State of research in foresight studies on education and training

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Research questions

This deliverable addresses the request of DG EAC to carry out a literature review on foresight studies and scenario building in education and training. It is framed by two research questions, namely:

RQ1: What evidence exists in the literature about foresight studies in education and training?

RQ2: What are thematic and methodological issues, challenges and opportunities identified in the selected literature on foresight studies in education and training?

Method

Our first reference point was to identify definitions of foresight studies. In the request for this ad hoc question, foresight is defined as "foresight in the broad sense — often called prospective or forward-looking activities — aims to shed light on different options for the future that may encompass different pathways of social and/or technological developments" (European Union, 2014). For the purpose of this systematic literature review, we enhance this formal definition with Wittgenstein's concept of 'family resemblance', and Rosch's 'prototypical examples'. According to the principle of family resemblance, categories may be regarded as similar because they share a pattern of features, but not necessarily – and, in most of the cases, not *all* – features. The idea of prototypical examples states that some things are more representative than the other.
To address the first research question, we conducted a systematic literature review applying the PRISMA approach (Moher, Liberati, Tetzlaff and Altman, 2009). After some consideration, we also included a number of elements from the 'PRACTICAL' - **P**rotocol for the **R**apid **A**ssessment, **C**onceptualisation and **TI**mely, **C**oncise **A**nalysis of the **L**iterature guidelines (Travaglia, Braithwaite & Debono, 2008), such as schemata in data collection and text mining during data analysis.

The PRISMA Statement is an established standard for conducting and reporting systematic literature reviews, meta-analyses and critical appraisals. The PRISMA Statement consists of a 27-item checklist and a four-phase flow diagram to guide authors. PRISMA suits the purpose, scope and nature of the present study as it is based on a simple idea, but at the same time provides a comprehensive step-by-step approach that can accommodate a range of reviews from qualitative critical appraisals to quantitative meta-analysis. PRISMA is also associated with good practice, being the preferred method for conducting and reporting systematic literature reviews used by two high impact journals in the domain of education and training, namely the *Educational Research Review* and the *Review of Educational Research*.

The Protocol for the Rapid Assessment, Conceptualisation and Timely Concise Analysis of the Literature (PRACTICAL) attracted our attention with its provisions on consulting 'grey' literature, ephemera and web sites; employing 'snowballing' as a method for identifying literature; and also its recognition of the need to outline theoretical schemata. Of particular interest to our review was the concept of content data mining.

A combined search was conducted using leading electronic databases including Academic Search Elite; the Psychology and Behavioral Sciences Collection; Business Source Premier; E-Journals; Library, Information Science & Technology Abstracts; APA PsycInfo; APA PsycArticles; and The Education Resource Information Center (ERIC). To identify the broadest possible scope of qualified papers, we applied Boolean operators (AND, OR). To

capture a range of common variations of certain expressions, a 'wildcard' character (asterisk) was used. For the purpose of this review, two sets of search terms were applied. One set contains terms relating to foresight studies such as foresight OR trends OR future scenarios OR prospective studies. The other set included search terms relating to education, learning, teaching, training, and instruction. The search strings were: (foresight OR trends OR prospective) AND (educat* OR training OR learn* OR teach* OR instruct* OR student). We instructed each search to look at the whole text, not just at titles and abstracts, but limited searches to the time period 2010-2020. The search was not restricted to peer-reviewed journal papers, nor to the English language.

To make the search more efficient and effective, we defined some criteria for inclusion and exclusion. The inclusion criteria aimed to address the ad hoc request, namely: "studies and analysis resulting from both academic and applied research; methodological studies on foresight in education as well as forward-looking, content-oriented analysis relevant for EU policy making. Priority should be given to studies and analysis related to the following topics: inclusive and quality education and training; attainment and participation in education and training; lifelong learning and skills development; digital competences and the use of digital tools in education and training; mobility between education and training systems, cross-border cooperation in education and training and multilingualism; and the role of education and training in building democratic, inclusive, green and sustainable societies." We aimed to identify studies that explicitly refer to the future of education and training, as well as those that discuss the issue implicitly (e.g. state-of-the-art reports aimed at developing frameworks for future use). We also included some studies on 'megatrends' such as demographic and technological changes that provide a context for developments in education and training. In addition, we looked for reports on the future of jobs and workplace learning, as work is the future reference situation for education.

Our exclusion criteria included: literature dealing with a specific subject matter (e.g. languages, history); literature relating to professions other than those relating to education and training (e.g. military, social workers); foresight as an instruction method; literature relating to a specific instructional method (e.g. enquiry-based learning) or technology (e.g. augmented reality); or to a particular type of country (e.g. developing), but we allowed reports from USA, Canada and Australia (as a kind of competitor analysis).

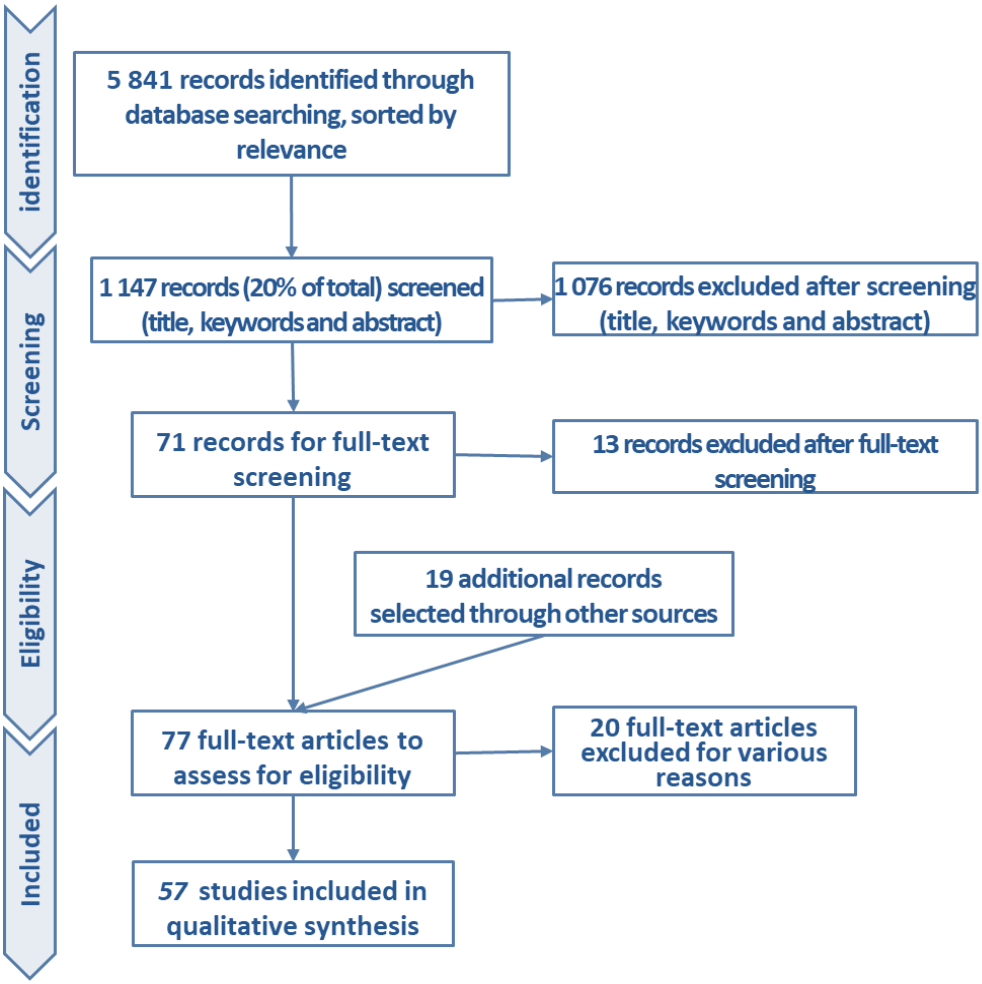
Results

Search results

The search identified 5,841 items, ranked by the databases in order of relevance to the combinations of search terms described above. The relevance of the search results diminished considerably after around the first 10% of matches. To avoid excluding potentially relevant results, we continued screening until we reached around the first 20% of results returned by the search. To identify a set of studies that were eligible for further analysis, we read the title and abstract, as well as briefly scanning quickly the entire text where it was immediately available. This process yielded 71 sources of information. Further refinement of the list resulted in the removal of 13 items. To the remaining 58 items, we added 12 publications identified using Google Scholar, and 7 from Scopus, resulting in a final total of 77.

Of these preselected articles, 20 were excluded for various reasons during the full-text screening. Annex A contains a list of the final set of 57 publications included in the content analysis. For a schematic representation of the selection process, see Figure 1 below.

Figure 1[1]. Process and outcomes for the selection of literature on foresight studies in education and training



Prototypical examples – results

In this section, we describe a number of prototypical examples for foresight studies in education and training. This will enable the reader to gain a general impression of the content themes depicted and methodologies applied. In the section 'Discussion and Conclusions', we conduct a critical appraisal and interoperation of the findings. Prototypical examples are those projects that are most representative of those that include discussion about the future of education or training, either by identifying trends or directly envisaging the future. All prototypical examples presented in this section discuss various trends that could have an impact on education or training in the short or long term.

Education

EDUCAUSE Horizon 2019 report

The EDUCAUSE Horizon 2019 report (Alexander et al., 2019) identified six innovations in higher education that it suggested would eventually be adopted in different time periods (up to 1 year; 2-3 years; 4-5 years). The long-term (4-5 years) trends are 'Rethinking how

[1] Figures 1, 8, 9, 10 and 11 were compiled by the author for the current report.

institutions work' and 'Modularised and disaggregated degrees'. In the medium term (2-3 years), the innovations suggested by the panellists were 'Advancing cultures of innovation' and 'Growing focus on measuring learning'. 'Redesigning learning spaces' and 'Blended learning' were the trends identified as short term.

The report also discussed challenges to the adoption of these innovations. The challenges are classified as 'solvable', 'difficult' or 'wicked'. For example, challenges regarded as being easy to address were 'Improving digital fluency' and 'Increasing demands for digital learning experience and instructional design expertise'. Difficult problems identified were 'Evolving faculty with educational technology strategies' and the 'Achievement gap'. The wicked challenges were 'Advancing digital equality' and 'Rethinking the practice of teaching'.

The development section of the Horizon Report includes six technologies forecasted to be important to teaching, learning and creative enquiry in the future. These forecasts are arranged along three time horizons over which the developments are expected to achieve widespread adoption: developments expected to scale in one year or less; those forecast to be adopted in 2-3 years; and those forecast to enter the mainstream of education within 4-5 years.

The technologies expected to be adopted into educational practice in the short term are mobile learning' and analytics technologies. Medium-term technologies are 'mixed reality', an umbrella term for virtual reality (VR) and augmented reality (AR), and artificial intelligence. Technologies with a time-to-adoption of 4-5 years include blockchain and virtual assistants.

Topics in the report were selected using a modified Delphi process. This began with a review of the literature: research reports, essays and blogs. A panel of experts discussed the existing applications of emerging technological innovations, and brainstormed new ones. A key criterion for the inclusion of a topic was its relevance to teaching, learning and creative inquiry in higher education. Following its literature review, the panel generated a comprehensive list of technologies, trends and challenges.

Hurdles to and accelerators of innovation in schools

The equivalent of the EDUCAUSE Horizon Report for education at K-12 level is the Consortium for School Networking's 'Hurdles and Accelerators for driving innovation in schools' (CoSN. 2019). According to this report, the five most important hurdles to address (as expressed by the percentage of experts ranking them) are 'Sustaining and scaling innovation' (44%); 'Digital equity' (43%); the 'Gap between technology and pedagogy' (42%); 'Ongoing professional development' (35%); and 'Technology and the future of work' (32%). The five most difficult hurdles to overcome, rated on a scale of 1 = easiest to 5 = most difficult, are (means figures = M): 'Ongoing professional development' (M = 3.35), 'Technology and the future of work' (M = 3.39); the 'Gap between technology and pedagogy' (M = 3.53); 'Digital equity' (M = 3.61); and 'Scaling and sustaining innovation' (M = 3.95).

The most important accelerators for K-12 teaching and learning innovations in the report are ranked as follows: 'Learners as creators' (49%); 'Design thinking' (45%); 'Personalisation' (38%); 'Building the capacity of human leaders' (37%); and 'Data-driven practices' (36%). The top five accelerators by speed and intensity (1 = slowest and least intense; 5 = fastest and most intense) are: 'Building the capacity of human leaders' (M = 3.29); 'Design thinking' (M =3.53), 'Personalisation' (M = 3.76); 'Data-driven practices' (M = 3.83); and 'Learners as creators' (M = 4.08).

An international advisory board of 111 renowned educational technology experts collaborated virtually to identify issues and rank them via questionnaires on the importance of issues and the difficulty of overcoming them.

Innovating Pedagogies report 2019

The Innovating Pedagogies report (Ferguson et al., 2019) distinguished new forms of learning and teaching that introduce a major shift in educational practice and could therefore guide educational professionals and policy makers to design and implement such innovations. The 'innovating pedagogies' identified are: 'Playful learning', 'Learning with robots', 'Decolonising learning', 'Drone-based learning', 'Learning through wonder', 'Action learning', 'Virtual studios', 'Place-based learning', 'Making thinking visible', and 'Roots of empathy'.

The researchers first proposed a long list of new educational terms, theories, and practices. These were refined down to a list of ten that the researchers believed have the potential to provoke major shifts in educational practice. Finally, the experts explored both published and unpublished works to compile sketches of these new pedagogies that might transform education.

Evidence-informed, innovative pedagogical approaches

A subset of the authors of the Innovating Pedagogies report above (Ferguson et al., 2019) reflected on those evidenced-informed, pedagogical approaches identified in the previous seven reports that made a clear reference to the future (Herodotou et al. 2019). The innovating pedagogies are seen as a bridge between current pedagogical practice and visions for the future of education. After critically reflecting on 70 innovative approaches and applying a robust framework, the authors selected the following innovative approaches as having the strongest evidence and potential to transform learning and teaching: Formative analytics; Teachback; Place-based learning; Learning with robots; Learning with drones; and Citizen inquiry. For each innovative pedagogy, the authors discuss its relevance to educational theories, research evidence about its effectiveness, innovative aspects of the pedagogy, and the level of adoption in educational practice.

The framework used to select of innovating pedagogies by impact includes five criteria: relevance to effective educational theories; contribution to the development of 21st-century skills or the education vision of 2030; innovative aspects of pedagogy; and the level of adoption in educational practice. A very important component of the proposed framework is effectiveness or evidence of impact. To determine this, the authors used the Strength of Evidence pyramid (John and McNeal, 2017). This categorises different types of evidence based on their strength, ranging from expert opinions as the least strong type of evidence, to meta-analysis or synthesis as the strongest. In addition, they adopted the standard of evidence proposed by the foundation Nesta to measure the level of confidence in the impact of an intervention (Puttick and Ludlow, 2012).

Adaptive learning as an overarching approach

In discussing innovative pedagogies, a slightly different approach was taken by Peterson, Dumont, Lafuente and Law (2018) on behalf of the OECD. Within the context of analysing the theoretical issues involved in defining what is an innovative pedagogy, the authors provided examples of pedagogical approaches. These include experience-based, spaced learning, problem-based, place-based, discussion-based, flipped learning, enquiry-based, and product-oriented. None of these is described in detail, but a suggestion is made to apply evidence relating to practice as the basis for combining different pedagogies. The authors of the report pay special attention to adaptive learning, which they call an

"overarching pedagogical approach". Students bring to the classroom different patterns of individual differences (cognitive, personality, culture, religion), which need be addressed. The authors discuss empirical evidence from research relevant to adaptive learning. Their conclusion is that so far, there is no strong evidence to support adaptive learning. The authors carried out only desk research.

Trends transforming education as we know it

Early childhood education has a huge effect on development in future life, and is one of the 10 trends for transforming education envisaged by the European Political Strategy Centre (European Political Strategy, 2017). The others are: 'Graduation is not the end of learning'; 'Digital skills are becoming a key literacy'; 'Humans will increasingly compete with machines to gain novel insights'; 'Personalisation and the digitally-enabled learning path'; 'Interdisciplinary, technology-powered learning'; 'Formal education provision is complemented by new entrepreneurial ventures'; 'The broken link between formal education and work'; 'The increased need for media literacy including fundamentals such as digital literacy, visual savviness, and critical thinking; and Growing global competition for universities. The study's methodology is not reported.

Learning Framework 2030

The OECD Learning Framework 2030 (2018) addressed the following two main questions: 'What knowledge, skills, attitudes and values will today's students need in order to thrive and shape their world?' and 'How can instructional systems develop this knowledge and these skills, attitudes and values effectively?' The project identified the need for a broader educational goal: individual and collective well-being. Education has a crucial role in developing the knowledge, skills, attitudes and values that "enable people to contribute to and benefit from an inclusive and sustainable future". Education must therefore not only to prepare young people for future work, but must support every student's development as a whole person in order to fulfil his or her potential. In a series of brief reports on various aspects of the Future of Education 2030, the OECD has discussed different conceptual learning frameworks (OECD, 2018b, c, d). The **Transformative learning competencies for 2030**, for example, consists of three transformative competencies. The first of these is 'Creating new value' – innovation is at the core of inclusive growth and sustainable development (sense of purpose, curiosity, open mindset, critical thinking and creativity, agility and adaptability, and managing of risks). The second is 'Reconciling tensions and dilemmas' – balancing competing, contradictory or incompatible demands (cognitive flexibility and perspective-taking skills, empathy and respect, creativity and problem solving, tolerance for complexity and ambiguity). The third is 'Taking responsibility' – considering the ethics of action (locus of control and sense of integrity, compassion and respect, critical thinking, self-regulation and reflective thinking).

The key constructs of the Learning Framework 2030 **Student Agency** conceptual learning framework are the development of an identity and a sense of belonging, motivation, self-efficacy and a growth mindset. The third framework is the **'Anticipation – Action – Reflection'** cycle (AAR). As the name suggests, the AAR cycle consists of three phases. During the anticipation phase, learners try to anticipate the short- and long-term consequences of their actions. During the next phase, learners need to take action towards planned objectives. In the reflection phase, learners improve their thinking by trying to achieve a deeper understanding of what happened and how to improve the actions taken. The AAR cycle is understood as a general heuristic that can be applied and adapted to a wide range of situations, and developed in combination with a variety of specific curriculum approaches and learning traditions. Critical thinking, reflective thinking and perspective-taking are the key constructs associated with the AAR cycle. In addition, AAR can function as a catalyst for the development of transformative learning and student agency.

The Learning Framework 2030 includes some design principles for eventual changes in the curricula and education systems of different countries over time. These are classified into two major categories: concept, content and topic design; and process design.

The Learning Framework 2030 is the collective effort of a large number of stakeholders from many countries (e.g. government representatives, thought leaders, experts, school networks, school leaders, teachers, students and youth groups, parents, universities, local organisations and social partners). They have reviewed, tested and validated in an iterative process the initial version of the framework, which was drafted by a working group.

Several foresight studies have been carried out under a broader project of digital skills to develop frameworks that could be used to guide various stakeholders in their future educational practice and research.

European Framework for Digitally Competent Organisations

The digital competence of an educational organisation depends mainly on the teaching, learning, assessment and related learning support activities the organisation undertakes. The DigCompOrg framework (Kampylis, Punie, and Devine, 2015) consists of seven key categories and 15 sub-elements represented graphically as a wheel, known as the 'European wheel for digitally competent educational organisations'. The key thematic categories are: Leadership and Governance Practices; Teaching and Learning Practices; Professional Development; Assessment practices; Content and Curricula; Collaboration and Networking; and Infrastructure.

The methodology of this study includes a comprehensive review of both academic and 'grey' literature and an inventory of existing frameworks, followed by a number of consultations with experts and stakeholders.

European Framework for the digital Competence of Educators

The European Framework for the Digital Competence of Educators - DigCompEdu, (Redecker, 2017) consists of six key components, namely: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence. These are further operationalised via a total of 22 concrete competences, arranged under three broad categories: educators' professional competences, educators' pedagogical competences, and learners' competences. A progression model is proposed (by analogy with classifying language proficiency) to support educators in determining their strengths and weakness with regard to professional and pedagogical digital competences.

No explicit information is provided about the methodology of this study, but we assume it is similar to that applied in digital competences studies. Working under the auspices of the JRC, the authors can be expected to have followed its guidelines on data collection and analysis.

Digital competence for citizens

Another of the selected studies aimed to define what it means to be digitally competent citizen (Janssen et al.,2013). Its results indicate that digital competence comprises knowledge, skills and attitudes relating to 12 thematic areas, namely: general knowledge and functional skills; use in everyday life; specialised and advanced competences for work and creative expression; technology-mediated communication and collaboration; information processing and management; privacy and security; legal and ethical aspects; a balanced attitude towards technology; understanding and awareness of the role of ICT

in society; learning about and with digital technologies; informed decisions on appropriate digital technologies; and seamless use demonstrating self-efficacy.

The study combined a systematic literature review with online consultation via a questionnaire and face-to-face focus groups. The thematic areas were identified using hierarchical cluster analysis, in addition to more traditional techniques used to analyse the ratings data (descriptive statistics and significance test).

The Future of Learning study

We decided to include as a prototypical example a study on the future of learning that was carried out 10 years ago. This study was selected because: (a) it marks the beginning of the period under review, 2010-2020; (b) it allows us to determine the extent to which its findings are relevant now; and (c) it applied a comprehensive methodology (Stoyanov, Hoogveld, and Kirschner, 2010; Redecker, et al., 2011).

The project applied the Group Concept Mapping method to support an online consultation with experts on the future of learning, which produced more than 200 statements in responses to the focus prompt: "One specific change in education in 20 years will be that…". Multivariate statistical analysis on the raw grouping and rating of ideas by the participants identified 12 thematic clusters in relation to the future of learning. These were: life-long learning; the epistemological and ontological basis for pedagogical methods; the individual and social nature of learning; formal education goes informal; the roles of institutions; individual and profession-driven education; the role of the teacher; the globalisation of education; assessment, accreditation and qualifications; open education and resources; technology in education; and tools and services to enhance learning. These findings are in line with other foresight studies conducted at a later date. The clusters and ideas therein were used to create persona scenarios: improving school education; combating early school leaving; promoting inclusion; re-skilling workers with low qualifications; re-qualifying for a job later in life; re-entering the labour market; transitioning from higher education to the labour market; professional development and up-skilling; the role of teachers; and training strategies.

New ways to learn new skills for future jobs

The Future of Learning GCM study was part of a broader project, one of the goals of which was to determine the links between new ways of learning and new skills for future jobs. Another study applied the same research methodology eight years later to address the question, "How can we educate for non-existent/not yet existing professions?" (Kirschner and Stoyanov, 2018). The study identified 15 clusters: critical thinking; skill transfer; high-level thinking; competences; metacognition and reflection; efficacy [self-Image] building; learning in authentic situations; integrating school and professions; collaboration; professionalisation of teachers; information literacy; redesigning the school; literacy and numeracy; information skills; and learning for the future. Ratings of importance and feasibility indicate that what are referred to as "higher-order skills" (metacognition and reflection, skills transfer, and critical thinking) are considered the most important clusters of ideas, but that these skills are at the same time seen as somewhat difficult to implement. In contrast, the participants found that the clusters rated as easiest to implement are those that deal with the so-called "21st-century skills" (literacy and numeracy, information skills and collaboration), but that these skills are at the same time ranked fairly low in importance in terms of what schools need to achieve.

Apart from the GCM approach, the project included a megatrends analysis (DESTEEP), personas, online discussion of personas through social media, and a survey by questionnaire.

Workplace learning

The enterprise guide to closing the skills gap

Surveys carried out on executives in enterprises indicate that one of the biggest threats faced by organisations is a shortage of talent (LaPrade, Mertens, Moore and Wright, 2019). But while executives acknowledge the skills gap, they admit that no adequate actions have so far been taken to deal with the issue. The shortage of skilled workers is expected to increase. By 2030, the global talent shortage could number more than 85 million vacancies for skilled workers. The authors emphasise that the issue is not a shortage of workers *per se*, but a shortage of workers with the right skills.

Technical skills are still considered crucial to the business success, but attention has shifted towards behavioural skills, namely problem-solving, critical thinking, creativity, empathy and teamwork. Of the 12 skills identified as most important in the survey, six are of the behavioural type, including the top four (willingness to be flexible, agile, and adaptable to change; time management skills and the ability to prioritise; the ability to work effectively in team environments; and the ability to communicate effectively in a business context). The others behavioural type skills are: capacity for innovation and creativity (in seventh place) and ethics and integrity, in eighth. While next-generation jobs will still require a university background, many will perhaps require less than four years' college education (so called 'new-collar' jobs). There will be a more flexible path to achieving a level valued by the business and industry. An example of this given in the report is the Pathways in Technology Early College High Schools (P-TECH) model. P-TECH combines formal education with apprenticeships and internships, enabling students to learn both technical and behavioural skills.

Intelligent automation is another factor considered a game-changer. In contrast to the popular pessimistic prediction of job losses, Artificial Intelligence is expected to create even more jobs. However, the issue of the skills gap remains. It is estimated that more than 120 million workers in the world's 12 largest economies will require retraining and upskilling over the next three years.

Half of all executives surveyed agreed that education is one of the best ways to prepare learners for advances in intelligent automation, but only 28% of respondents thought that their country was willing to provide such a training. The executives also believed that the responsibility to do so lies not with individual businesses, but with the country.
Only a few of the tactics applied by executives to close the skills gap are "outward-looking" tactics (e.g. acquiring talent from outside the organisation; leveraging visa programmes to source international talent; and perhaps leveraging talent through ecosystem partners). Most tactics employed are "inward-looking": moving talent between business units and divisions; re-skilling employees based on business priorities; leveraging apprenticeship/internship programmes to train talent; leveraging new and emerging educational programmes/platforms to enhance employee skills; applying analytics to predict the supply of and demand for skills; implementing initiatives to recognise and track skills progression; leveraging talent through ecosystem partners.

The authors propose a number of recommendations based on approaches to skills development that have been proven to have a strong impact on closing skills gaps. These are: personalisation at scale; increased transparency; and leveraging the ecosystem. AI is expected to play a substantial role in helping organisations to close skills-related gaps. The methodology of this study is entirely based on surveys with executives.

Workplace Learning Trends Report

The positioning statement of the 2020 Workplace Learning Trends Report is that AI is reshaping the world of work, but most of organisations are not yet ready for it (Udemy, 2020). The authors refer to the Deloitte Global Human Capital Trends for 2019, according to which 65% of leaders think that Artificial Intelligence (AI) and robotics are either important or very important forces for the development of human capital. However, in the same Deloitte report, only 26% of organisations said that they were ready or very ready to address the impact of these technologies.

According to the Workplace Learning Trends report the five workplace learning trends in 2020 are: 'AI goes mainstream'; 'Realising the full potential of humans and machines will be a fact sooner rather than later'; 'Learning and development is starting to tackle reskilling of the workforce'; 'Organisations are building a data-driven culture'; and 'Countries across the world are upskilling in highly coveted tech skills'.

A growth mindset, creativity, critical thinking, communication, storytelling and emotional intelligence top the list of the fastest-growing soft skills in the workplace in 2020.

The Workplace Learning Report's five predictions for preparing the workforce for the future are as follows: skills mapping will chart the future workforce; Focused Capability Academies will replace ad hoc training; communities of practice will help to quickly keep skills up to date; the learning and development (L&D) function will transform radically over the next decade; and organisations will build marketplaces for internal talent. The advice given throughout the report is to "build rather than buy talent".
The main methodological approach used in the report is a survey of industry leaders, executives and human resource management officers.

Digital competence in the workplace

Some of the key findings of a study on the building of digital competence in the workplace (Centeno et al., 2010) are that companies should provide a benchmarking service for digital competence, promote a role for digital competence in developing soft skills, and introduce the idea of a Digital Competence Ambassador. The most effective way to teach digital competence is together with other competences such as creativity, critical thinking and entrepreneurship) in the form of project-based learning.

A cross-case analysis complemented the individual case analysis in this research.

Discussion and conclusions

For the second phase of this project, we subjected the textual data from the selected literature to rigorous qualitative analysis (Yin, 2011; Creswell, 2012). To achieve this, we employed the Grounded Theory Approach (Corbin and Strauss, 2008). Open, axial, and selective coding was applied to the texts to identify recurrent themes and their relationships within the publications. These codes were further integrated into broader categories. Brief memos were written to capture ideas as they appeared through the analysing and synthesis of the text.

Our first impression – namely, that the most relevant publications are 'in-house' EC reports – was confirmed by our analysis of the publications. In their majority the selected sources are targeted, aimed at developing polices, and apply proven research methodologies (both qualitative and quantitative). Other useful reports have been published by organisations including the OECD and UNESCO.

In carrying out the analysis, we spotted something that appears to be a form of 'publication bias'. Publication bias occurs when researchers tend to publish, and journals accept, only favourable quantitative results. Typically, 'publication bias' (e.g. a fail-safe *N* test and funnel plot) is a phenomenon discussed in meta-analytical studies encompassing only quantitative data. We noted that there were relatively a few relevant foresight studies published in high-impact, peer-reviewed journals.

In publications reviewed as part of our literature review, the identification of discussions concerning the future of learning or training requires that the 'future' be referred to either directly and explicitly, or implicitly through the analysis of trends. Examples of such implied references to the future include hurdles and accelerators for driving innovation in schools in the Innovating Pedagogies report 2019; adaptive learning as overarching approach; digital competence for organisations; digital competence for educators; digital competence for citizens; 'The enterprise guide to closing the skills gap'; the Workplace Learning Trends Report; and digital competence for workplace. Studies that explore the future directly include the Learning Framework 2030; the Future of Learning study; and New ways to learn new skills for future jobs.

On the one hand, none of the trend analyses reviewed constitutes mere a 'state-of-the-art' with no relation to future. On the other hand, the fact that experts generate ideas directly referring to future does not necessary exclude them from making reference to the present. Indeed, the future cannot be considered independently of its relationship to the present, regardless of whether this relationship is openly acknowledged or not. In addition, a generic model of foresight suggests that the understanding of foresight cannot be limited only to a direct, forward-looking approach (Voros, 2003). The generic foresight model comprises a number of levels that could guide the selection of foresight methodologies: input ("what is going on"), analytical ("what appears to be happening?"), interpretive ("what's really happening?"), and prospective ("what might happen?").

Thematic analysis

One theme that cuts across all prototypical examples relating to foresight is **creativity and innovation**. This often goes together with **critical thinking** (e.g. EDUCAUSE's trend towards advancing cultures of innovation; hurdles and accelerators in the Innovating Pedagogies report such as Learners as creators and design thinking; playful learning; learning with robots; drone-based learning; learning through wonder; virtual studios; and making thinking visible. Technologies such as AR and VR are also linked to creativity and critical thinking. Other themes combining creativity with critical thinking include discovery learning and adaptive learning in the OECD innovative pedagogies report; the tree components of transforming learning in the Learning Framework 2030 - creating new value, reconciling tensions and dilemmas and taking responsibility; the shift to soft skills as identified by 'The enterprise guide to closing the skills gap' and the Workplace Learning Trends Report; the specialised and advanced competences for work and creative expression cluster as defined in the study on digital competence for citizens; critical thinking and higher-order thinking in the study on educating for non-existent/not yet existing professions.)

Digital competence is another topic discussed in most of the projects reviewed (e.g. the dedicated reports on digital competence – organisation, educators and citizens; digital equality and digital fluency in EDUCAUSE and the 'Hurdles and Accelerators for driving innovation in schools' reports; data-driven practices in the 'Hurdles and Accelerators for driving innovation in schools' report); building a data-driven culture in 'The enterprise guide to closing the skills gap' and Workplace Learning Trends reports; media literacy and the concept of the "digital native" in 'Trends transforming education as we know it';

information literacy and information skills in the study on educating for non-existent/not yet existing professions).

The next topic discussed extensively in the reports is **personalisation** (the growing focus on measuring learning and analytics technologies in EDUCAUSE; personalisation in the 'Hurdles and Accelerators for driving innovation in schools' report; formative analytics in 'Evidence-informed innovative pedagogical approaches'; adaptive learning in 'Adaptive learning as an overarching approach' report; making it personal in 'The enterprise guide to closing the skills gap' and Workplace Learning Trends reports).

The next, cross-thematic, finding is the emphasising of **learning, teaching and pedagogies** in adopting and implementing technologies. Examples of this are: rethinking the practice of teaching and instructional design expertise and evolving faculty with educational technology strategies (in EDUCAUSE); the gap between technology and pedagogy (in 'Hurdles and Accelerators for driving innovation in schools'). All trends in evidence-informed innovative pedagogical approaches are included because of their relevance to teaching, learning and creative inquiry. Learning, teaching and pedagogies are emphasised in transforming learning, student agency and the 'Anticipation - Action – Reflection' cycle (AAR) in the Learning Framework 2030. Teaching and learning practices, assessment practices, content and curricula are key thematic categories of the digital competence for organisations report. The epistemological and ontological bases of pedagogical methods, and the individual and social nature of learning, are clusters in the GCM study on the future of learning.

Alternative paths for study and getting a degree is the next cross-cutting theme identified (how institutions work and modularised and trends towards disaggregated degrees in the EDUCAUSE report; flexible paths for achieving a level valued by business and industry in 'The enterprise guide to closing the skills gap' and the 'Workplace Learning Trends Report'; 'graduation is not the end of learning' and 'formal education provision is complemented by new entrepreneurial ventures' in 'Trends transforming education as we know it'; the GCM study on the Future of Learning – clusters for life-long learning, formal education goes informal, roles of institutions, individual and profession driven education, and accreditation and qualifications).

If we need to identify one overarching question that run throughout the whole set of papers selected, but is never explicitly stated, it would be this: **shall we prepare youth for the future requirements of the labour market, or do we need to follow specific educational goals towards developing students as whole persons?** Rather than adopting a binary 'either/or' position on this issue, the publications reviewed take a fairly balanced approach. Certainly, students need be prepared for the requirements of existing (and even not-yet-existing) professions. However, this intention must be complemented by working towards achieving specific educational goals, i.e. developing cognitive and non-cognitive competences that are not necessarily directly related to a specific job (curiosity, imagination, self-regulation; respect for and appreciation of the ideas, perspectives and values of others; coping with failure and rejection; motivation not only to get a good job but to care about the well-being of friends, families, communities and society). Students who develop general-purpose knowledge, skills and attitudes are more able to adapt themselves smoothly to new conditions.

Some inconsistencies appear in the ways in which trends are classified across most of the reports reviewed. Some trends and challenges mentioned in EDUCAUSE are closely related in terms of meaning, and yet these apparent links are not discussed (e.g. 'rethinking how institutions work' and 'modularised and disaggregated degrees'; 'the growing focus on measuring learning' and the achievement gap; 'rethinking the practice of teaching' and 'instructional design expertise'; learning analytics, achievement gaps, and instructional

design; the use of technologies such as virtual reality (VR), augmented reality (AR), artificial intelligence, blockchain and virtual assistants, and evolving faculty using educational technology strategies).

The classification of innovative pedagogies in the Innovating Pedagogies Report 2019 employs a mixture of different criteria. For example, it includes trends that refer to a pedagogical approach (playful learning, learning through wonder, virtual studios, making thinking visible) as well as trends that refer to a specific technology (e.g. learning with robots, drone-based learning).

The research methodology employed in the study on Evidence-informed innovative pedagogical approaches is very impressive. However, the evidence referred to in the study is mostly confirmatory. Falsification is just as important as confirmation. It would have been useful to not only refer to publications as evidence for impact, but also to consult the primary research on a specific topic. Another issue is so-called "streetlight" phenomenon – that is, paying more attention to issues that are easy to investigate while ignoring research problems that are relevant but difficult to investigate. An example of this is the issue of how to align design for learning with learning analytics. Another controversial concept whose argumentation ought to be subject to falsification is 'learning style'. Certainly, we should not expect better results due to learning style. It is a preference-type cognitive construct (i.e. "in what way?"), rather than a level type ("how much?" – e.g., abilities, knowledge, skills). For some reason, most researchers fail to make this distinction. But then, the question remains: if we have no strong theoretical basic to assume *better* learning achievements due to learning style, should we expect an increase in satisfaction or motivation? More research into this aspect is required before we can claim learning style is a useless variable and blame teachers for liking it.

Some of the pairs of opposing trends identified in the report 'Trends transforming education as we know it' do not entirely correspond with one another, either by number or by content. The report discusses 10 trends, while something that resembles an advanced organiser presents nine dichotomous statements ("From here… to there"). There is an implied value in "to there" as the desired state. The dichotomy presented also suggests an either/or relationship between the two, when in fact some current ("From here…") approaches can still be useful. In addition, the report includes some controversial statements such as "humans will increasingly compete with machines". In fact, most studies actually suggest that human and machine will work together and complement each other. In addition, there is insufficient evidence to suggest that so-called 'digital natives' will outperform other adult learners.

While the GCM study on the Future of Learning returned some useful results, its authors were not entirely consistent in their use of the GCM findings to inform the creation of personas.

The GCM study on educating youth for non-existent/not yet existing professions produced some valuable results on what is a rarely addressed topic, yet the study's quantitative analysis struggles to accommodate all of the different perspectives, despite the fact that GCM is arguably one of the best research method for doing so. We suspect this was due to the focus prompts (the initial statements used to gather opinions), which were insufficiently clear to the participants.

Methodologies employed by the studies under review

Most of the prototypical examples included in this review applied a modification of the Delphi method, which usually is combined with a desk research. Delphi includes both online and face-to-face consultations with experts. The method involves the collection and

analysis of both qualitative and quantitative data. Only in a few instances has a megatrends analysis been conducted as part of a foresight project (Redecker et al. 2011 – DESTEP: demographic, economic, social, technological, ecological and political factors; Zweck et al., 2017b – Identification of Social Changes 2030; Leitner et al., 2019; part of the Learning Framework 2030). Some projects created future scenarios (Zweck et al., 2017b; Leitner et al., 2019).

Overall, the literature proposes a wide range of foresight methods (Global Centre for Public Service Excellence, 2015; Popper, 2008). The website of the European Foresight Platform (EFP) also provides some useful insights (http://www.foresight-platform.eu/).

In this section, we address a number of issues faced in carrying out foresight studies in education and training that have attracted limited attention, but which could contribute significantly to the quality of these types of studies.

Group Concept Mapping

We strongly recommend applying the Group Concept Mapping method – either independently, or in combination with other methods – for data collection and analysis (Kane and Trochim, 2007; Kane and Rosas, 2018; Trochim and McLinden, 2017). Group Concept Mapping is a consensus-driven approach that combines qualitative data collection with quantitative analysis to support a group of stakeholders to conceptualise and visually represent ideas and their relationships on an issue. GCM includes some well-known activities for data collection such as the brainstorming of ideas, sorting of the brainstormed ideas into thematic groups and rating of the ideas according to certain criteria. Multivariate statistical techniques, such as multidimensional scaling (MDS) and hierarchical cluster analysis (HCA) are then used to aggregate the individual contributions made by participants during the brainstorming, sorting and rating. These techniques allow the shared collective perspective of the group on the issue under investigation to be visualised, using some form of graphical representation (e.g. a series of conceptual maps and ladder graphs called 'pattern matches'). Probably the most distinctive feature of GCM is that although the participants structure the ideas generated independently of each other, the method is still able to integrate the different perspectives to display the common vision of the group. GCM analysis can identify short- and long-term actions by locating the ideas generated, sorted and rated in quadrants ('go zones' diagrams).This is an effective way of identifying short- and long-term perspectives in comparison to asking people to determine the time horizons for themselves. Sometimes, the distinction is fairly arbitrary (e.g. 2-3 years and 4-5 years). The software used to support GCM activities online is user-friendly (Concept System Global Max, 2017; the new version is Groupwisdom, 2020). Annex B includes a number of images intended to help the reader gain an idea of the outcomes that can be expected from using the GCM method.

Personas

Some studies create 'personas' or 'scenarios' based on findings derived from GCM and/or other methods. A persona is a textual description of a typical user. This user is a synthesis of elements drawn from multiple users who share common characteristics such as job roles, demographics, and user needs. Each persona is given a realistic user name, textual description and, if possible, a 'head shot' photo to portray the type of users represented. Two of the publications included in the current review created personas (Redecker, 2011; Zweck et al., 2017b) – although the second publication prefers the term 'scenario' over 'persona'. Persona should be based on some empirical evidence.

Cognitive bias

Cognitive bias must be addressed during all phases of a foresight study (Winkler and Moser, 2016). Examples of cognitive bias include (but are not limited to): framing and anchoring; desirability bias; the bandwagon effect; and belief perseverance. Cognitive bias affects the way in which inferences, judgements and predictions are made.

Cognitive style

Another cognitive construct that should be taken into account when carrying out foresight studies is cognitive style for problem solving and decision making. In contrast to cognitive bias, which gives rise to errors in judgement, 'cognitive style' describes a person's preference as to how they perceive and tackle information in order to inform decision making. People with the same educational background and experience may have different cognitive styles. A wide gap in the range of cognitive styles among a group of participants discussing a foresight issue may have serious consequences. The group may spend the most of its time dealing with differences in cognitive style, rather than discussing the problem at hand. The range of cognitive styles can be determined relatively easily. Practice examples show that simply being aware of these differences is already very helpful. If the intention with regard to cognitive biases is to avoid them, cognitive styles should be accommodated and complemented.

'Black swans'

The current COVID-19 crisis is a very representative example of a so-called 'black swan'[2]: an unpredictable or unforeseen events that may have extreme consequences Such events must be taken very seriously.

Text mining

Text mining can be a useful exercise to supplement a classical content analysis. Annex C presents a several screenshots illustrating what the results achieved from a text mining of the literature collected for this study. The analysis is 'unsupervised', as we simply uploaded the publications into the software and made no changes to the settings during pre-processing. For the quantitative content analysis, we used Leximancer 5 (portal version, 2020). This software was chosen because it claims to identify concepts rather than simply words.

Leximancer automatically extracts concepts from the text and displays the relationships between them. The software carries out several iterations to find evidence that a particular concept is well-represented by the terms with which it is associated. In addition, the concepts are clustered into themes. These themes and concepts are visualised as a conceptual map. The themes are heat-mapped, with 'hot' colours (red, orange) indicating the most important themes, and 'cooler' colours (blue, green) denoting themes of lesser importance. The text browser helps to interpret the results.

Leximancer applies language technologies and machine learning to identify the most important concepts and the relationships between them. A 'concept', according to Leximancer, is a combination of words that co-occur frequently in the text. The software assigns weights to words based on how frequently a word occurs in a context in which a concept is discussed, and how infrequently they occur outside this context. Leximancer re-reads the corpus until it finds sufficient evidence to identify a concept (i.e. when the sum

[2] The writing of this deliverable was affected by such a 'black swan'. 16 pages of coding of notes and memos were lost due to the organisational VPN crashing because too many people were using simultaneously as a result of working remotely during the coronavirus outbreak.

of the weighted terms exceeds a defined threshold). Leximancer thus creates a specific thesaurus of terms for that corpus, which defines each concept. A 'theme' is a combination of concepts that appear close together in the text. These are shown in close proximity on the map. Themes are named according to the most prominent concept in the cluster. Aside from the conceptual map, Leximancer provides a text browser to explore the text from which the concepts are extracted, as well their relationships with other concepts.

Limitations of this study

This review may be subject to some limitations. In total, we assessed the suitability of around 20% of all the literature that appeared in the search. This figure is based on previous experience, which was borne out in the present case: after the highest-ranked 10% of search results, the relevance of matches decreases significantly. We estimate that there is some chance, albeit small, that relevant studies could appear beyond the 20% of search results checked.

In addition, this review made no measure of the methodological quality of the resources reviewed. Specific tools exist to conduct such assessment (e.g. The Medical Education Research Study Quality Instrument - MERSQI); however, we have gained the impression that such instruments may suffer from inherent bias. For example, they rank expert opinion at the lowest level of methodological quality. Expert opinion is not necessarily associated only with *qualitative* research design – and qualitative data can be analysed quantitatively by employing advanced statistical methods. In addition, research designs ranked most highly for methodological quality by such tools (e.g. randomised control trials) generate issues with external validity. And while we acknowledge that the number of citations a study receives, or its acceptance rate at conferences (e.g. judgement-only abstracts only vs. peer-reviewed, with roughly a 20% acceptance rate) could be used as criteria to judge the quality of a report, we believe this aspect is not of sufficient importance at this stage to determine whether to include or exclude a publication.

At first glance, the reader may gain the impression that this review is biased toward publications in English. However, it should be emphasised that we did not explicitly restrict our search to English-only. There might be some alternative explanations for this phenomenon. For example, the search engine may not be as sensitive in capturing publications in languages other than the English. Alternatively, it may be that the most relevant publications are indeed in English.

We have a basic understanding of how the algorithm works that is used to performed a search across several electronic databases, and acknowledge that there is a chance that it may not reliably accommodate all search terms. On the other hand, the search engine is used by many universities, and we have experienced no major issues during previous projects we have undertaken.

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Annexes

Annex A

Final set of publications included in the content analysis

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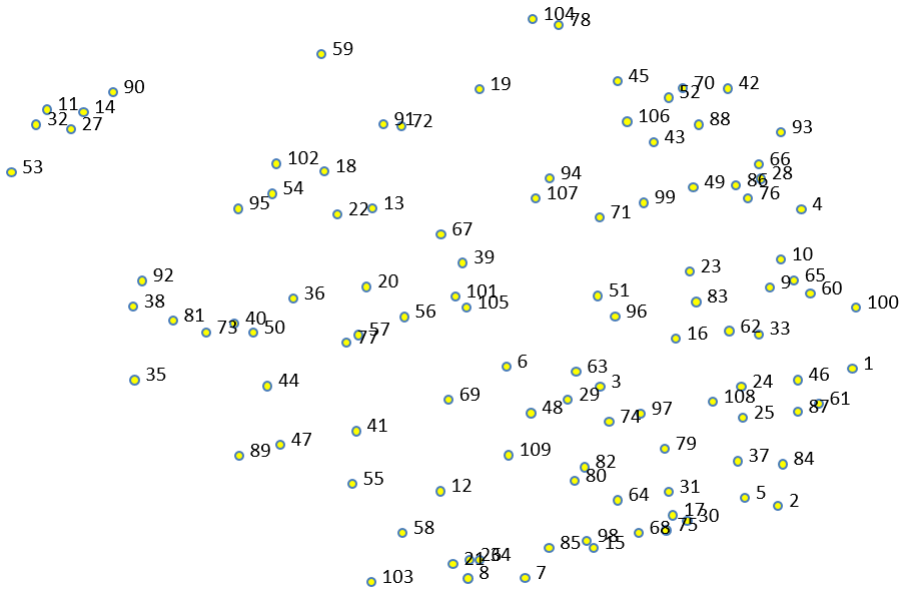
Annex B

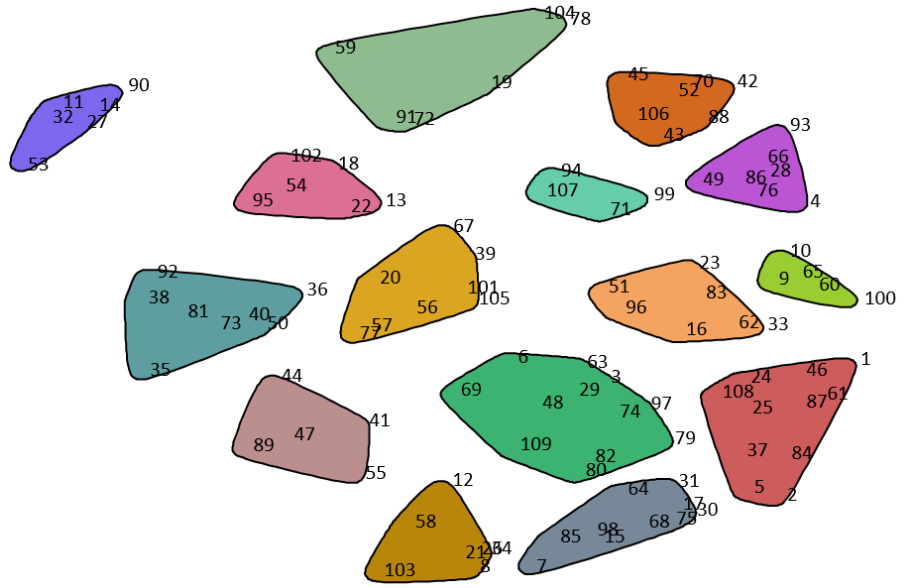
Examples of the outcomes that can be expected from using the GCM method

Figure 2[3]. Point map



Multidimensional scaling aggregates the individual input of every participant during sorting and shows all ideas located on two-dimensional space. The closer the ideas to each other the closer in meaning they are ("Educating Youth for Non-existent/Not Yet Existing Professions").

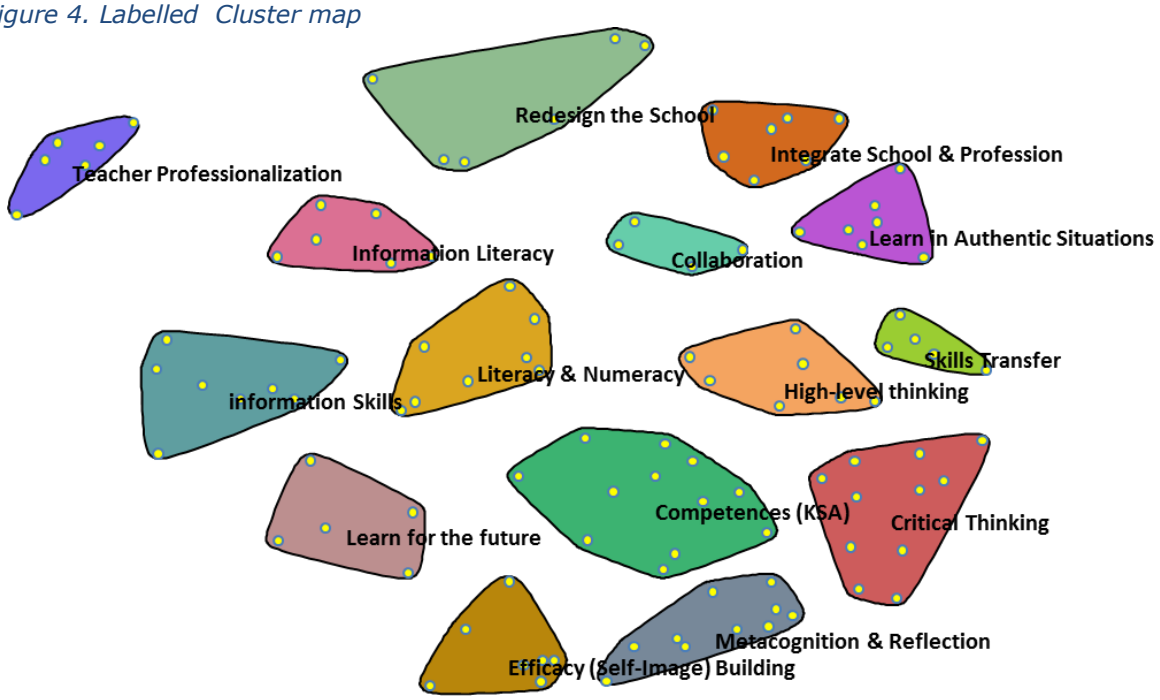
Figure 3. Cluster map



The ideas are grouped thematically following suggestions made by a hierarchical cluster analysis ("Educating Youth for Non-existent/Not Yet Existing Professions")

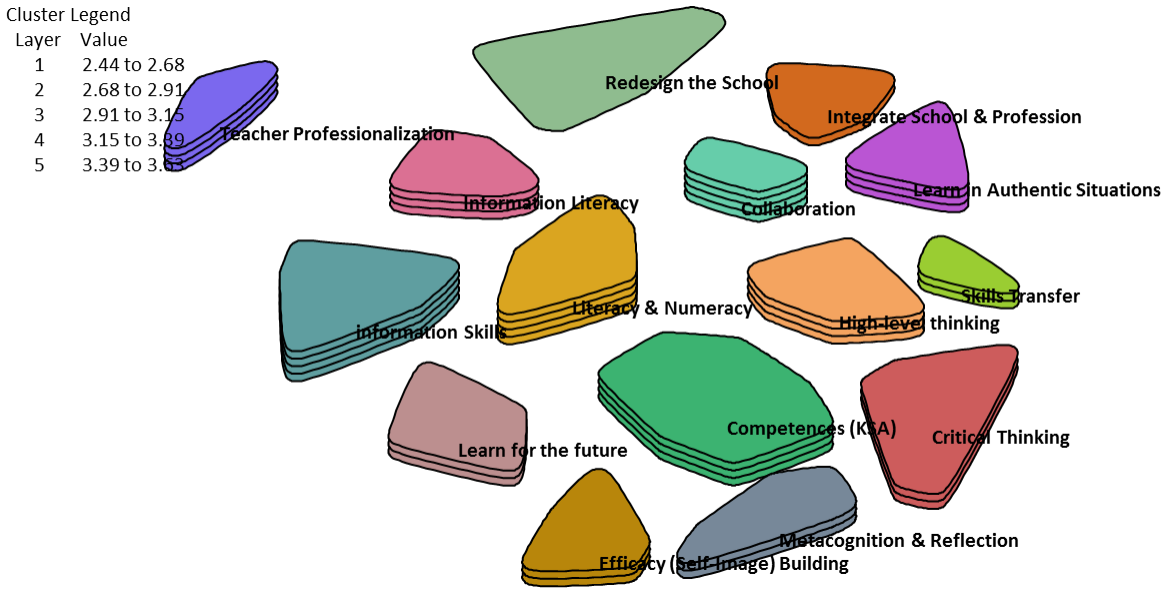
[3] The source of figures 2, 3, 4, 5 and 6 can be found here.

Figure 4. Labelled Cluster map



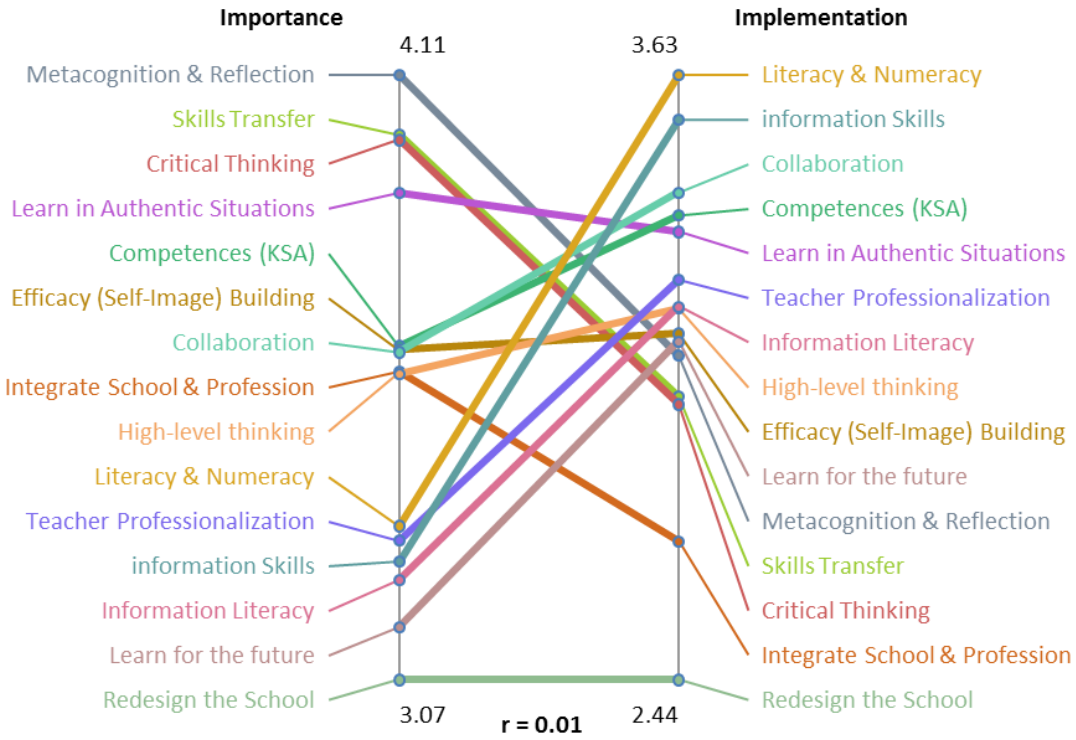
The clusters' names are based on the suggestions made by the participants, bridging value statistics and reviewing the ideas in each cluster ("Educating youth for non-existent/not yet existing professions")

Figure 5. Cluster rating map (Implementation)



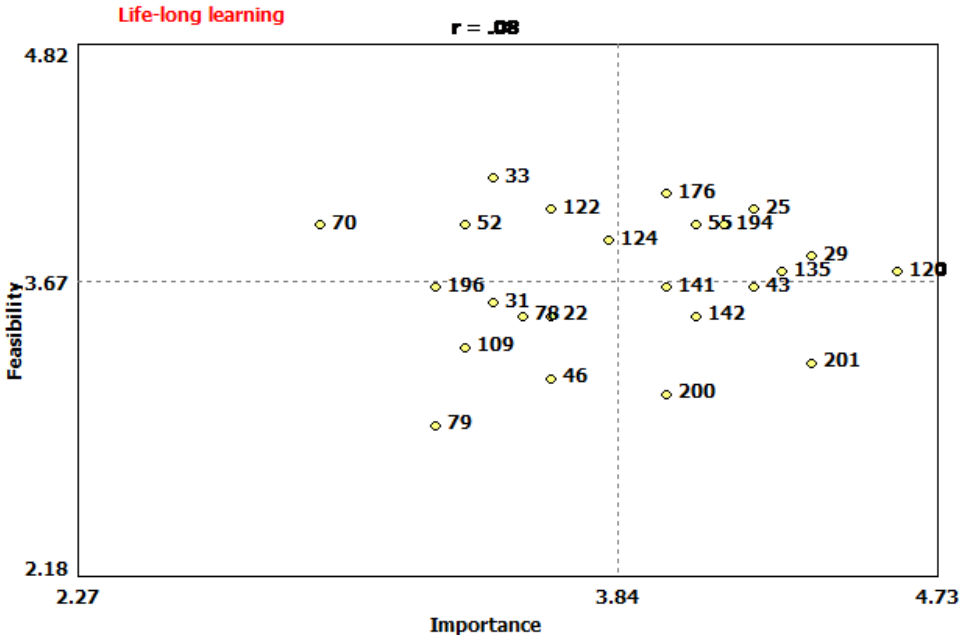
One layer means 'very difficult' to implement into practice; 5 means 'very easy' ("Educating Youth for Non-existent/Not Yet Existing Professions")

Figure 6. Pattern match



It compares clusters on the average rating of the two rating values. In this particular case some of the clusters score relatively high on one value but relatively low on the other. The correlation is very low. ("Educating youth for non-existing professions").

Figure 7[4]. Go-Zone



Each cluster is divided into 4 quadrants based on the mean values of the two ratings. The upper right quadrant suggests actions/measures in short term (important and feasible).

[4] The source of figure 7 can be found here.

The quadrant below of it implies long term actions/measures (important but not feasible) ("The future of learning"").

Annex C

Examples of results that can be achieved using text mining

Figure 8. Conceptual map of all publications reviewed, created via data mining using Leximancer

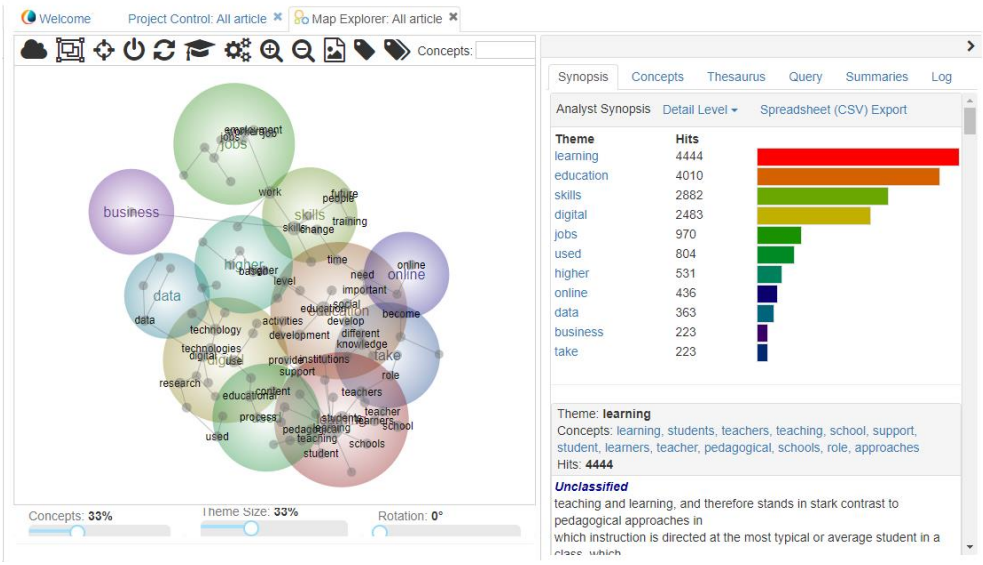


Figure 9. Conceptual map of publications relating to foresights in education

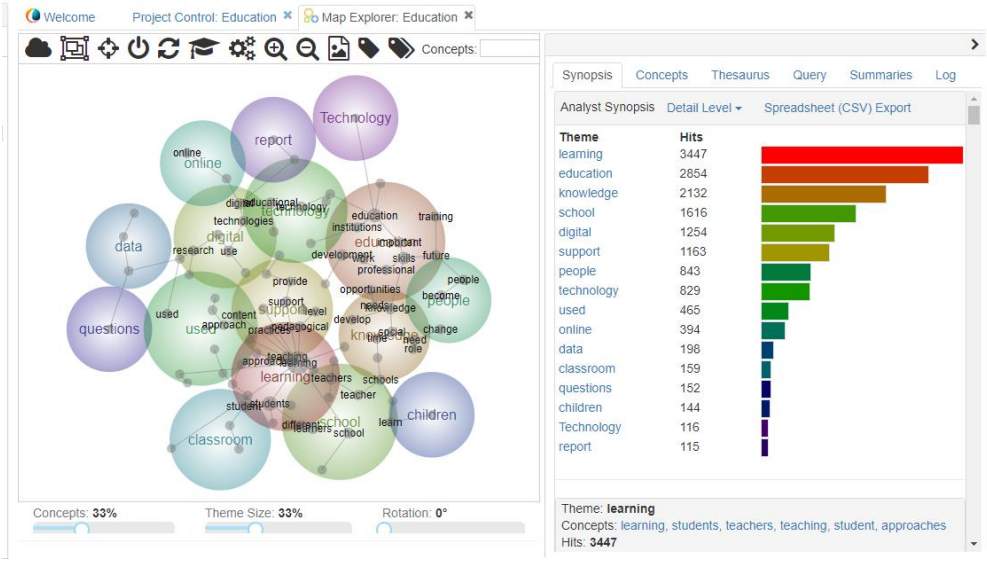


Figure 10. Conceptual map of publications relating to foresights in workplace learning

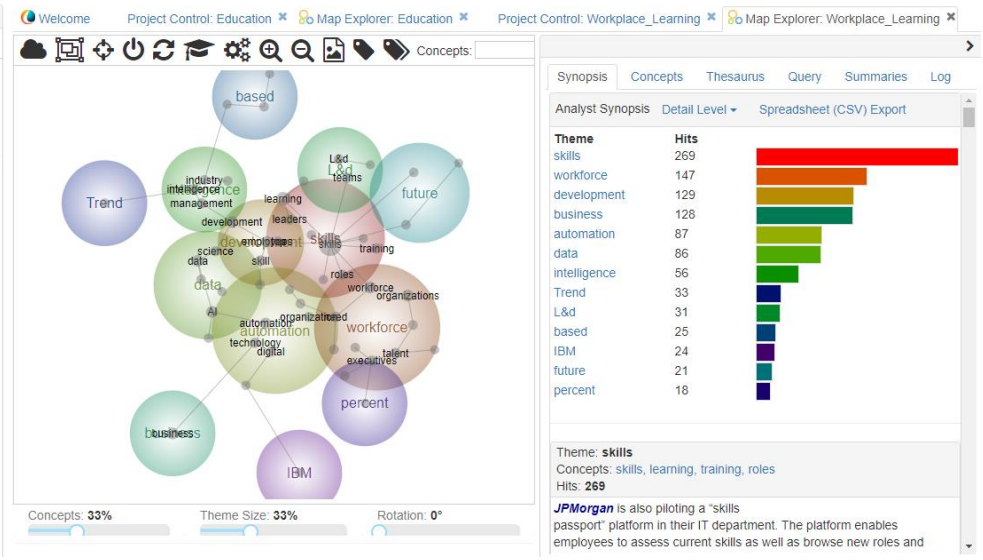


Figure 11. Conceptual map of publications relating to megatrends