|---|---|
| Skills | 4C's | 50.6% |
| | Digital literacy information | 25.3% |
| | Autonomy | 8.9% |
| | Problem solving | 6.3% |
| | Meta-cognitive skills | 5.1% |
| | Design thinking | 2.5% |
| | Traditional literacies | 1.3% |
| Curriculum | STEM | 20.4% |
| | Social responsiveness | 14.3% |
| | Trans-disciplinary curricula | 14.3% |
| | Global awareness | 12.2% |
| | Personalized learning experiences | 12.2% |
| | Multiculturalism | 12.2% |
| | International quality standards | 8.1% |
| | Inclusion | 6.1% |
| Emotions (Educating for awareness) | Global/digital citizenship | 27.3% |
| | Resilience | 13.5% |
| Technology | ICT | 48.6% |
| | Multimodal learning | 28.6% |
| | M-learning | 14.3% |
| | Videogames | 8.6% |
| Teaching/pedagogy | Research-based learning | 23.5% |
| | Trans-disciplinary teaching | 14.7% |
| | Transformative teaching | 14.7% |
| | Personalized learning paths | 8.8% |
| | Social learning | 8.8% |
| | Lifelong learning | 5.9% |
| | Other pedagogies | 2.9% |
| School Management | Teacher training | 30% |
| | Quality standards | 20% |
| | Links to the university | 20% |
| | Sustainable development | 10% |

Table 2. Key-ideas by Category. Source: own elaboration

It is interesting to note that all categories are composed of key ideas that relate to or have an effect on one another and even have an effect on other key ideas of other categories, so that none of them is mutually exclusive. However, the data indicate that there are some categories that are more relevant than others, including skills development, curricular aspects and the use of ICT.

*3.1. It's All About Skills*

The literature shows great emphasis on the development of different types of skills. Of all the key ideas found in the reviewed literature, 38% of them indicated a close relationship between 21st-century education and the development of "21st-century skills". However, when literature refers to skills there is a wide range including the so-called "4C's" (50,6%) which allude to the development of communication, collaboration, critical thinking and creativity skills.

Some articles (Drigas & Karyotaki, 2014; Gelerstein, Río, Nussbaum, Chiuminatto, & López, 2016; Gilbert, 2016; La Porte, 2016; Ramamuruthy & Rao, 2015) refer directly to those "4C's" as presented by the Partnership for 21st-Century Skills (2008). Other authors, however, broaden the spectrum of skills to be included. Slot (2013) for example, states that "the most important skills to bring into 21st-century are: Collaboration, Knowledge building, Real-world problem solving and innovation, Use of ICT for learning, and Self-regulation." (p. 2). While Fuller et al. (2014) refer to the AASL's Standards for the 21st-Century Learner that "focus on students' becoming independent learners who inquire, access, and use information from multiple literacies effectively and learn from others as well as produce and share information in a variety of ways" (p. 57).

Another relevant set of skills has been organized under the category "digital literacy information" (25.3%) within which are the capacity for information management, computational skills and generally, those skills that allow a person to cope suitably in interactive digital environments.

> Critics suggest that a holistic view of 21st-century teaching and learning that combines student learning outcomes (a blending of specific skills, content knowledge, expertise, and literacies) with innovative support systems is necessary to prepare students for effective participation in this century. In this digital era, information literacy, internet literacy, and computer literacy are particularly important (Lau & Yuen, 2014, p. 1).

In addition to the above, a third component of skills focuses on the development of autonomy (8.9%), linked to the development of metacognitive competencies (Giuchici, 2011), problem solving abilities (6.3%), which seem critical in 21st-century education due to the enormous and diverse challenges seen in an ambiguous and changing contemporary society.

Additionally, the results show the importance of meta-cognitive skills (5.1%), which empower students to learn how to learn and become life-long learners. "Individuals will also need to develop meta-cognitive skills in order to interpret new complex scientific information and know when they need additional information" (Choi, Lee, Shin, Kim, & Krajcik, 2011, p. 670). Design thinking (2.5%) also appears as a skill to develop that may actually be quite neglected. "Art and design education hold a unique role in preparing the kinds of innovative, balanced, synthetic creators and thinkers needed in the 21st-century[...]" (Vanada, 2014, p. 21). Nonetheless, this does not imply totally abandoning traditional literacies (1.3%), as posited by Pires (2013).

*3.2. The 21st Century Curriculum*

The specialized literature on 21st-century education presents curriculum as a considerable challenge, as 23.6% of the key ideas found in the literature review discussed relevant and diverse curricular approaches. Of these aspects, the one which appeared most frequently in the literature reviewed is STEM (20.4%), an orientation of the curriculum with a marked emphasis on science, technology, engineering and mathematics. "STEM education can promote understanding of scientific concepts in the actual context, can stimulate innovation and creativity, and also at the same time encourage the mastery of 21st-century skills the much needed ability for the 21st-century economy" (Bahri, Suryawati, & Osman, 2014, p. 197).

A second group of results, with 14.3% and 12.2% each, includes social responsiveness and global awareness. "These creative demonstrations of knowledge encouraged student peers to empathize with historical or cultural issues and take social, economic, political, or environmental action" (La Porte, 2016, p. 470).

A third group of results with 12.2% and 6.1% each, includes multiculturalism/ multilingualism and inclusion.

> Education for international mindedness is the study of issues which have application beyond national borders and to which competencies such as critical thinking and collaboration are applied in order to shape attitudes leading to action which will be conducive to intercultural understanding, peaceful co-existence and global sustainable development for the future of the human race (Hill, 2012, p. 259).

A fourth group of results, 14.3%, includes trans-disciplinary curricula and trans media storytelling. "Thus, 21st-century competencies and pedagogy can play an integral role in structuring a trans-disciplinary approach of the school curriculum" (Drigas & Karyotaki, 2014, p. 71).

A fifth group of results, 12.2%, includes personalized learning experiences, a student-oriented approach to curriculum and formative assessment.

> For dynamic plurilingual education to succeed in the 21st-century, teachers would have to be educated to pay close attention to the singularities that make up our plurality—to clearly notice the individual linguistic experience that is the "moving force" in learning an additional language and all learning (García & Sylvan, 2011, p. 398).

Finally, a last group of results, 8.1%, includes fulfillment of international quality standards, a necessary school-university connection and the expectation of a high performance on standardized exams. Teräs & Herrington (2014) point out that "Academic educators everywhere are dealing with questions related to change: the pressure of integrating technology in education, changing curriculum, quality standards and measures, and increasingly multicultural and diverse groups of learners" (p. 233).

### 3.3. Educating for Awareness

Emotions and behaviors are mentioned in 10.6% of the key ideas extracted from the literature reviewed. This is in line with much that has been said about the need to go "beyond" academic learning in contemporary education. The World Economic Forum (2016) states that "To thrive in the 21st-century, students need more than traditional academic learning. They must be adept at collaboration, communication and problem-solving, which are some of the skills developed through social and emotional learning (SEL)" (p. 4).

Some of those key ideas (59.2%) are shared with the category mentioned above. That is, there seems to be a coincidence among the development of certain types of awareness as part of a relevant curriculum for the 21st-century, rather than a limited focus on content or skills.

It would seem that many of the researchers find that students should be helped to develop awareness of others and their personal impact on society, their responsibility in global issues and the importance of citizenship in a global and digital society. In that sense, global and digital citizenship (27.3%) is shown as an important feature of the 21st-century school. Smaldino (2011) stresses that " there are exciting advances in the preparation of students in their content knowledge and technology skills, challenging them to prepare for global citizenship and successful futures" (p. 1).

There is also a third group of key ideas, 13.5%, that seem to point to the importance of developing awareness of self; that is, it would seem that it is not just a matter of developing awareness of others, society, and the world as such, but also, of a more introspective vision including resilience, high productivity and promotion of health. This is shown, for example, in Jin (2013) when he states that "The new curriculum shift of emphasis from sports performance to student participation for health promotion coincides with a demand to get young people to be actively involved in their learning" (p. 24).

### 3.4. Educating with Technology

A category that seems obvious at first glance is the incorporation of technology in school. With 16.8% of the key ideas found in the literature review, aspects related to technology appear often when literature refers to 21st-century education.

Regarding this, 48.6% of the key ideas grouped in this category refer to the use of Information and Communication Technologies (ICT) as stated by Savage (2007) "New technologies are transforming approaches to teaching in primary and secondary schools. Their adoption as part of teaching and learning processes is part of a much larger social and cultural change driven by the arrival of digital technologies" (p. 65).

Also, beyond the use of ICT, the literature indicates that 21st-century education should be conducted in a multimodal manner. In this sense, 28.6% of those key ideas are related to diverse resources and forms of teaching and learning. Bevan & Dillon (2010), describe how:

> In exploring the terrain of bridging formal and informal settings, the CILS program seeks to develop a new breed of educational researcher and practitioner who approaches science education with broad

perspectives on learning, and who seeks to design and support science learning by drawing on a variety of resources and settings, spanning multiple timeframes and institutional settings (p. 178).

Moreover, two other relevant groups of findings emerge in this category: m-learning (14.3%) and the use of videogames (8.6%). The first, with the ubiquitous nature of mobile devices and their wide availability, becomes an interesting possibility for teachers to explore as assets to teaching and learning, especially in contexts where resources are limited. Husbye & Elsener (2013) explain how "as literacy educators in teacher preparation programs, we must consider how emerging and mobile technology may be used within coursework to not only create multiple ways to conceptualize teaching 21st-century literacy, but also as a professional imperative" (p. 46). Finally, as to the second, Bourgonjon et al. (2010), posit that "Videogames are often regarded as promising teaching and learning tools for the 21st-century" (p. 1145).

### 3.5. A New World Deserves New Teaching

A diverse set of pedagogy-related concepts emerges from the review of literature, where nine different pedagogical approaches were found under the category "teaching/pedagogy". It is interesting to note that there are no comments related to a specific theory or approach; nor do any of the ideas mentioned in the articles refer to discrete disciplines but rather to more integrated, holistic approaches. This would seem to be related to what Perkins (2014) refers to when he says that "The way traditional education works simply does not align very well with the buzzing, blooming connectivity of today's world" (p. 40). Instead, the aspects mentioned seem to mirror approaches that encourage the development of new and diverse cultures of teaching and learning in classrooms and schools.

The first pedagogical approach that is consistently considered pertinent for 21st-century education (23.5%) has to do with research-based learning. Kong & Song (2014) present a strong case for the importance of this approach when they state that:

> Educational reform calls for a paradigm shift to learner-centered domain knowledge learning. It is well recognized that the inquiry-based learning approach is a useful pedagogy for realizing learner-centered learning (Marshall, Smart, & Horton, 2010). The inquiry-based learning process helps learners to develop inquiry skills, which are an important type of 21st-century skill (p.127).

There are also expectations for trans-disciplinary teaching (14.7%) in educational institutions that claim to be 21st-century schools. La Porte (2016) explains how "trans-disciplinary learning through the arts challenged and motivated students to think and make decisions in collaboration with others, using and valuing the expertise of peers" (p. 477).

Besides the above, other pedagogical perspectives become relevant as foundations of educational institutions for the 21st-century. For example, m-learning or use of mobile devices which is also related to the integration of technology, as seen above, (14.7%), transformative teaching (14.7%), personalized learning experiences or paths (8.8%), social learning (8.8%), design thinking which also appeared above related to the skills to be developed in a 21st-century school (5.9%), lifelong learning (5.9%) and other pedagogies (2.9%).

In the case of transformative teaching, Sunal et al. (2010) highlight its importance when saying that "Transformative teaching is needed to assist students in developing their identities as citizens in a world in which the concepts of culture and citizenship are shifting" (p. 42). Moreover, building personalized learning experiences or paths becomes a central issue to be considered when teaching, as stated by Malmberg & Maull (2013): "finding locally relevant and personally significant science topics helped keep the students motivated to explore their research questions" (p. 263).

Besides the aspects listed above, social learning represents a focus for teaching in the 21st-century. "Conventional teaching materials may not prepare students to learn the inquiry way and to become self-directed and social learners who could learn 'everywhere and all the time (seamlessly)' using mobile technologies" (Zhang et al., 2010, p. 1504). Finally, lifelong learning becomes a challenge to respond to the multiple changes that students face and will face. Voogt (2010), when reporting on an international study on pedagogical practices, describes how the participants' "pedagogy was oriented towards lifelong learning which is considered relevant for the 21st-century" (p. 453).

*3.6. A Different Kind of Education Requires School Management Changes*

Dede (2011) states sweepingly that "We live in a time when the industrial era school system is on the verge of collapse" (p. 4). His article refers primarily to the change needed to re-conceptualize the use of technology in education to achieve a new model that responds better to the realities of the 21st-century. However, this is a situation that permeates the educational landscape of contemporary society. Such changes require not only transformations in the classroom or the curricula, but in the entire institution. Therefore, school management must also make adjustments to support the type of education that will respond to the varying needs of society. In that sense, 30% of the responses refer to the knowledge society and how schools must ensure that teachers and students are involved in the creation, as well as the productive use of the enormous amounts of information that is currently available. Otherwise, as stated by Starkey (2011), "teachers, even the digitally able, will be limited in their ability to teach the upcoming generation to be active participants in a digitally enhanced society without understanding how to apply theories of learning that are relevant to a digital age into their practice" (p. 19).

Additionally, responses allude to the importance of school management focusing on teacher training (30%), international quality standards (20%), the links to the university (20%) and sustainable development (10%).

The transformations that are required in education cannot be achieved without adequately trained teachers. Carmona & Ibáñez (2011) state that "As a minimum, there should be pedagogical and methodological training along with an integration of ICT content in order to address the curricular aspects already presented and to direct them towards the necessary changes of the proposed paradigm" (p. 92).

## 4. Discussion

It is interesting to note that many of the key ideas that are relevant to the needs of 21st-century education are not new ideas and have been mentioned for a long time in specialized educational literature. Phenomenon or project-based learning, student-centered or personalized education, flexible curriculum, among others, are ideas or theories that have been raised for several decades, but their implementation has not been widely realized or reached its potential, due to the fact that perhaps the conditions at the time of their emergence did not allow it. This situation is described by Van Raan (2004) as "sleeping beauties"; very interesting ideas that have been widely talked about yet have remained dormant for many years waiting for the appropriate conditions to appear. As mentioned by Zapata-Ros (2016), referring to Bloom's "two sigma problem", the development of ICT in the last 15 years has constituted the "kiss of true love" for these ideas or theories in such a way that the right conditions for their correct implementation are found in the context of the 21st-century.

*4.1. Sleeping Beauty #1: Personal Learning Paths or the Real Student-Centered Education*

Student-centered education is one of those widely addressed ideas that has been proposed for years in contrast to that education in which the teacher is the protagonist and the learning process is passive, predetermined and homogenizing. This pedagogical approach has focused mainly on the change from passive methodologies (like lecturing) to active learning and could be managed from the formulation of learning objectives, teaching strategies, content and assessment (Isikoglu, Basturk, & Karaca, 2009).

In this regard, while it is possible to evidence the development and wide application of various active methodologies in 21st-century schools, the potential of student-centered education remains very limited because the persistent idea in which all students must learn the same (whether actively) and in the same conditions of time, mode and place, leaving aside the student´s personal interests and considering them subjects with insufficient criteria as to decide for themselves about what, how and when to learn. However, a broader view of student-centered education will recognize the importance of personal learning paths, which can actually be addressed by building a digital learning support ecosystem that is barely available in recent years.

*4.2. Sleeping Beauty #2: Research-based Teaching instead of Instruction*

One of the most interesting conclusions, and one that, at the same time implies a great challenge in relation to the pedagogical dimension in the 21st-century school, has to do with the minimization of instruction in favor of a maximization of research-based learning. Considering the flexibility and natural capacity of research for the

generation of knowledge, it makes sense that research occupies the place of instruction as a teaching strategy, especially when it is recognized that not all students should learn the same and in the same way.

Regarding this, we must bear in mind that it will be painful for teachers to change what they have been doing for so many years, even more so when many of them are convinced that this is the proper way of teaching (Alsuwat & Young, 2016). However, the most difficult thing will not be to change the way teachers think about this, but to change parents' and the entire educational system's beliefs on this matter, especially considering their reluctance to accept and assimilate changes of this nature (Kramer, 2010).

### 4.3 Sleeping Beauty #3: Flexible Curriculum

Curricular flexibility is another of those ideas associated with 21st-century education that have already been addressed at length. The concept of flexible curriculum has been related to: (1) the student´s possibility to take electives, (2) different Programs to share study plans, (3) availability of transversal courses, among others. Additionally and more recently, curricular flexibility is conceived within the framework of the design and implementation of educational content in multiple formats to support pedagogical proposals such as Universal Design for Learning (Hitchock, Meyer, Rose, & Jackson, 2002).

A flexible curriculum, within the framework of a student-centered education, as previously mentioned, should not be an equal curriculum for all students. In that sense, digital environments provide the support of a personalized flexible curriculum that activates itself due to the student's needs instead of school´s ease of operation. Digital content is easier and cheaper to update and share which provides a suitable ecosystem for content flow and customization.

In this way, content activation that corresponds to the needs of different plans or personal learning paths cannot be carried out in an efficient and timely manner without an adequate platform as a digital ecology (García-Peñalvo, 2016), that integrates support, communication, management and assessment of learning systems, among others.

### 4.4. Sleeping Beauty #4: Lifelong Learning

The idea that learning is not confined within the boundaries of the school but that it happens from birth, permanently -in a changing world- and in any place, and that has to do with the needs and interests of the individual learner, is not a recent idea and re-emerged strongly in 1990's (Sharples, 2000).

However, few practical or concrete initiatives correlated with lifelong learning can be identified in the daily life of the current schools and universities, beyond the application and policies of social education (Makarova, Andreeva, Baratova, & Zelenkova, 2018), adult learning, or the development of social and professionals skills (Zhan, Ammar, & Taylor, 2017). In the context of the 21st-century, lifelong learning is developed with a new perspective from the construction of Personal Learning Environments (PLE) (Humante, García-Peñalvo, & Conde-González, 2016; Wilson, Liber, Johnson, Beauvoir, Sharples, & Milligan, 2007), which, by the way, has always existed in the life of the human beings. Particularly, current PLEs may include the use of information networks, MOOCs (García-Peñalvo, Fidalgo-Blanco, & Sein-Echaluce, 2018), virtual learning (García-Peñalvo & Seoane-Pado, 2015; Gros & García-Peñalvo, 2016) and communities of practice (Wenger, 1998), among others, which are more permanent and allow a person to conduct their learning in a more responsive way, facing properly to the accelerated and uncertain changes in the current context.

**References**

Alsuwat, S., & Young, J. R. (2016). Meta-Analysis of the Effects of Traditional versus Technology-based Instruction on Reading Comprehension of EFL Students. *EFL Journal*, *1*(3), 189–202. doi:https://doi.org/10.21462/eflj.v1i3.18

Aoun, J. E. (2016, December 4). Hybrid Jobs Call for Hybrid Education. *Harvard Business Review*, [online]. Retrieved from https://bit.ly/2Szn63D.

Bahri, N. M., Suryawati, E., & Osman, K. (2014). Students' biotechnology literacy: The pillars of STEM education in Malaysia. *Eurasia Journal of Mathematics, Science & Technology Education*, *10*(3), 195–207. doi:https://doi.org/10.12973/eurasia.2014.1074a

Barnett-Page, E., & Thomas, J. (2009). Methods for the synthesis of qualitative research: A critical review. *BMC Medical Research Methodology*, *9*(1). doi:https://doi.org/10.1186/1471-2288-9-59

Bates, A. W. (Tony). (2015). Teaching in a Digital Age. *Glokalde*, *1*(3), 1–594.

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. doi:https://doi.org/10.1080/00098650903505415

Bevan, B., & Dillon, J. (2010). Broadening views of learning: Developing educators for the 21st Century through an international research partnership at the Exploratorium and King's College London. *The New Educator*, *6*(3–4), 167–180. doi:https://doi.org/10.1080/1547688X.2010.10399599

Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review* (second edition). London, UK: SAGE Publications.

Bourgonjon, J., Valcke, M., Soetaert, R., & Schellens, T. (2010). Students' perceptions about the use of video games in the classroom. *Computers & Education*, *54*(4), 1145–1156. doi:https://doi.org/10.1016/j.compedu.2009.10.022

Carmona, J. J. C., & Ibañez, L. (2011). Pedagogía crítica y Web 2.0: Formación del profesorado para transformar el aula. *Revista Electrónica Interuniversitaria de Formación Del Profesorado*, *14*(2), 81–95.

Choi, K., Lee, H., Shin, N., Kim, S.-W., & Krajcik, J. (2011). Re-conceptualization of scientific literacy in South Korea for the 21st century. *Journal of Research in Science Teaching*, *48*(6), 670–697. doi:https://doi.org/10.1002/tea.20424

de Paula, B. H., Burn, A., Noss, R., & Valente, J. A. (2018). Playing Beowulf: Bridging computational thinking, arts and literature through game-making. *International Journal of Child-Computer Interaction*, *16*, 39–46. doi:https://doi.org/10.1016/j.ijcci.2017.11.003

Dede, C. (2011). Reconceptualizing Technology Integration to Meet the Necessity of Transformation. *Journal of Curriculum and Instruction*, *5*(1), 4–16. doi:https://doi.org/10.3776/joci.2011.v5n1p4-16

Drigas, A., & Karyotaki, M. (2014). Learning Tools and Applications for Cognitive Improvement. *International Journal of Engineering Pedagogy (IJEP)*, *4*(3), 71. doi:https://doi.org/10.3991/ijep.v4i3.3665

Feldman, R., & Sanger, J. (2008). *The text mining handbook: Advanced approaches in analyzing unstructured data* (Reprinted). Cambridge: Cambridge Univ. Press.

Fuller, C., Byerle, G., Kearley, D., & Ramin, L. (2014). Community collaboration for inquiry success. *Knowledge Quest*, *43*(2), 56.

García, O., & Sylvan, C. E. (2011). Pedagogies and Practices in Multilingual Classrooms: Singularities in Pluralities. *The Modern Language Journal*, *95*(3), 385–400. doi:https://doi.org/10.1111/j.1540-4781.2011.01208.x

García-Peñalvo, F. J. (2016). *Ecologías de Aprendizaje*. Paper presented at the Estancia de investigación en la Universidad Técnica Federico Santa María, Valparaíso, Chile. https://goo.gl/rcS7iB

García-Peñalvo, F. J. (2018). Computational thinking and programming education principles. In F. J. García-Peñalvo (Ed.), *TEEM'18 Proceedings of the Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality (Salamanca, Spain, October 24th-26th, 2018)* (pp. 14-17). New York, NY, USA: ACM. doi:https://doi.org/10.1145/3284179.3284184

García-Peñalvo, F. J., Fidalgo-Blanco, Á., & Sein-Echaluce, M. L. (2018). An adaptive hybrid MOOC model: Disrupting the MOOC concept in higher education. *Telematics and Informatics, 35*, 1018-1030. doi:https://doi.org/10.1016/j.tele.2017.09.012

García-Peñalvo, F. J., & Mendes, J. A. (2018). Exploring the computational thinking effects in pre-university education. *Computers in Human Behavior, 80*, 407-411. doi:https://doi.org/10.1016/j.chb.2017.12.005

García-Peñalvo, F. J., & Seoane-Pardo, A. M. (2015). An updated review of the concept of eLearning. Tenth anniversary. *Education in the Knowledge Society, 16*(1), 119-144. doi:https://doi.org/10.14201/eks2015161119144

Gelerstein, D., Río, R. del, Nussbaum, M., Chiuminatto, P., & López, X. (2016). Designing and implementing a test for measuring critical thinking in primary school. *Thinking Skills and Creativity*, *20*, 40–49. doi:https://doi.org/10.1016/j.tsc.2016.02.002

Gentleman, R. C., Carey, V. J., Bates, D. M., Bolstad, B., Dettling, M., Dudoit, S., … others. (2004). Bioconductor: Open software development for computational biology and bioinformatics. *Genome Biology*, *5*(10), [online]. doi:https://doi.org/10.1186/gb-2004-5-10-r80

Gilbert, A. D. (2016). The Framework for 21st Century Learning: A first-rate foundation for music education assessment and teacher evaluation. *Arts Education Policy Review*, *117*(1), 13–18. doi:https://doi.org/10.1080/10632913.2014.966285

Giuchici, M. (2011). Killing Two Birds with the Same Stone. Higher Order Skills Embedded in E-teaching Strategies. *RATE*, *4*, 18–23.

Gough, D., Oliver, S., & Thomas, J. (2012). *An introduction to systematic reviews*. Retrieved from https://goo.gl/oI0dYM

Gros, B., & García-Peñalvo, F. J. (2016). Future trends in the design strategies and technological affordances of e-learning. In M. Spector, B. B. Lockee, & M. D. Childress (Eds.), *Learning, Design, and Technology. An International Compendium of Theory, Research, Practice, and Policy* (pp. 1-23). Switzerland: Springer International Publishing. doi:https://doi.org/10.1007/978-3-319-17727-4_67-1

Hill, I. (2012). Evolution of education for international mindedness. *Journal of Research in International Education*, *11*(3), 245–261. doi:https://doi.org/10.1177/1475240912461990

Hitchock, C., Meyer, A., Rose, Da., & Jackson, R. (2002). Providing new access to the general curriculum. *Teaching Exceptional Children; Reston*, *35*(2), 8–17. doi:https://doi.org/10.1177/004005990203500201

Hofmann, M., & Chisholm, A. (2015). *Text Mining and Visualization Case Studies Using Open-Source Tools*. Boca Raton: CRC Press. doi:https://doi.org/10.1201/b19007

Humante-Ramos, P. R., García-Peñalvo, F. J., & Conde-González, M. Á. (2016). PLEs in mobile contexts: New ways to personalize learning. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje (IEEE RITA), 11*(4), 220-226. doi:https://doi.og/10.1109/RITA.2016.2619121

Husbye, N. E., & Elsener, A. A. (2013). To Move Forward, We Must Be Mobile: Practical Uses of Mobile Technology in Literacy Education Courses. *Journal of Digital Learning in Teacher Education*, *30*(2), 46–51. doi:https://doi.org/10.1080/21532974.2013.10784726

Isikoglu, N., Basturk, R., & Karaca, F. (2009). Assessing in-service teachers' instructional beliefs about student-centered education: A Turkish perspective. *Teaching and Teacher Education*, *25*(2), 350–356. doi:https://doi.org/10.1016/j.tate.2008.08.004

Jin, A. (2013). Physical education curriculum reform in China: A perspective from physical education teachers. *Physical Education & Sport Pedagogy*, *18*(1), 15–27. doi:https://doi.org/10.1080/17408989.2011.623231

Kong, S. C., & Song, Y. (2014). The Impact of a Principle-based Pedagogical Design on Inquiry-based Learning in a Seamless Learning Environment in Hong Kong. *Educational Technology & Society*, *17*(2), 127–141.

Kramer, M. (Ed.). (2010). *The Stress of Change: Testing the Resilience of Institutions*. Chichester, United Kingdom: John Wiley and Sons Ltd.

La Porte, A. M. (2016). Efficacy of the Arts in a Transdisciplinary Learning Experience for Culturally Diverse Fourth Graders. *International Electronic Journal of Elementary Education*, *8*(3), 467.

Lau, W. W. F., & Yuen, A. H. K. (2014). Developing and validating of a perceived ICT literacy scale for junior secondary school students: Pedagogical and educational contributions. *Computers & Education*, *78*, 1–9. doi:https://doi.org/10.1016/j.compedu.2014.04.016

Lockheed, M. E. (2012). The condition of primary education in developing countries. In H. R. Levin & M. E. Lockheed (Eds.), *Effective schools in developing countries* (pp. 20-40). Oxon, UK: Routledge.

López, A., Méndez, D., Paz, A., & Arboleda, H. (2016). Desarrollo e Instrumentación de un Proceso de Vigilancia Tecnológica basado en Protocolos de Revisión Sistemática de la Literatura. *Información Tecnológica*, *27*(4), 155–164. doi:https://doi.org/10.4067/S0718-07642016000400017

Makarova, O. Yu., Andreeva, M. I., Baratova, O. A., & Zelenkova, A. V. (2018). Supplementary Professional Education as a Socially Relevant Component of Lifelong Learning. In A. Filchenko & Z. Anikina (Eds.), *Linguistic and Cultural Studies: Traditions and Innovations* (Vol. 677, pp. 21–27). doi:https://doi.org/10.1007/978-3-319-67843-6_3

Malmberg, J., & Maull, K. E. (2013). Supporting Climate Science Research With 21st Century Technologies and a Virtual Student Confer-ence for Upper Elementary to High School Students. *Learning Landscapes - Teaching and Learning in the Digital World: Possibilities and Challenges*, *6*(2), 249–264. doi:https://doi.org/10.36510/learnland.v6i2.615

Marshall, J. C., Smart, J., & Horton, R. M. (2010). The design and validation of equip: An instrument to assess inquiry-based instruction. *International Journal of Science and Mathematics Education, 8*(2), 299-321. doi:https://doi.org/10.1007/s10763-009-9174-y

Marzano, R. J., & Heflebower, T. (2012). *Teaching & Assessing 21St Century Skills. The ClassroomStrategies Series.* Bloomington, IN, US: Marzano Research Laboratory.

McDonald, D., & Kelly, U. (2012). *The Value and Benefits of Text Mining (Digital Infrastructure)* (No. Doc# 811). Retrieved from JISC - Digital Infrastructure website: http://bit.ly/jisc-textm

Meyer, D., Hornik, K., & Feinerer, I. (2008). Text mining infrastructure in R. *Journal of Statistical Software*, *25*(5), 1–54. doi:https://doi.org/10.18637/jss.v025.i05

Partnership for 21st Century Skills. (2008). *21st Century Skills, Education & Competitiveness: A Resource and Policy Guide*. Retrieved from https://bit.ly/361Daij

Perkins, D. N. (2014). *Future wise: Educating our children for a changing world* (First ed). San Francisco, CA: Jossey-Bass, A Wiley Brand.

Ramamuruthy, V., & Rao, S. (2015). Smartphones Promote Autonomous Learning in ESL Classrooms. *Malaysian Online Journal of Educational Technology*, *3*(4), 23–35. Retrieved from https://bit.ly/2ZyaP0M

Savage, J. (2007). Reconstructing music education through ICT. *Research in Education*, *78*(1), 65–77. doi:https://doi.org/10.7227/RIE.78.6

Shapiro, G., & Markoff, J. (1998). *Revolutionary demands: A content analysis of the Cahiers de doléances of 1789*. Stanford, CA: Stanford University Press.

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers & Education*, *34*(3), 177–193. doi: ¡https://doi.org/10.1016/S0360-1315(99)00044-5

Sim, J., & Wright, C. C. (2005). The kappa statistic in reliability studies: Use, interpretation, and sample size requirements. *Physical Therapy*, *85*(3), 257–268. ¡

Slot, M. F. (2013). Scaffolding students' assignments. *Iartem E-Journal*, *7*(1), 1–15.

Smaldino, S. E. (2011). Preparing Students with 21st Century ICT Literacy in Math and Science Education. *Journal of Curriculum and Instruction*, *5*(1), 1–3. doi:https://doi.org/10.3776/joci.2011.v5n1p1-3

Starkey, L. (2011). Evaluating learning in the 21st century: A digital age learning matrix. *Technology, Pedagogy and Education*, *20*(1), 19–39. doi:https://doi.org/10.1080/1475939X.2011.554021

Sunal, C. S., Christensen, L. M., Shwery, C. S., Lovorn, M., & Sunal, D. W. (2010). Teachers from Five Nations Share Perspectives on Culture and Citizenship. *Action in Teacher Education*, *32*(2), 42–55. doi:https://doi.org/10.1080/01626620.2010.10463549

Teräs, H., & Herrington, J. (2014). Neither the frying pan nor the fire: In search of a balanced authentic e-learning design through an educational design research process. *The International Review of Research in Open and Distributed Learning*, *15*(2), 232–253. doi:https://doi.org/10.19173/irrodl.v15i2.1705

Van Raan, A. F. J. (2004). Sleeping Beauties in science. *Scientometrics*, *59*(3), 467–472. doi:https://doi.org/10.1023/B:SCIE.0000018543.82441.f1

Vanada, D. I. (2014). Practically Creative: The Role of Design Thinking as an Improved Paradigm for 21st Century Art Education. *Techne Series-Research in Sloyd Education and Craft Science A*, *21*(2), 21–33.

Villalba-Condori, K. O., García-Peñalvo, F. J., Lavonen, J., & Zapata-Ros, M. (2018). What kinds of innovations do we need in education? *CEUR Workshop Proceedings*, 1–7.

Voogt, J. (2010). Teacher factors associated with innovative curriculum goals and pedagogical practices: Differences between extensive and non-extensive ICT-using science teachers: ICT-using science teachers. *Journal of Computer Assisted Learning*, *26*(6), 453–464. doi:https://doi.org/10.1111/j.1365-2729.2010.00373.x

Wenger, E. C. (1998). *Communities of Practice: Learning, Meaning, and Identity*. New York, NY, USA: Cambridge University Press. doi:https://doi.org/10.1017/CBO9780511803932

Wilson, S., Liber, O., Johnson, M., Beauvoir, P., Sharples, P., & Milligan, C. (2007). Personal Learning Environments: Challenging the dominant design of educational systems *Journal of e-Learning and Knowledge Society, 3*(3), 27-38.

World Economic Forum. (2016). *New Vision for Education: Fostering Social and Emotional Learning through Technology* (pp. 1–36). Geneva: World Economic Forum - The Boston Consulting Group. Retrieved from https://bit.ly/3983F7E

Zapata-Ros, M. (2016). El "problema de las dos sigmas", una bella durmiente de la Educación [Blog]. Retrieved from Redes Abiertas website: https://bit.ly/2MwJmHh

Zhan, Y., Ammar, H. B., & Taylor, M. E. (2017). Scalable lifelong reinforcement learning. *Pattern Recognition*, *72*, 407–418. doi:https://doi.org/10.1016/j.patcog.2017.07.031

Zhang, B., Looi, C.-K., Seow, P., Chia, G., Wong, L.-H., Chen, W., So, H.-J., Soloway, E., Norris, C. (2010). Deconstructing and reconstructing: Transforming primary science learning via a mobilized curriculum. *Computers & Education*, *55*(4), 1504–1523. doi:https://doi.org/10.1016/j.compedu.2010.06.016

Zhao, Y., & Cen, Y. (2014). *Data mining applications with R*. Amsterdam: Elsevier, AP Academic Press.