

Exploring singularity in higher education: innovating to adapt to an uncertain future

Explorando la singularidad en la educación superior: innovar para adaptarse a un futuro incierto



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ABSTRACT

This research presents an analytical model designed to detect, organize, and classify singularity in higher education based on futures studies. To achieve this, evidence is gathered to identify distinctive features in the educational field, empowering universities to make strategic decisions in complex environments worldwide. The study is grounded in analytical techniques supported by future research, aiming to identify trends and innovative organizations in various global educational contexts. These singularities are categorized and organized using a mixed methodological approach that combines confirmatory research with the collection of qualitative and quantitative data. The study's findings offer insights into 55 higher education organizations with unique characteristics, emphasizing critical aspects of each. Furthermore, the utility of the developed instrument is validated as a pivotal tool enabling universities to continually review and adapt their educational practices, keeping them current and responsive to social and technological advancements in our ever-changing world. Additionally, the research seeks to stimulate a discussion about the future role of universities as influential entities in a dynamic, complex, and uncertain society. This underscores the vital importance of universities being well-prepared to confront challenges and seize opportunities emerging in this evolving context, ultimately contributing to their sustained relevance and effectiveness in the continuously changing educational landscape.

Keywords: comparative analysis; trend; educational innovation; higher education; future studies.

RESUMEN

Esta investigación presenta un modelo de análisis diseñado para detectar, organizar y clasificar la singularidad en la educación superior basado en estudios de futurización. Para ello, se recopilan evidencias con el fin de identificar rasgos diferenciales en el campo educativo, lo que permite a las universidades tomar decisiones estratégicas en entornos complejos. El estudio se fundamenta en técnicas de análisis respaldadas por investigaciones futurísticas para identificar tendencias y organizaciones innovadoras en diversos contextos educativos. Estas singularidades se clasifican y organizan mediante una propuesta metodológica mixta que combina investigación confirmatoria y la recopilación de datos cualitativos y cuantitativos. Los resultados del estudio proporcionan una visión de 55 organizaciones de educación superior con características singulares, destacando aspectos importantes de cada una de ellas. Además, se valida la utilidad del instrumento desarrollado como una herramienta crucial que permite a las universidades revisar y adaptar constantemente sus prácticas educativas, manteniéndolas actualizadas y respondiendo a los avances sociales y tecnológicos en un mundo en constante cambio. Asimismo, la investigación busca fomentar un debate sobre el papel futuro de las universidades como actores en una sociedad dinámica, compleja e incierta. Esto resalta la importancia de que las universidades estén preparadas para enfrentar los desafíos y aprovechar las oportunidades que surgen en este contexto cambiante.

Palabras clave: análisis de tendencia; innovación pedagógica; enseñanza superior; tecnología de la educación, estudios de futurización.

How to cite: Lara-Navarra, P., Sánchez-Navarro, J., Fitó-Bertran, A., López-Ruiz, J., & Girona, C. (2024). Exploring singularity in higher education: innovating to adapt to an uncertain future. [Explorando la singularidad en la educación superior: innovar para adaptarse a un futuro incierto]. *RIED-Revista Iberoamericana de Educación a Distancia*, 27(1), 115-137.

<https://doi.org/10.5944/ried.27.1.37675>

INTRODUCTION

In today's complex, dynamic, and uncertain world, universities must constantly review their teaching practices to keep up with the ever-changing needs of society (Guàrdia et al., 2016, 2021; Manetti et al., 2022a, 2022b). Higher education institutions must also strive to provide environments that effectively meet the challenges of modern-day society, focusing on how to improve the university ecosystem as it faces a future characterized by more unknowns than certainties (Baig et al., 2023). To this end, universities need to understand the scale and impact of change in order to create distinctive, transformative spaces that can revolutionize educational systems (Patterson et al., 2022).

This study proposes to achieve this goal by exploring the concept of the "educational singularity" as a conceptual framework for analyzing the factors that make an educational institution a differentiated project. The term "singularity" refers to a hypothetical point in time at which technological growth becomes uncontrollable and irreversible, resulting in unforeseeable changes to human civilization. In the context of education, the educational singularity could be seen as a point in time at which traditional educational systems are disrupted by new technologies and pedagogical approaches, leading to a fundamental transformation of the way we learn and teach. It is important to note that the characteristics defining the emergence of singularity may appear in different ways and go beyond institutions' traditional teaching models. This leads to the urgent need to develop new analytical approaches in the educational field (Cai, 2017; Ramírez-Montoya et al., 2022).

Thus, the basic aim of this research is to establish a study framework that will characterize the concept of singularity in education. The theoretical foundation of this study is based on the seminal paper by Wenham (1987), "Singular Problems in Science and Science Education." To achieve this aim, we propose an analytical model focusing on the identification, organization, and classification of educational singularity based on previous research in Wenham (1987) and Andriushchenko et al. (2020). The ultimate goal of this inquiry is to provide universities with a set of innovative tools enabling them to face and adapt to the challenges of change. This approach is based on the premise that the ability to identify an educational singularity has become an essential element for improving the adaptability of such institutions when dealing with fast-moving changes in the social, cultural, demographic, economic, and technological fields and in the markets (Manetti et al., 2022a) and ultimately, to strengthen their ability to respond to these changes (Gros & Lara, 2009).

This research intends to define singularity in the field of education, as a turning point in the way higher education is conducted and organised. Thus, the study focuses on gathering evidence which helps detect differentiating features in the world of higher education, with the ultimate aim of enabling universities to make strategic decisions in the complex environments in which they operate. Our research is supported by prospective and futures studies (Decoufle, 1974; Godet, 2001; Mojica, 2005; Brown & Kuratko, 2015; Kuosa, 2010, 2016; Berenskoetter, 2011; Ito & Howe, 2016) combined with the theoretical and methodological bases of concept analysis (Meyer & Mackintosh, 1994) to establish an instrument for classifying and organising educational singularities. In brief, we intend to explore trends in higher education as an innovation space in order to deal with the challenges of the new and uncertain global scenario (Guàrdia et al., 2016; Manetti et al., 2022a).

Thus, the main goal of this study is to detect trends in the higher education system which enable the identification of institutions with distinctive practices, which could be considered singular. The results obtained will provide an enriching view of universities which stand out for their unique characteristics, contributing to highlight outstanding aspects of each one. Additionally, it is hoped that discussion of the future of universities as fundamental institutions supporting a society characterised by rapid change, complexity, and uncertainty will be fostered.

RESEARCH METHODOLOGY

This study aims to define the concept of singularity as a distinctive element and driver of change in the context of higher education. It uses a mixed methodology, combining confirmatory research with gathering qualitative data. This method is based on analysis supported by prospective studies to find trends leading to the identification of innovative institutions in various educational contexts (Gough, 1990; Hicks, 2012; Hicks & Slaughter, 1998; Toffler, 1974). We begin with the premise that prospective studies are a process using analytical tools to identify trends and establish possible future scenarios (Manetti et al., 2022b).

In the sphere of higher education, futures studies methodologies are frequently associated with radical changes or substantial reforms in areas such as academic papers, the syllabus, teaching, learning, or technology (Cai, 2017). The scientific literature attests to the robust connection between the concepts of futures studies and education (Menéndez et al., 2022), showing that methodologies for the definition of future scenarios have the potential to profoundly transform education (Bodinet, 2016; Gee & Esteban-Guitar, 2019; Hicks, 2012). Thus, a clear and robust association is established between prospective methods and such concepts as "education", "learning", "training programmes", "syllabus", "literacy", and "teaching", alongside other terms like "centres", "university", "lecturers", and "students" (Menéndez et al., 2022).

The proposed steps of the research are described below:

- Identification of key themes and concepts relating to innovative trends and practices in higher education.
- An exhaustive bibliographic review of studies on these themes and concepts.
- Selection of a representative sample of studies for qualitative analysis, basing the selection on pre-established criteria such as research quality, relevance of results, and diversity of sources.
- Extraction of relevant qualitative data from the selected studies via the codification and categorisation of the gathered information.
- Analysis of the qualitative data using thematic analysis and/or content analysis, to identify patterns, trends, and relationships between the key concepts.
- Development of a rubric based on the results of the qualitative analysis.
- Design of expert interviews to complement and/or validate the results of the qualitative analysis.
- Presentation of the results of the analysis.
- Discussion and conclusions about the implications for higher education.

In short, this research process follows a series of sequential steps, each with a specific objective. Essentially, the research will look for trends relating to unique practices in higher education, for later in-depth analysis of educational institutions. The following research questions, taken as a whole, explore how to detect trends, identify unique institutions, and determine the level of singularity of a university:

- RQ1. How can we identify trends in higher education?
- RQ2. Can we discover new models of higher education based on the identified trends?
- RQ3. How can we organise and classify the higher education institutions with differentiating characteristics?
- RQ4. How can we establish the level of singularity of a university?

Answering these questions will enable us to validate a rigorous, systematic approach for exploring singularity, futurology, and higher education, in order to offer a system for organising and classifying differentiating practices in higher education institutions.

RESULTS

The research begins with the identification of key themes and concepts relating to trends in higher education, with a special emphasis on looking for unique practices in education, based on the review of the literature produced in the period 2015-2020. We examined the ERIC database with the following search equations: “Higher education AND Innovative practices AND Research reports”, which offered 107 documents in the period mentioned; “Higher education AND Innovative practices AND Descriptive reports”, giving a result of 49 documents; “Higher education AND Trends AND Technology AND Research reports”, with a total of 170 papers; and “Higher education AND Trends AND Technology AND Descriptive reports”, giving us 64 documents. The corpus of documents was completed with searches in Google Scholar, which has been shown to be valid for this type of research approach, both in terms of coverage for systematic reviews (Gehanno et al., 2013), and in academic terms of precision, authority, objectivity, topicality, inclusion, and relevance (Howland et al., 2009).

The Mendeley reference management system was used to store and share files and create notes in the documentary analysis phase. Next, we selected a representative sample of studies for qualitative analysis. The screening stage eliminated duplicate documents and established selection criteria, such as whether the reports have participants from various countries or institutions, contain meta-analysis, and offer large samples for specific case studies. Once the outstanding themes were identified, it could be established that the key trends were those appearing in more than two sources. It should be pointed out that here we were more interested in studying the institutions linked to the trends than in examining the trends in more depth.

During the data extraction process the information gathered was codified and categorised using content analysis techniques, in order to identify trends in the higher education system which would help us find institutions with practices that could be considered unique. These analyses identified 25 trends (Table 1) linked to 110 institutions in Europe, the USA, Canada, and Australia, and in supraterritorial organisations. In the analysis process we observed that several universities mentioned

in the reference documents are considered inspiring institutions by other centres, leading us to resize the sample to 55 universities, which third parties consider to be competitive leaders in the worldwide university system (Table 2).

Table 1
Higher education trends identified

| | | | | |
|------------------------------------|---------------------------|---|-------------------------------|-------------------------------|
| Self-regulated learning | Inquiry-based learning | Project- and problem-based learning (PBL) | Rhizomatic learning | Authenticity |
| Community of interest and practice | Skills-oriented education | Metacognitive approach to learning | Smart learning environment | Personal learning environment |
| E-portfolio | Gamification | Digital badges | Artificial intelligence | The Internet of Things |
| Serious games | Modularity | Virtual mobility | Virtual worlds | Data portability |
| Augmented reality | Virtual reality | Recognition of open and informal learning | Social networks for education | Robotics applied to education |

Source: by the authors.

Once the trends were identified, we identified the institutions linked to them and began the research stage, to develop and design a rubric to serve as an instrument of reference to analyse the differentiating elements of each organisation. The purpose of this rubric was to establish the disruptive contribution of higher education to society, and to study the innovation, development, and knowledge transfer models of the analysed centres.

In the first exploration, to construct the measurement indicators, we consulted papers on the quality of innovation in higher education (Beran & Violato, 2005; Fernández, 2008; Vásquez et al., 2023). During this process, we observed a general lack of suitable indicators for measuring innovative elements in the quality of education (Velasco et al., 2019). This results in a dependency on indicators which often over-simplify or are taken out of context (Loukkola et al., 2020). The well-known international college rankings offer very little of use for studying unique practices. Also, the disparity of models and measurement options, which also entail diverse and sometimes different dimensions and indicators (Guerrero, 2018) for assessing quality in teaching innovation processes, reveals the need to establish common frameworks of reference for evaluating educational innovation.

Given that the observation process particularly emphasises how higher education organisations approach and institutionalise major challenges, and the evident difficulty of finding examples, other sources are needed to establish the singularity variables in the rubric to be presented below. One supporting reference is the working model of the Sustainable Development Goals, which establishes far-reaching and transformative universal goals (Southern, 2020). Another is the Global Innovation Index, which classifies world economies according to their innovation level (Torres-

Samuel et al. 2020). This report uses around 80 indicators to capture the different dimensions of innovation. These sources give us a solid base for assessing and analysing the innovation programmes, strategies, and plans of higher education institutions.

Table 2
Institutions selected for analysis

| | | | | |
|--|---|---|--|--|
| Arizona State University (Global F. A, M-Open edX) | Berlin School of Creative Leadership | Coursera | DigiPen Institute of Technology | Duke-NUS Medical School (National University of Singapore) |
| ECIU University | École 42 | edX | Estonian Entrepreneurship University of Applied Sciences | Fabrica Benetton |
| Harvard University | Hyper Island | IE University | Kaospilot | Karolinska Institutet |
| Knowmads Business School | Lomonosov Moscow State University | Massachusetts Institute of Technology (MIT) | McGill University | Minerva Schools at KGI |
| Monash University | Mondragon Unibertsitatea / Team Academy LEINN | NASA Int. | Open Universities Australia | Pontificia Universidad Católica de Chile |
| Princeton University | Queen's University | Queensland University of Technology | Quest University | Royal Melbourne Institute of Technology (RMIT Creds) |
| Royal Roads University | Schumacher College | Stanford D.School. Hasso Plattner Institute of Design | Tecnológico de Monterrey | The CERN Accelerator School, School of Computing + Student Opportunities |
| The Hebrew University of Jerusalem | The Open University (Badged Courses OpenLearn, Open degree) | The Schulich School of Business | The Sustainability Institute | The University of Auckland |
| The University of Tokyo (Todai) | The Wharton School. University of Pennsylvania | THNK. School of Creative Leadership | Tsinghua University | Udacity |
| Universidad de los Andes | Universidad Peruana de Ciencias Aplicadas | University of Alberta (for credit MOOCs) | University of Bradford (School of Pharmacy and Medical Sciences) | University of Buckingham |
| University of Cape Town | University of Melbourne | University of the People | University of Toronto | Western Governors University |

Source: by the authors.

Based on the results of a synthetic analysis of the above papers, we began laying the foundations for the rubric, using futures studies methodologies in higher education (Menéndez et al., 2022). We opted for in-person workshops based on research skills, critical and creative thinking, and teamwork. These workshops used the DeflyCompass method, which allows us to generate future scenarios combined with the discipline of

design for the challenges envisaged (Manetti et al., 2022b). These working sessions used the Manual Thinking mind-map technique with movable tags (Huber & Veldman, 2015), an effective tool for visualising processes, contextualising ideas, and organising thoughts, which facilitates teamwork and is useful for the phases of creating, exploring, prioritising, organising and prototyping scenarios in a dynamic yet structured way. Next, we used a dot-voting system, distributing a limited number of dots so that each participant could vote. By placing their dots, workshop participants voted individually on the importance of the scenarios.

By the end of two work sessions three fields of interest were established: the teaching model, organisation management, and the service experience, defined by 15 factors (Table 3) linked to 9 megatrends: increasing business volatility, change in global economic power, constant growth in the world population, rising life expectancy, the crisis in systems of governance, the democratisation of personalisation, the standardisation of cultural patterns, new technologies and especially those linked to artificial intelligence, and hyperconnectivity. Based on prospective investigation, three scenarios were established, as shown below.

Table 3
Innovative trends based on scenarios

| Training model | Organisation management | Service experience |
|------------------------|--------------------------------|---------------------------|
| A1. Syllabus approach | B1. Processes | C1. Recipients/Ecosystem |
| A2. Learning design | B2. Agents and roles | C2. Student services |
| A3. Assessment model | B3. Organisational structure | C3. Enrolment |
| A4. Teaching action | B4. Relational model | C4. Student certification |
| A5. Learning resources | B5. Disruptive commitment | C5. Educational outreach |

Source: by the authors.

To complement and validate the results of the qualitative analysis, we consulted 25 experts on education and learning technologies to identify additional areas of interest, through a focus group session based on the workshop on future teaching scenarios (Manetti et al., 2022b). The goal of this session was to imagine future learning scenarios in higher education. Consulting the participants revealed positive and negative aspects and possibilities of interest in future scenarios, plus a brainstorming session on emerging practices in higher education. A summary of the configuration of scenarios defined based on the workshops and expert interviews is presented below.

Teaching model

In this scenario the goal is to identify differences between the various higher education institutions in terms of strategy and syllabus design. We looked for signs of agile update implementation or real-time adaptation of the educational portfolio to the qualifications demanded in the 21st-century labour market. We also took into account

factors such as diversity and flexibility in study plans and programmes, and personalised, adaptable and modular content. In this scenario we analysed:

- Learning design and planning and the integration of innovative methodologies such as active learning, flipped classrooms, etc.
- Use of collaborative learning, diverse educational resources in different formats such as immersive, gamified, etc., and a multimodal assessment system including hetero-, self- and co-evaluation.
- The combination of technology and teaching in the classroom, study plans, and the centre's physical and digital infrastructure to create value for students.
- The impact and benefits of new ways of organising and conducting teacher accompaniment adapted to each educational model.

Organisation management

The indicators focus on investigating the non-teaching processes which have a transformational component, whether technological, organisational, or to do with knowledge generation, and which visibly contribute to changing the institution's activity and performance in an original and disruptive way. The following elements, among others, were considered:

- Key chain configuration processes: assessing the internal processes considered critical for the functioning of the institution and which directly impact its speciality or singularity.
- Strategically outsourced processes which can have a profound impact on the organisation: new figures, performance roles and forms of intermediation contributing to conducting academic activity or management in a different way, encouraging more interaction between both dimensions.
- New models of relationship and participation between people and/or communities which add value to the institution: outstanding groups in knowledge generation and transfer which contribute to academic excellence and the advancement of the institution.
- An organisational and decision-making structure which allows interaction aligned with the strategic goals and complexity of the techno-educational context, with a special focus on open, innovative organisations. This involves fluid, autonomous decision-making based on data.
- A disruptive profile of the institution, transforming its environment and society.

Service experience

The analysis of this area sought to identify a series of special characteristics among new intake students, and common skill features among graduates. Some examples of these features include creative abilities, ecological awareness, and the ability to be change agents, among others. Another important factor is the innovation catalyst model; in other words, the institution's strategy for driving creation and knowledge transfer in an agile and transparent way for maximum impact. We also evaluated the organisation's networks of influence, analysing its ability to attract "inputs" such as enrolment, funding, talent, employers, partnerships, etc., and the impact of its

programmes and activities on the communities of the educational institution. Among services for students, we paid special attention to admission processes, enrolment management, and other services supporting students' careers, encouraging the development of their vocation from the start. We also explored forms of offering students guidance and personalised strategies which improve students' experience, making use of technologies like data mining, analytics, artificial intelligence, electronic services, virtual assistants, and online resources and websites. In enrolment, we investigated flexible, simplified, personalised processes focusing on students' needs. We also examined financial aid programmes for students to increase and promote inclusion. Our metrics also included accreditation systems and extended learning registers, using flexible, open, modular certification systems such as micro-credentials, which meet new social and employment demands without compromising education quality.

Creating the rubric

While constructing the components of the rubric for measuring the singularity factors in relation to the scenarios mentioned above, we were interested in new classification systems centred on innovation, which go beyond the traditional metrics. Here, we referred to the WURI ranking model (World's Universities with Real Impact). This ranking evaluates universities' research and teaching programmes, considering their innovative contributions and creative approaches (Steiner & Posch, 2006; Manzoni, 2022; Peris-Ortiz et al., 2023). One aspect of WURI which attracted our attention and which matched the goals of our research is that, as well as considering traditionally accredited universities, it also included those with less conventional educational models, such as Minerva Schools at KGI in the USA and Ecole 42 in France, which offer innovative teaching models and attract strong enrolment demand among young people interested in the new digital professions of the fourth industrial revolution. Also, the three criteria of innovation, implementability and impact used by WURI to measure each of its six analysis categories: industrial applications, entrepreneurial spirit, ethical value, student mobility and openness to exchange, crisis management, and the fourth industrial revolution, served as inspiration to establish the dimensions of our rubric.

The rubric is divided into three dimensions: Implementation, Innovation, and Impact, with three scoring levels. These dimensions help us measure each singularity factor. To form a basis for the scores, we took information mainly from institutional reports, policies and regulations (academic, organisational, personnel, etc.); strategic plans (on education, research, innovation, environmental sustainability, digitisation, internationalisation, etc.); yearbooks and reports on the state of the centre and its premises; programme catalogues, manuals, publications and news items; academic articles, and all types of public documents linked to the organisation.

Implementation

This dimension focused on the level of institutionalisation of the singularity factors in the context of the analysed element, and the resources used for it to function. Like the other dimensions, this was evaluated broadly to determine if the factor was at the planning or pilot stage, or if it had already been institutionalised in the internal

structures of the organisation. Although this task was complex, we also wanted to find out how the factor connected to the centre's strategy and policies, its relationship with other processes of the model, the local services it activated, its apparent sustainability, and whether it had been introduced gradually through internal initiatives or externally driven.

Innovation

This dimension was based on the definition given by the OECD and Eurostat (2005), which describes innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. In our evaluation, we assessed the innovation component present in each of the factors of the element, whether they were new creations (novelty), and whether the innovations they contained had been adopted. For example, we wanted to identify the addition of new or transformed educational services or products, approaches and teaching methods, organisation of work and personnel, or the integration of information and communication technologies (ICT) in educational processes. Thus, our goal was to confirm that the innovation generated changes in the institution's model, contributing a differential value which facilitated its adaptation to contexts of accelerated change (Marcet, 2016).

Impact

The goal of this dimension was to verify and evaluate the effects of the singularity factor on the analysed element, and its influences on the other domains of the model. We wanted to determine how the apparent results satisfied social, organisational educational and other demands, and whether they had a positive impact on the organisation's fame, reputation, and positioning. To evaluate these models we assigned a numerical singularity level. These levels are:

Level 1. The element is not differential. The university presents a standard version of this element, or the element is not applicable because it does not exist or no data are available for it.

Level 2. There is some differentiation from the norm but this level of singularity does not significantly influence the differentiation of the university. This singularity is probably a knock-on effect of another more significant singularity.

Level 3. The differentiation from the norm is a differential feature with a significant impact on the differentiation of the university.

Application of the rubric

After establishing the dimensions and levels of the rubric, we began the process of analysing the 55 institutions compiled in the trend detection process, seeking and gathering information about the chosen centres in order to describe their characteristics in more depth and establish the differential features of the different contexts analysed (Table 4). It is important to note that the three scenarios established for analysing the organisations are closely interrelated, as can be seen in most of the

analysed cases. In general, we found that a unique teaching model is usually accompanied by a particular organisation management system and service experience. To be able to identify and evaluate the uniqueness of each of these three models, we established a standard reference situation for universities as a basis for recognising singular centres. Once the three dimensions were defined, we developed the singularity rubric, complete with the name and description of each factor or indicator, the standard elements, and the levels of singularity to consider in each case.

Table 4
Application of the rubric

| | A 1 | A 2 | A 3 | A 4 | A 5 | B 1 | B 2 | B 3 | B 4 | B 5 | C 1 | C 2 | C 3 | C 4 | C 5 |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 4 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| 5 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 6 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 7 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 8 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| 9 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 10 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| 11 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 12 | 3 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| 13 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 |
| 14 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| 15 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 16 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| 17 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| 18 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| 19 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 2 |
| 20 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 21 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| 22 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| 23 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 24 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |

| | A | A | A | A | A | B | B | B | B | B | C | C | C | C | C |
|----|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 25 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 26 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 27 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 28 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 29 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 30 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 31 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| 32 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| 33 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| 34 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 35 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| 36 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| 37 | 2 | 2 | 2 | 1 | 1 | 3 | 1 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| 38 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | 1 | 3 | 2 | 3 |
| 39 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 40 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| 41 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 42 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| 43 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 44 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 |
| 45 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| 46 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 3 | 2 |
| 47 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| 48 | 3 | 3 | 2 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| 49 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| 50 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| 51 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 |
| 52 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| 53 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| 54 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 3 | 3 |
| 55 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

Source: by the authors.

After obtaining the results of the qualitative sampling of singularity in the selected higher education centres, the next step was a mathematical analysis of the scores assigned in the model for the characterisation and classification of unique institutions. Next, we checked their viability mathematically as the basis for our analytical instrument. It should be noted that the classification model for these profiles was intended to cover all the aspects where a given higher education institution could be considered unique or singular, as described above. To do this, first we constructed a mathematical model for comparing the codified information and using it to formally establish the relationships between the universities involved in the model.

In this case, we applied a principal component analysis (Jolliffe & Cadima, 2016) to our initial database in order to reduce the number of significant variables from the original 15. This analysis provided a procedure for determining the appropriate number of variables to describe the data. Using the R programming language, we calculated the correlation matrix for the values of the 15 initial variables, considering all the sampled institutions. In the programme results the variables were labelled from X1 to X15, in the order they were initially entered, and grouped in categories A1 to C5. When examining this matrix directly, no very strong relationships were observed between the different variables, as shown in Table 5. Therefore, it did not seem appropriate to exclude any of the initial variables using this criterion, validating the proposed analysis model.

Table 5
Correlation matrix relating to the initial variables

| | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 | X15 |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| X1 | 1.000 | 0.230 | 0.088 | 0.136 | 0.127 | -0.225 | -0.205 | 0.377 | 0.209 | 0.165 | 0.197 | 0.091 | 0.136 | 0.503 | 0.205 |
| X2 | 0.230 | 1.000 | 0.164 | 0.249 | 0.141 | 0.084 | -0.012 | 0.195 | 0.392 | 0.000 | 0.289 | 0.251 | -0.005 | 0.017 | 0.206 |
| X3 | 0.088 | 0.164 | 1.000 | -0.063 | -0.007 | -0.223 | -0.145 | -0.202 | 0.077 | -0.173 | 0.021 | -0.004 | -0.253 | -0.223 | -0.091 |
| X4 | 0.136 | 0.249 | -0.063 | 1.000 | 0.130 | 0.066 | -0.168 | 0.521 | -0.072 | 0.130 | -0.011 | -0.199 | -0.148 | -0.155 | -0.282 |
| X5 | 0.127 | 0.141 | -0.007 | 0.130 | 1.000 | 0.110 | 0.335 | 0.246 | 0.087 | -0.024 | 0.167 | 0.087 | 0.178 | 0.325 | 0.158 |
| X6 | -0.225 | 0.084 | -0.223 | 0.066 | 0.110 | 1.000 | 0.198 | -0.132 | -0.202 | -0.134 | 0.075 | 0.289 | -0.020 | 0.045 | 0.168 |
| X7 | -0.205 | -0.012 | -0.145 | -0.168 | 0.335 | 0.198 | 1.000 | -0.041 | -0.133 | -0.131 | 0.449 | 0.381 | 0.141 | 0.286 | 0.399 |
| X8 | 0.377 | 0.195 | -0.202 | 0.521 | 0.246 | -0.132 | -0.041 | 1.000 | 0.085 | 0.398 | 0.076 | 0.067 | 0.199 | 0.146 | 0.031 |
| X9 | 0.209 | 0.392 | 0.077 | -0.072 | 0.087 | -0.202 | -0.133 | 0.085 | 1.000 | 0.187 | 0.447 | 0.132 | 0.285 | 0.333 | 0.073 |
| X10 | 0.165 | 0.000 | -0.173 | 0.130 | -0.024 | -0.134 | -0.131 | 0.398 | 0.187 | 1.000 | 0.335 | 0.113 | 0.201 | 0.329 | -0.047 |
| X11 | 0.197 | 0.182 | 0.021 | -0.011 | -0.062 | -0.058 | -0.034 | 0.166 | 0.447 | 0.335 | 1.000 | 0.386 | 0.331 | 0.328 | 0.314 |
| X12 | 0.091 | 0.289 | -0.004 | -0.199 | 0.167 | 0.075 | 0.449 | 0.076 | 0.398 | 0.109 | 0.544 | 1.000 | 0.310 | 0.302 | 0.625 |
| X13 | 0.136 | 0.251 | -0.253 | -0.148 | 0.087 | 0.289 | 0.381 | 0.067 | 0.132 | 0.113 | 0.544 | 0.365 | 1.000 | 0.474 | 0.510 |
| X14 | 0.503 | -0.005 | -0.223 | -0.155 | 0.178 | -0.020 | 0.141 | 0.199 | 0.285 | 0.201 | 0.331 | 0.351 | 0.435 | 1.000 | 0.027 |
| X15 | 0.205 | 0.017 | -0.091 | -0.282 | 0.325 | 0.045 | 0.286 | 0.146 | 0.333 | 0.329 | 0.328 | 0.474 | 0.435 | 0.248 | 1.000 |

Source: by the authors.

DISCUSSION

The purpose of this paper is to invite the academic world to discuss the concept of singularity in education, in order to create a new framework for study and analysis according to this perspective, which transcends singularity in technology, economics, mathematics, or physics. To achieve this, we had to search the academic literature in which the concepts of education and singularity are closely linked, yet unfortunately, there are very few examples. As we have indicated, our research was based on Wenham's (1987) "Singular Problems in Science and Science Education", published in the *Journal of Philosophy of Education*, which deals with the need to develop the concept of singularity in the field of education. This article represents one of the few documents establishing a framework for studying singularity in the educational sphere, and its theoretical basis inspired us to create an analytical model facilitating its detection, organisation and classification, enabling us to characterise singularity in higher education. Once the theoretical part was established, we began the process of characterising singularity in education, looking to identify changes and illustrate examples with institutions presenting differentiating features in their educational practice.

Meanwhile, we found a problem relating to the close link between trends and technology, which shifted our approach to the concept of singularity in the field of education. For example, when concepts such as future scenarios and futures studies are included, this might give the impression that we are talking exclusively about the technological singularity. However, it is important to note that these terms do not necessarily refer to the technological singularity, as is the case in this paper. There is extensive literature associating trends, future scenarios and future studies with the field of the social sciences (Decoufle, 1974; Godet, 2001; Mojica, 2005; Brown & Kuratko, 2015; Kuosa, 2010, 2016; Berenskoetter, 2011; Ito & Howe, 2016), and more specifically, with the field of education (Menéndez et al. 2022; Manetti et al., 2022b).

Our results enable us to offer the following answers to our research questions:

RQ1. How can we identify transformative trends in higher education?

Identifying transformative trends in higher education requires an exhaustive analysis of changes and progress in various relevant areas. Higher education is constantly evolving to adapt to the changing demands of society, technological advances, and the needs of the labour market. Through reviewing research projects, reports, and case studies, we identified 25 emerging patterns, innovations in teaching, and significant changes in how higher education is delivered.

RQ2. Can new models of higher education be identified based on the observed trends?

By finding and analysing transformative trends in higher education, we initially identified 110 educational organisations, which were then reduced to 55 which are implementing incremental or disruptive changes. These trends reflect transformations in teaching and learning, and in the structure and organisation of educational institutions. By observing these trends, we can identify new forms of higher education and understand how the educational environment is being transformed.

RQ3 How can we analyse the ways in which universities introduce singularity?

To analyse the introduction of singularity in universities we must examine in detail the elements of the teaching model, the organisation and service models they use. Each university has its own unique and differentiated approach to teaching, organising its structure, and offering student services. By studying these aspects, we can understand their differences and how they create singularity compared to other institutions. This involves reviewing their academic programmes, management strategies, organisational structure, approaches to teaching and learning, and the quality and diversity of the services offered to students.

RQ4. How can we evaluate the level of singularity of universities?

Evaluating the level of singularity of universities involves analysing various aspects which distinguish them from other institutions. This includes considering their unique approach to teaching, how their organisational model differs from other universities, the originality of the services and programmes they offer, and how third parties perceive their leadership and excellence in the university sphere. The level of singularity can be determined through a comparative analysis of relevant indicators such as educational innovation, academic reputation, graduate employability, and impact on society. We can also take into account external assessments, recognitions and awards received by the university relating to its singularity and its contribution to the field of higher education.

CONCLUSIONS

The search for differentiation in higher education is a phenomenon which is reconfiguring how education is perceived by students, teaching staff, and education centres. This transformation is strongly influenced by an amalgam of social and technological factors, which means that universities must be ready to adapt to these changes. Therefore, an exhaustive analysis is needed of the factors influencing this search for singularity, and a deep understanding of how these changes impact education access and quality. Only through this comprehensive approach can university institutions foresee and prepare for a future in which singularity becomes a reality.

As explained above, singularity, closely linked to innovation and technology in education, represents one of the components which can raise the quality of teaching and enable educational institutions to stand out successfully. Through our research framework, we have arrived at an in-depth understanding of the social and technological trends which may influence higher education. Thus, we have seen how the educational environment is altered by the adoption of new models, and we have identified, organised, and classified the elements of singularity in higher education. This covers the analysis of how singularity is impacting the university ecosystem and how universities can prepare to adopt singularity effectively. In this context, our paper seeks to stimulate debate, approaching singularity according to the conceptualisation of Wenham, with the idea of involving as many academics as possible in the

characterisation of singularity in order to encourage substantive changes in higher education.

For future lines of work, we envisage the creation of an analytical tool which can transform the singularities found into crucial elements for implementing changes in higher education institutions. We also hope that this paper will contribute to beginning a process of creating work groups specialising in this subject, establishing an academic network for futures studies and singularity in higher education institutions.

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Date of reception: 1 June 2023

Date of acceptance: 12 September 2023

Date of approval for layout: 6 October 2023

Date of publication in OnlineFirst: 23 October 2023

Date of publication: 1 January 2024