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Review

Shaping Educational Strategies: A Literature Review on Uncertainty and the Unexpected

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Abstract: A key feature of contemporary times is the high degree of complexity that impacts all spheres and aspects of today's society, particularly within education. This complexity, deriving from a postdigital world in a polycrisis, causes continuous eventualities and results in these conditions of uncertainty. This contribution reviews the present literature on the issues of the unexpected and uncertainty. From the 13 articles included in the review, an attempt is made to define the terms "uncertainty" and "unexpected" in order to scan the management strategies proposed by various authors in diverse fields, highlighting the correlation between uncertainty, the unexpected, and anxiety. Although this review revealed a lack of a universal definition of the "unexpected" and "uncertainty", the analysis seems to have revealed some common and essential features in various articles and perspectives on the topic. Suggestions drawn from the analysis prove particularly useful in investigating the implications that uncertainty and the unexpected have in education, especially in training future teachers.

Keywords: uncertainty; unexpected; unforeseen; uncertainty management; anxiety; teacher training

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1. Introduction

The increasing complexity that characterizes the contemporary world finds a cause in the situation of global polycrisis, which [1] defines as the intertwining of different emergencies occurring at different times and in different places interacting with each other, making it almost impossible to predict the consequences. Society is called upon to respond to the challenges posed by this growing complexity, including the actors in the educational scene. Indeed, socio-political, economic, and health crises create a climate of uncertainty in classrooms, manifesting in the following ways: changes in curricula in response to the new demands of tomorrow's society and the world of work [2], the growing multiculturalism and migration phenomenon, and the rapid and unpredictable change of the class group and school routines. The change that has taken place over the past 20 years has also involved the teaching profession [3–5]. Teachers have been required to assume a multiplicity of roles compared to the past as well as to train on various elements, including new teaching and assessment strategies, teaching content and methodologies, technologies, and digital environments [6]. Increasing complexity has significantly impacted not only the role of the teacher, but also, for example, the students who have changed their knowledge base and needs, the extrinsic and intrinsic factors by which they feel motivated, and learning styles and modes [7].

We were driven by an interest in understanding how this situation of increased complexity impacted the teacher profession in training, so we began to study the literature, conducting a series of experiments with students enrolled on the Theory and Methods of Educational Design and Assessment course at the University of Macerata [8,9]. During the research, we realized that we often used terms such as "uncertainty", "unexpected", and "emergency" without sharing a definition. It was, therefore, necessary to explore the meaning attributed to the terms used, and the nuances of meaning they

take on in the literature and that scholars, from different fields, have highlighted. It is for these reasons that it was deemed essential to conduct a literature review that would delve into the definitions that are attributed in the literature to terms such as "uncertainty", "unexpected", and "emergency", and what the existing strategies are in terms of how to deal with these conditions in school settings and beyond.

2. Background

2.1. Uncertainty and Risk in Education

In 1929, with the publication of *Experience and Nature*, Dewey [10] addressed the problem of uncertainty. According to the author, the world is an uncertain, precarious, and unstable "scene of risk" in which humans keep yearning for order, continually trying to predict what might happen based on their knowledge. Dewey assigns the two following forms to predictability: the first relates to the fact that humans are creatures of habit and, therefore, tend to create patterns that recur over time; the second relates to the vain human belief that objectivity is achievable through rational thought. While recognizing that much of human behavior is dominated by habit, impulses often intervene, detouring habitual behavior and restoring new qualities to the interactions with the world. Impulse and redefinition of habits are necessary and due elements in an ever-changing world; however, deviations from habit, impulses, are not guarantors of a new functioning mode of interaction with the world. To cope with the uncertainty that characterizes the world, humans establish modes of operation by uniting in groups within society. The author's analysis shows that in order to cope with uncertainty, humans start from the experienced situation based on which they begin to exercise reflective thinking. First, they derive contextual data, then they connect them to their knowledge and experiences, thus creating inferences and anticipation, imagining the possible consequences. At a later stage, the inferences first verified only in mind must be verified in action.

A few decades after Dewey, Perrenoud [11] formalized the discourse on the unexpected in education in his article "Gestion de l'imprévu, analyse de l'action et costruction de compétences" and attempted to give a definition. For Perrenoud, most so-called unexpected events are such because of their timing rather than their nature. The author distinguishes the types of unexpected events into two macro-categories as follows: relative and radical unexpected events. The first category concerns those events that can be foreseen in the design but whose timing cannot be predicted; the second category concerns events whose occurrence is unimaginable to the project designer.

Events of the first type can be responded to by preparing a response in advance, by resorting to tried and tested or already prepared solutions; the events of the second category can only be responded to by improvisation. However, for Perrenoud, improvisation does not come out of the blue, but rather relies on a professional habitus and resources that favor rapid decision-making and the ability to operate quickly. According to the researcher, the issue of uncertainty is particularly concerning to those working in schools, since "teaching means acting in emergency and deciding in uncertainty" [12]. He notes that developing reflective competence is, in his opinion, the most impactful strategy.

2.2. Uncertainty and Risk in Project Management

Management literature has investigated the topic of uncertainty since the second half of the last century. However, it has regained popularity in the wake of recent emergency events, such as the COVID-19 pandemic, the Russian–Ukrainian or Israeli–Palestinian conflicts, the earthquakes in Turkey, Syria, and Morocco, and the floods in Libya, to name a few. In those years, two statistical models, the project evaluation review technique (PERT) and the critical path method (CPM), were conceived to support the management of a project's timeline via the controlling of the dimension of uncertainty as much as possible. The PERT model [13] is a statistical method for identifying the optimal, probable, and pessimistic value of time and/or cost in project implementation. The CPM model [14] allows for the identification of a critical path for the activities that constitute the project

by highlighting the relationships of priority during the implementation. In response to the problem of managing uncertainty and coordinating many people to meet budgeted time and costs, these early models proposed standardizing the division of labor and time and focusing on optimization [15,16], suggesting that project managers "stick to the plan". These models remained universal solutions for the next several decades, applicable to almost any project.

Since the 2000s, project management has established itself as an indispensable discipline at the strategic and operational levels. In classical theory, the project is considered as a phase antecedent to implementation, and only in the last twenty years have reflections on the unexpected led some authors to think of the project as a diachronic process, accompanying implementation in all its phases [17,18]. Simultaneously with this change, the project manager has shifted from focusing on the gap between what was designed and what was realized, viewing this gap as a negative element to avoid, to focusing on these differences and considering them as a neutral element to be analyzed on a case-by-case basis to capture potential and problematic issues.

This shift in focus coincided with the shift from traditional risk management theory to the more recent uncertainty of management theory [17,19–21]. If in the past the focus was on minimizing risks by hypothesizing them as early as the design stage, the level of complexity is presently too high for us to predict them. Moreover, it is not assured that all possible events will cause adverse developments or necessarily have negative effects. For these reasons, there has been a shift in project management from talking about risk management to uncertainty management. However, the two terms are often erroneously used as synonyms in the literature [17].

Risk quantification is seen as a way to eliminate uncertainty. This approach finds its roots in economics, where risk is defined as an event whose probability of occurrence is known or knowable [22]. Risk implies calculability and controllability, due to there being some knowledge of the situation or at least some ability to imagine its evolution. Risk, therefore, is generally expressed through a probabilistic estimate of its occurrence. On the other hand, uncertainty is, as inferred from the term itself, a lack of certainty, knowledge, and thus predictability of the outcomes. Moreover, uncertainty is related not only to the environment, but also to the sense of doubt that the individual may feel when facing a situation [23]. Zio [24] distinguishes two types of uncertainty as follows: ontological uncertainty, due to the environment, and subjective uncertainty, due to the partial or insufficient knowledge possessed by the project manager.

For years, risk management has adopted an approach, defined as ex-post, based on probability. After observing a significant number of cases similar to each other, the types of unexpected events and their frequency would be circumscribed, and the risk factor calculated. Uncertainty management, aware of the impossibility of circumscribing unexpected events and of the difficulties in making predictions in the contemporary context, adopts an ex-ante approach. This means that once possible forms of uncertainty have been hypothesized, an attempt is made to understand them, to predict and analyze the possible consequences that those forms of uncertainty might entail. The main distinction between these two types of project management is the ability to critically reflect on the uncertainty dimension, which the manager must possess. Projects are not unique in an absolute way; over time, a practitioner begins to identify several repetitions and similarities, detectable even in different projects. Identifying these repetitions and creating routines could be very useful in risk management because the predicted risks are often the same. However, this is much less so in uncertainty management, which is implemented primarily during the executive project and has to cope with the ever-changing complexity arising from the continuous flow of information and the continuous evolution of the complex relationships that characterize and change the system in which one operates. Identifying events that reoccurred over time, in risk management, served to build a habitus, a baggage of operating modes that can be reused in various projects; in uncertainty management, this serves to provide critical insights into how uncertainty impacts a particular environment. In other

words, if risk management operated on circumscribing the causes of the crisis, uncertainty management intervenes in the effects of the crisis.

In the literature of the last century, risk has been given a predominantly negative connotation [19], while uncertainty has been given an ambiguous connotation, potentially harmful or positive, based on various elements like the stimulus of curiosity, the degree of the experience of the project manager, and the greater or lower flexibility of the project, to name a few. Currently, however, interest in the dimension of uncertainty has increased, and numerous scholars have tried to explore the topic in order to arrive at definitions that are more comprehensive and better able to provide procedural guidance.

3. Method

The review was constructed following the guidelines of Creswell and Clark [25] and using the protocol proposed by Machi and McEvoy [26].

This process started with topic selection and problem definition. The problem is related to the lack of a systematic and shared definition for "uncertainty" and "unexpected", as well as policy proposals for managing these dimensions. Initially, the term "emergency" was also investigated; however, this was not then considered in the writing of this review because no general or generalizable definitions of the term were found in the selected literature. Instead, it was always used regarding the COVID-19 emergency or emergency remote teaching (ERT).

From the initial problem identification, we circumscribed two research questions as follows:

1. What definition can be given to the terms "unexpected" and "uncertainty"?
2. What critical issues does the literature on uncertainty and the unexpected identify, and what strategies are proposed?

To these two questions, after an initial review of the literature, the following question was added:

3. Is there a correlation between the presence of uncertainty and that of anxiety?

The second point of the protocol is about creating a plan to answer the research questions. In this regard, it was chosen to scan the literature in order to investigate the current scope of work concerning the selected questions and to search for definitions proposed by different authors in different fields, highlighting points of similarity and difference.

In compliance with the third point of the protocol, actual steps were taken to define the inclusion and exclusion criteria and to analyze the literature. Two databases were considered for the analysis; these were the Web of Science and the AERA archive. It was deemed appropriate to investigate the WoS database for its breadth and supply of authoritative scientific articles, and the AERA database for having articles purely related to the educational field, which is the field in which the results of this review will later be used. Multiple searches were conducted, each time with a different term. The keywords with which the research was conducted were "uncertainty", "unexpected", and "emergency". In the second stage of the literature review, "uncertainty" was combined with "management". The inclusion criteria were (1) articles published between 2016 and 2022; (2) open access articles; (3) articles in written in the Italian or English language; and (4) the presence of the searched term in at least one of the following fields: title, abstract, keywords, and text.

The data from the selected articles will be made explicit in the next paragraph.

The last two points of the protocol are drawing conclusions and writing the review.

The literature search was conducted for about six months, taking place between November 2022 and April 2023. The Web of Science database was accessible through the Ianus network provided by the University of Macerata. On the other hand, the Aera web repository is an open-access database. In the first search on the Web of Science, the term "uncertainty" was searched, limiting the domains to education and economics, and subsequently obtaining 391 results. The second search, also on the Web of Science, looked at the string "uncertainty management + project", returning 429 results. Searching for "uncertainty" in the AERA repository yielded 424 results. Reading the abstracts allowed us to identify those that contained a

definition of the terms and/or proposed action strategies. These elements allowed 32 articles to be selected for a complete reading of the 391 obtained on the WoS, 31 from the 429, and 22 for a complete reading of the 424 articles found on AERA.

The second search was conducted by searching for "emergency" in the Web of Science. In this case, the search was limited to education and educational research areas, obtaining 412 results, of which 18 were selected. When searching for "emergency" in the AERA repository, 161 results were found, of which 4 were selected.

The third search was completed by searching the term "unexpected", and limiting the areas to education and educational research, yielding 238 results in the Web of Science, of which 16 were selected. The search for "unexpected" yielded 858 results in the AERA repository since the term is polysemantic. Given the number of results obtained, excluding the text field from the search was deemed appropriate, thus obtaining only one paper that met all the requirements.

All 124 articles initially selected were read and analyzed. Articles were excluded in which

- Uncertainty is treated with generic references, as if it was a transitional situation;
- Reference is made to the topics under consideration only concerning the COVID-19 pandemic or emergency remote teaching (ERT);
- The proposals are strongly related to the economic sphere and are difficult to generalize to the educational sphere.

In adopting these selection criteria, all articles initially selected via the search for the term "emergency" were excluded because they did not provide generative or valuable definitions for the purposes of this review, as the term was always used to discuss the COVID-19 emergency or emergency remote teaching (ERT).

Next, in a table for each article, it was noted whether the definition of the words sought was present, as well as what critical issues/proposals the author made. Secondarily, it was also noted whether or not reference to the issue of anxiety or emotions was made. This analysis made it possible to exclude articles in which at least one of the following parameters was not present:

- One or more explicit definitions of the terms "uncertainty" and "unexpected";
- A proposal for a strategy, more or less formalized, on how to cope with uncertainty and/or the unexpected;
- A direct reference to anxiety or, more generally, to negative emotions.

Thanks to the criteria described above, 13 papers were selected among the 124 initially considered to be the subject of this review, as shown in the table below (Table 1).

Table 1. List of Reviewed Papers.

N	Authors	Title	Year	Journal	Vol	Pages	Field
1	Anne Sigismund Huff; Frances J. Milliken; Gerard P. Hodgkinson; Robert Galavan;Kristian J. Sund	A conversation on uncertainty in managerial and organizational cognition.	2016	Uncertainty and strategic decision making		1–31	Economy and management
2	Sara Hajikazemia; Anandasivakumar Ekambarama; Bjørn Andersenb; Youcef J-T. Zidane	The Black Swan—Knowing the unknown in projects	2016	Procedia—Social and Behavioral Sciences	226	184–192	Economy and management
3	Øyvind Kvalnes	Living With the Unknown Unknown: Uncertainty in Projects	2016	Project Management Journal	47(3)	101–108	Economy and management
4	Agnar Johansen; Petter Eik-Andresen; Andreas Dypvik Landmark; Anandasivakumar Ekambaram; Asbjørn Rolstadås.	Value of Uncertainty: The lost opportunities in large projects	2016	Administrative Sciences	6(3)	1–17	Economy and management

Table 1. *Cont.*

N	Authors	Title	Year	Journal	Vol	Pages	Field
5	Lin Wang; Martin Kunc; Si-jun Bai	Realizing value from project implementation under uncertainty: An exploratory study using system dynamics	2017	International Journal of Project Management	35	341–352	Economy and management
6	Mette Vinther Larsen; Jorgen Gulddahl Rasmussen	When unforeseen events become strategic	2018	Journal of Management & Organization	24(2)	209–223	Economy and management
7	Oana Costache; Eva Susann Becker; Fritz C. Staub; Tim Mainhard	Exploring Uncertainty as Learning Opportunity in Pre-Lesson Conferences During the Teaching Practicum	2019	AERA Online Repository			Education
8	Marianna Lamnina; Catherine Chase	How Different Types of Uncertainty Affect Learning, Transfer, curiosity, and Affect	2018	AERA Online Repository			Education
9	Serina A. Cinnamon	A Quest for Certainty in the Face of Uncertainty: Dewey, Chaos, and Explaining the Unexplainable	2017	AERA Online Repository			Education
10	Lisbeth M. Brevik	Planned and Emergent Designs: The Value of Planning for the Unexpected in Mixed-Methods Research	2022	AERA Online Repository			Education
11	Ghita Jalal; Valentin Lachand; Aurélien Tabard; Christine Michel	How teachers prepare for the unexpected: bright spots and breakdowns in enacting pedagogical plans in class	2018	13th European Conference on Technology Enhanced Learning		59–73	Education
12	Sumeyra Dogan Coskun; Mine Isiksal Bostan; Tim Rowland	An In-Service Primary Teacher's Responses to Unexpected Moments in the Mathematics Classroom	2021	International Journal of Science and Mathematics Education	19	193–213	Education
13	Maxwell Yurkofsky	How Educational Uncertainty Influences and Is Influenced by Continuous Improvement	2020	AERA Online Repository			Education

4. Results

The selected papers are predominantly from the years between 2016 and 2018, with only one paper being published more recently. A likely explanation could be related to the COVID-19 pandemic, which caused many academic efforts regarding uncertainty and emergency to reconnect findings to events related to it, thus being of little use for this review. Geographically, the distribution appears to be global (US, UK, Australia, Taiwan, and Northern Europe), with a predominance of authors being American and Northern European.

4.1. Definitions

From the papers reviewed, differences, often subtle, emerged in the definitions that various authors attribute to the terms "uncertainty" and "unexpected" (or the synonym "unforeseen"). All the definitions found, however, overcome the classic distinction between risk and uncertainty mentioned in the opening paragraphs and the negative connotation that traditionally characterized these concepts in favor of a neutral interpretation. In describing the results that emerged, we first consider the articles pertaining to the field of economics and management, and then those pertaining to the field of education, this is to sketch, in a third paragraph, the threads identified that connect all the articles.

4.1.1. Research in Economy and Management

The essay by Huff et al. [27] moves from the observation that all of their previous research work has somehow dealt with uncertainty. The paper takes the form of a written conversation in which, at each exchange, the various scholars add information concerning the topic of uncertainty in an attempt to define it and provide a comprehensive theoretical framework. Two reasons why it is helpful to arrive at a definition of uncertainty are identified as follows: because the same environment may be perceived differently by different managers, and because very different types of uncertainty are often clustered together. In particular, definitions are given of the following terms:

- State uncertainty, i.e., not knowing what the future will be like;
- Effect uncertainty, i.e., the implications of future events on the company;
- Response uncertainty, i.e., what the company will do in response to these events;
- Uncertainty as the difficulty in understanding the different interpretations of observers;
- Uncertainty as the unpredictable changes due to learning and changes in the focus of attention.

The essay by Hajikazemi et al. [28] defines Black Swans, i.e., those that are considered radical unforeseen events and have three main characteristics. These are as follows: they are not predictable, they lead to extreme impact, and, after they have happened, they are interpreted by humans who, in retrospect, make them seem predictable. What characterizes Black Swans is the unpredictability and high improbability of the event happening. The author, however, does not fail to mention how, even in this case, some research argues that elements allowing for anticipation can be identified. It is pointed out how different people often attach different meanings to the same data sets, often based on their own personal knowledge (experiences, values, contextual information, expert insight). The knowledge an individual has is essential for interpreting data and generating useful information. The unpredictability of Black Swans is related to very high levels of uncertainty, which, however, the author ties in double-strand with the degree of knowledge and awareness that the observer possesses.

The essay by Kvalnes [29] also considers the possibilities that unforeseen events open, thus giving a positive view of them, not necessarily seeing uncertainty as something to be reduced or eliminated. Although uncertainty is always an obstacle in some types of project management, in other cases, it can open up interesting opportunities. Kvalnes distinguishes between risk (known unknowns) and uncertainty (unknown unknowns), stating that both pose a challenge to project implementation, but the latter is in a much more dramatic sense. However, the author argues that the fact that the project goes as envisioned initially may not be the most desirable turn of events, since unexpected and surprising opportunities may arise at any point.

This article's philosophical sources offer further insights into how uncertainty can fuel human curiosity rather than inhibit it. The negative connotations of uncertainty stem from a rationalist view of the project process, in which the basic assumption is that successful planning and execution are based on a high degree of certainty and adherence concerning goals, resources, methods, and other factors that may influence the project life cycle.

Kvalnes quotes the findings of Lechler and colleagues [30], who identified six categories of uncertainty as follows: context turbulence, stakeholder uncertainty, technological uncertainty, organizational uncertainty, project uncertainty, and negligence. Their common characteristic is introducing elements into project implementation that are impossible to define in the initial design phase and are unlikely to remain constant during the design process.

In agreement with Lechler et al. [30], for Kvalnes et al. [29], uncertainty, rather than an obstacle, becomes a condition for exploring the world. They distinguish a welcome uncertainty, which brings innovation from the unwelcome which hinders the process. Assessing the quality of uncertainty depends on the context and can be challenging to grasp. Uncertainty, therefore, is closely related to project development and must be embraced. Embracing uncertainty does not require a break from the traditional way of thinking about a project cycle; instead, it is a pragmatic perspective that complements the design approach,

making it less prescriptive. Embracing the unexpected may, in some cases, lead to a better outcome and, in any case, allows one to avoid a rationalistic view of the design process, in which a high degree of certainty is expected regarding the factors that impact the project life cycle.

The essay by Johansen et al. [31] quotes the opinions of various authors, arguing that uncertainty could positively or negatively impact processes. Thus, a theme already seen in previous authors reoccurs. Namely, uncertainty cannot be prescribed an absolute negative connotation. Johansen et al. take from Lichtenberg's [32] definition of uncertainty as a neutral process that is characterized by not having all the information needed at the time decisions are made, a theme also highlighted by Galbraith [33], Betts and Lansley [34], and Kolltveit et al. [35], who define uncertainty as the distance between the information needed to perform a task and the information one has. From the text of De Meyer and colleagues [36], the authors derive the four categories of projects, to which four types of uncertainty correspond, as follows: ranging from small perturbations that minimally change the possible outcomes of a project, to chaos in which uncertainty involves more radical disruption that fundamentally transforms goals and strategies. Between the two ends of the spectrum, the authors place foreseen uncertainty, i.e., events that can be identified at the design stage and may or may not occur but could have an effect on execution, and unforeseen uncertainty, which includes events that are not or could not have been foreseen at the design stage of the project. Hillson and Simon [37], who use the terms uncertainty and risk as synonyms, also propose the following four-level categorization: stochastic uncertainty (events that may or may not happen); aleatoric uncertainty (events that will happen in the future with variable characteristics); epistemic uncertainty (events that will happen in the future with ambiguous characteristics); and ontological uncertainty, also known as unknown unknowns. Chapman and Ward [38] add that the same time devoted to highlighting risks should be devoted to highlighting opportunities (while it usually remains easier to highlight the first ones and take these into account in the analysis). Among the authors cited in this paper, some regard uncertainty and risk as synonymous, others as separate terms with different connotations, but, in each case, both are used in connection with projects and their management. The authors warn that some researchers regard risk as an objective fact (because it is epistemologically probable due to its analysis being objective, technical, and neutral; a rational decision-making practice). In contrast, others regard it as a subjective fact and believe that it has different epistemological dimensions that vary in importance, depending on the observer's point of view. The Project Management Institute [39] defines "risk" as an uncertain event or condition that, should it occur, may have a positive or negative effect on goals but is nevertheless calculable. The term uncertainty has multiple meanings, ranging from a lack of knowledge to potential outcomes of a project and random forces that may impact execution. The authors of this article suggest that uncertainty should be defined as the set of controllable and non-controllable factors that could happen and will impact project objectives.

The essay by Wang et al. [40] defines uncertainties as unknown unknowns, i.e., impediments that impact project implementation, forcing deviation from planned objectives. If projects are not flexible enough, they fail since the unexpected is always present. This is exacerbated by the interdependence of system components. Human activities dominate project implementation processes, from the perception of necessary changes to their implementation. When unfathomable uncertainty is considered, i.e., events that occur without warning, the likelihood and magnitude of which are impossible to predict, a reactive mode and reflective thinking are required. For this reason, in-progress monitoring based on a static plan, as if the set goals were determined and unchangeable, does not allow the unexpected or the project to be managed. For the authors, uncertainty has two main consequences as follows: the modification of goals and the presence of interruptions and delays. Wang and colleagues propose a two-level categorization of uncertainties, which entails continuous uncertainties, which are unanticipated crises that are not significant enough to disrupt project implementation but still require monitoring and control because of their

long-term impact, and unanticipated crises that occur more rarely, but could have a substantial impact on the project because their nature makes them difficult to define or prevent.

The essay by Larsen et al. [41] defines unexpected events as unplanned and unintended events that people cope with by attempting to bring meaning back to the unfolding of events. The authors ask how unexpected events change managerial strategies and why it is essential to focus on them. Although they do not constitute a new or surprising element in organizing and strategizing practices, the paper's authors wonder about their significance and impact on strategizing processes. It is therefore noted that strategic processes are far from orderly and linear, but rather appear emergent, nonlinear, and modified by local meaning-making processes. Emphasis is incrementally (among both academics and practitioners) directed toward the concrete practices that follow the formulation of strategies, missions, visions, and action plans. This has led social science researchers to suggest that academia and practitioners should work together to develop knowledge that helps support research on organizational practices. Strategic processes are unpredictable, context dependent, nonlinear, and often lead to inadvertent outcomes.

4.1.2. Research in Education

We now turn to analyze contributions from educational research.

The essay by Costache et al. [42] examines which uncertainties future teachers suggest in terms of lesson planning during pre-lesson conferences and which responses of the mentor or teacher help increase teaching competence.

Floden and Clark [43] identified five sources of uncertainty for the teacher: (a) the pupils' knowledge, (b) educational design, (c) lesson content, (d) teacher authority, and (e) professional experience. Based on a claim by Kruger and Dunning [44] that more experienced people are also more aware of their limitations, the researchers analyzed interviews between trainees and host tutors regarding the latter's teaching plans. The researchers focused on future teachers' uncertainties during lesson planning as well as the support tutors to enhance the expected teaching skills of trainees. The experimentation conducted by the authors is relevant as uncertainty is an inherent feature of the teaching profession, and dealing with it at the beginning of training can assist them in becoming more familiar with it and, in turn, managing it effectively.

The essay by Lamnina et al. [45] defines uncertainty as the lack of predictability in an environment, as well as considering it a key variable in promoting curiosity. According to this paper, introducing a certain level of uncertainty into lessons can promote curiosity and learning. For the authors, uncertainty exists in the two following forms: unforeseen and expected (when the fact that uncertainty exists is stable and known). According to this research, having expectations that something unforeseen might happen leads to a reduction in negative feelings if it does happen later. The paper also wants to explore the effects of expected uncertainty on curiosity and learning by noting that the effects of uncertainty training are positive on both curiosity and skill development. The paper suggests a study of personal levels of uncertainty tolerance/intolerance to future research.

The essay by Cinnamon [46] reminds us that, in a world dominated by chaos and instability, it is human to attempt to impose order and seek certainty with the expectation that some form of order is eventually possible. The paper attempts to provide a theoretical framework for understanding the complexity present in educational science by exploring Dewey's views on complexity and chaos. Dewey [10] identifies the world as a scene of uncertain and unstable risk. He believes that the world is a dangerous place, characterized by unpredictability, to the point where the possibility of bringing order to it is limited, although humans inevitably pursue and desire this stability. According to Dewey, in classical philosophy, the world is interpreted through the lens of what is known; humans are creatures of habit and demonstrate a certain level of predictability, and the scientific method seeks to examine these patterns via rational thought. These patterns are driven by the false belief that some scientific objectivity is achievable and by thinking that what is valid for someone is universal or without limits and conditions. However, Dewey notes

that some level of stability exists at the expense of subjectivity. The fact that the world is constantly threatened by disorder constitutes the objective uncertainty that cannot be reduced to personal uncertainty. Although, according to the educational philosopher, habits primarily drive human behavior, the continuous reiteration of routines is interrupted by impulsive behavior. For Dewey, therefore, the opportunity for change in any context is circumscribed only by the subject's self-imposed limits. Although a reliance on routines and socially shared behaviors is a strategy traditionally adopted to restore order to the chaotic world around us, chaos and complexity, and, in turn, uncertainty, can represent alternative perspectives and solutions to old problems. The creation of meaning resides in the subjective experience and the attempt to make sense of one's own experiences.

The essay by Brevik [47] discusses the unforeseen in terms of a research project by defining it as an emergent phase that had not been considered during the planning stage. The traditional way of writing a research plan, which includes the design of all the steps to follow during the execution phase, is different from an emergent design. In line with the principles of this research method, one does not conceptualize all the steps in advance, but rather follows the course of events by reacting to what emerges. Brevik's article attempts to beat a path that takes the form of a middle ground between emergent design and traditional research, asking whether including the possibility of the occurrence of the unexpected as early as the planning stage allows one to have the solution prepared when and if the emergence happens.

The essay by Jalal et al. [48] defines pedagogical plans as anticipations of the activities that teachers plan to carry out. Even as they plan the activities, teachers know the plans will likely have to be modified as the activity unfolds. As they carry out their planning in the classroom, they discover more regarding the planned activities, modifying them as the situation unfolds. These adjustments, refinements that teachers make to pedagogical plans, are made within seconds or minutes, simultaneously with the conduct of the lessons. This becomes particularly complex when they have to do this while managing pedagogical and technical constraints. Routines (practices developed over the years) and improvisations (quick adjustments they enact during the lesson in response to unexpected situations) are usually resorted to. Improvisation, however, is self-assessed by the teacher only after the lesson. Lesson design models do not consider the challenges that teachers face while performing them in the classroom. Teachers also develop scripts that anticipate the dynamics of collaborative activities. The authors believe that having the scripts and information helps the teacher to anticipate what might happen in the classroom, while orchestrating the tools, support, and the actual execution of the design in the classroom. However, scripts and plans do not support the transition from design to action or the post-action reflection. In this article, unexpected events, which can be positive or negative, are divided into three categories as follows: time, space, and resources. Time represents a contingency when the lesson times do not match the planned times. Space contingencies include situations where the teacher needs to move around the classroom. Resource contingencies include the transfer and distribution of content, the ability to access teacher-created designs at home, and the management of software or devices. These unforeseen events can hinder the transition from design to action for teachers.

The essay by Coskun et al. [49] defines unexpected moments as events embedded in a classrooms' complex, rich, and dynamic nature. Several scholars have concurred with this thesis. Brookfield [50] states that teaching is full of unexpected events and surprises, and that no matter how a teacher plans their lesson, they can be sure that there will be moments characterized by uncertainty. Rowland et al. [51] cite student interventions, a lack of materials, and insights from teachers who, for example, may realize they are not helping or may decide to value a student's contribution among the unforeseen events in teaching. Anthony et al. [52] consider the ability to notice unexpected moments a critical element of effective teaching. Although teachers hope and expect students can perform as planned, students may ask questions or make suggestions that were not anticipated. These unexpected events from students have, in the literature, a positive connotation, as they are identified as learning

opportunities or decisive moments for teaching. Finally, echoing Kilundo [53], they assert that it is impossible to teach without using resources and materials, meaning if these are not available as planned, the teacher will face a negative contingency.

The essay by Yurkofsky [54] delves into and defines three types of uncertainty as follows: technical, representational, and environmental, which can impact the improvement efforts of the school system. Technical uncertainty relates to the ambiguity of the technologies and the variety of materials and tasks, impacting both organizational structure and behavior; representational uncertainty relates to the ability of organizational members to assemble adequate representations of what is going on; and environmental uncertainty relates to the external environment, concerning the plurality and instability of environmental expectations.

4.2. Strategies

This section will address the strategies proposed by various authors for dealing with dimensions of uncertainty and occurrences of the unexpected. We again begin with the field of economics.

4.2.1. Strategies in Economy and Management

The essay by Huff et al. [27] devotes an entire paragraph to project planning methods that also consider the uncertainty dimension. The paper begins by proposing the two following exemplary types of strategies for managing uncertainty:

- The military type involves simplification; general objectives are defined, and all necessary resources are specified afterward;
- The diplomatic one is where the possibility of eliminating complexity is lacking and much more time is available; one can proceed in small steps, maintaining a high degree of vigilance, sensing reactions, and making decisions accordingly.

Statistics say that as uncertainty increases, the tendency of organizations to do strategic planning decreases. The authors interpret this reaction to uncertainty, attributing its cause to the 2008 financial crisis and the subsequent economic recession, which led managers to focus their strategic efforts more on the short term. In fact, following the 2007 financial crisis, the percentage of companies that reported using strategic planning dropped from 80 percent to just over 40 percent. The uncertainty following the crisis led organizations to focus on short-term planning in a somewhat deliberate manner. However, the authors consider it necessary to return to long-term strategizing practices and propose increasing information exchanges between leaders and their employees as a valuable practice in the management of uncertainty.

The essay by Hajikazemi et al. [28] argues that to protect oneself from unforeseen events (which, in this case, are viewed negatively as adverse events), it is necessary to adopt a resilient attitude. According to the author, most of the unexpected events that impact the development of a project are not unpredictable, but are rather a series of minor contingencies (whose effects build over time) that are ignored; even the most experienced project managers often ignore the signals, continuing to slavishly follow the initial plan until these initial signals or minor problems become Black Swans. According to the statement, proactive actions could be implemented to limit the consequences if early warnings are considered. Steps are proposed to anticipate a Black Swan as follows: identify possible risks and potential impacts, develop strategies to avoid the risks or at least mitigate their effects, reflect on the strategies, apply risk cover, and monitor the progress of the situation. For the authors, a Black Swan could even destroy the impacted organization if not properly managed. Reactions can include responding to the crisis and finding ways to solve the problem (figuring out whether new solutions need to be created or previous solutions can be used).

The paper aims to lay out possible approaches preventing or reducing the impact of Black Swans in a timely manner. There are two perspectives towards these contingencies. These include that they are managed via foresight, or circumstances are managed as they

occur. In addition to the strategies mentioned above, Hajikazemi and colleagues [28] also suggest adopting systemic thinking, which views a system (e.g., a project) not only as a sum of all its parts, but also as the interconnection between them [55]. This holistic understanding (along with detailed knowledge) is essential for identifying EW signals. Another key aspect of identifying EW signals is critical reflection. In particular, critical reflection, including divergent thinking, is necessary in creating the knowledge that contributes to identifying EW signs. Through reflection, the reflective practitioner [56] can highlight and criticize the lack of awareness of the elements underlying their practice and repetition of experiences, making new sense of the situation of uncertainty or uniqueness that they experience.

The essay by Kvalnes [29] describes each project by narrating a life cycle that includes project initiation, development and planning, implementation, execution, and monitoring before project completion and closure. Uncertainty can affect a project in many forms. According to the author, the way to deal with uncertainty is to accommodate unforeseen events by seeing them as an opportunity, rather than a threat to project implementation. Given the current complexity, it is impossible to follow the classic risk management technique of minimizing baseline variations. Uncertainty becomes a "natural" component of project development that must be dealt with without fear of deviating and changing the initial plan, and also with no fear of dealing with the component of anxiety that is naturally related to developing a project. The discovery and development of opportunities is not an obvious process; the creativity and analysis of potential solutions beyond the constraints of the project are required.

The essay by Johansen et al. [31] argues that, in today's complex reality, "sticking to the plan" as a response to uncertainty is no longer an option for many projects, and that uncertainty should be actively managed. The study shows that most participants see uncertainty as a threat rather than an opportunity. The authors propose a set of questions that can support the decision-making process, should unforeseen events arise. The moment the unexpected emerges, the decision-making process must be initiated in which, at least in part, there is an abandonment of a previous investment in time and money. Project managers must then ask whether the opportunity is favorable for the project and the project owner, and whether the change will increase the value and/or benefit for which the project was created. The authors also note that as project execution progresses, the unexpected tends to have a more significant impact, and seeing it as an opportunity rather than a threat becomes more complex. Managing uncertainty is not seen as an easy process; however, it is not avoidable, given the increasing complexity in contemporary society. Therefore, project managers must become increasingly open to embracing the unexpected as an opportunity.

The essay by Wang et al. [40] argues that the effective implementation of a project, which is subjected to the condition of uncertainty, consists primarily of dynamism. In contrast to traditional implementation, which follows a "back on track" approach to the original project, more recent research suggests a more open and dynamic implementation, adapting to the context and emerging demands resulting from the widespread condition of "uncertainty". It is insufficient or impossible to predict, but it is necessary to remediate with proactive and reactive actions in response to unforeseen changes. This implies that the value of a project is not given at the beginning, but is defined as the project develops. However, if strategic changes are not considered, even well-executed projects become outdated, thus wasting time and resources. When changes are made in response to uncertainty, there is a shift from expected value to realized value; in other words, from determining the value of a project based on expectations to determining it based on how it was completed in the specific context despite unforeseen events. The deviation between the two signals that remedial actions have been performed and that the impact of unforeseen events has been reduced or mitigated. This makes the cycle of the monitoring–deviation–development of solutions and evaluation iterative from the beginning to the end of a project.

The essay by Larsen et al. [41] lists two schools of thought on strategy-as-practice as follows:

- Strategy-as-practice researchers strive to link micro-processes within an organization with broader, more general macro-practices in order to achieve a more general understanding of the strategy;
- Strategy-in-practice researchers, on the other hand, argue that how managers and employees incrementally strategize is unique, local, and contextualized through everyday practices, and linking these micro-practices to more general processes is impossible.

Practice can be understood and applied in the three following ways:

- As an empirical phenomenon (by prioritizing the micro-based actions that are carried out contextually in practice by managers, employees, and so on in their everyday contexts, without substantial recourse to practice theory);
- As a theoretical perspective (meaning drawing explicitly on practice theory and epistemologically, embracing the fact that practices produce, shape, and/or reinforce reality);
- As a philosophy (accepting the ontological premises associated with practice theory, wherein practice consists of and constitutes a socio-material world).

Environments are uncertain, and actions take place in often unforeseen ways as the strategy is being developed. This means paying attention to and working creatively and constructively with people both inside and outside the organization and co-constructing meaning as the strategy unfolds. Wayfaring/wayfinding are two verbs that refer to welcoming and working constructively with the unpredictable and unforeseen circumstances that emerge when moving from one place to another. When managers strategize, they imagine a desirable future that they, based on their actions and communication, try to actualize as presently as possible. In the wayfaring/wayfinding process, they know that the strategy will only be realized if they constantly change and incrementally rework the previously formulated strategy, adapting it to their surroundings. Wayfaring/wayfinding helps them understand that how managers handle unforeseen events, which emerge as planning becomes action, changes how the strategy is realized.

Becoming aware of and accommodating events that were unforeseen in planning involves "temporal work", i.e., looking back at the past, imagining a new future, and using these images to change the way people communicate and act in the present while also planning. This means moving beyond what was planned and "traveling" in ways in which unforeseen events are explored and experienced, even if it requires deviating from the original strategic plan. One must work creatively and constructively with the possibilities that uncertainty offers, and understand whether capitalizing on these possibilities enables the realization of the intentions pinpointed in the strategic plan. In conclusion, one must prioritize the microactions carried out in the actual context to understand the strategizing processes. Those who do the planning (we are focusing on management, so those who plan and those who do the action do not coincide) must witness the actual unfolding of actions.

4.2.2. Strategies in Education

The essay by Costache et al. [42] recounts conversations between host tutors and trainees before class as an optimal learning context for discussing uncertainty and reflecting on the possible consequences. Uncertainties were detected by adopting a linguistic approach. We selected markers (adverbs, nouns, use of the conditional, pauses) that helped the researchers determine when trainees felt uncertain, while also teaching the welcoming tutors to pick up on these cues, meaning that they could use them as a starting point with which to begin a constructive dialogue. Citing Floden and Clark [43], they note that some of these uncertainties are more prevalent than others (knowledge of pupils, instructional design, teaching content, teacher authority) and recommended that mentors and teachers try to make trainees aware of uncertainties that are less likely to surface during their daily classroom experience, providing them with the appropriate tools to reduce them. According to the authors, the greater the awareness of uncertainty, the greater the ability to cope with it.

The essay by Lamnina et al. [45] describes the experiment the authors conducted, assigning students to three different conditions, which were unexpected, expected, and no uncertainty. The group not exposed to uncertainty was provided with an explanation of a task, and was then asked to perform it. The two groups exposed to uncertainty were not given an explanation of the theory and were then asked to perform the activity. Of these two groups, one was exposed to expected uncertainty and was shown a video, warning them that the activity they would be working on would most likely make them feel uncertain. The other group, the unexpected uncertainty group, was not warned about the possibility that engaging in an unknown activity might make them feel uncertain. The results showed that the groups prepared for uncertainty significantly gained skills, curiosity, and motivation. The authors identified the anticipation of uncertainty (expected uncertainty group) as a reasonable trade-off for achieving the positive outcomes that the uncertain dimension has been shown to prompt, while limiting the negative aspects related to anxiety and frustration.

The essay by Cinnamon [46], configuring itself primarily as a read-through of Dewey's [10] thoughts on uncertainty, even at the strategic level, does not provide any additional leads beyond that of the philosopher of education who sees uncertainty as an aspect inherent in the precariousness of the world. An awareness of the uncertainty and complexity that dominate the world, an awareness of the mutual influence that characterizes the elements of a system, an awareness of the inaccuracy of predictions, and the complexity of the patterns of the relationships of humans become the tools for interpreting reality. Attributing meaning to the world starts with recognizing it as inherently uncertain. Again echoing Dewey's thought, it is argued that although it is impossible to capture the unpredictable and unexpected microchanges that contribute to creating the uncertain condition, observing their effects and seeking an equilibrium of the system is possible.

The essay by Brevik [47], consistent with her definition of the unforeseen, proposes that the unexpected should be included as early as the design phase of a research project, so that solutions to emerging problems can also begin to be imagined. During the execution of the initial project, the author argues that having designed for the unexpected proved helpful because solutions were already envisioned in the design. However, at the end of the experiment, the author states that she combined designing for the unexpected with the emergent design method. Therefore, it appears that, while design that considers the unexpected has some positive aspects, flexibility remains essential to enable an adequate response to the unexpected and emergent.

The essay by Jalal et al. [48] presents data from a study on how teachers implement their educational plans. In most of the narratives regarding the conduct of teaching action, teachers consider themselves satisfied. Their plans reflect different levels of involvement in teaching activities and different examples of routines to resort to. Most teachers have created a paper or digital version that keeps track of their practices, meaning that they can improve these over time. Some teachers have created very detailed projects, covering all the educational objectives of the session. In other cases, the projects are limited or intentionally open-ended, so that one can add activities directly in the classroom. Effectively putting their projects into action required teachers to consider potential unexpected contingencies. Given the uncertainty dimension, teachers should be able to modify their projects as they develop, use alternative resources, and change assignments and/or content based on unforeseen events that can emerge during the teaching session.

The authors, after analyzing the sessions and contingencies that involved the teachers who took part in the experiment, listed the three following key points that projects and their implementation in the classroom should follow if they are to best cope with these contingencies:

- One should keep track of the session as it unfolds, including changes to the initial project and responses to unforeseen events. This can take many forms, but these observations must become a tool for reflection at the end of the session.
- Projects should be shared with students before the session and left as a trace throughout, so that the teacher and the students can constantly refer to them in order to keep

track of and regulate their progress. Both teachers and students should be able to add to, refine, and modify the educational plan as it develops.

- Many of the contingencies during the sessions under consideration involved the software used. Planning and execution tools need to be designed according to the storage and network constraints of the school environment.

The essay by Coskun et al. [49] defines the ability of teachers to interpret their interaction with students in a meaningful way as one of the indicators of effective teaching. The teacher's competence is to take into account unexpected student interventions, determining very quickly which ones are important for the planned objectives for that teaching session. Although efficiently responding is an important characteristic, helping students learn content in a relevant way seems more crucial. This article, echoing some of Rowland and Zazkis's [57] assertions, claims that teaching is not about adhering to designed scenarios and ensuring the execution of a predetermined curriculum. Therefore, planning becomes an exercise in anticipation and preparation, not pre-specification [58], i.e., it becomes a helpful tool for drawing a guideline that may be subject to change as the action unfolds. Lampert [59] adds that the response to the unexpected should be instantaneous, and should be provided to students immediately during the session.

The essay by Yurkofsky [54] on the strategic plan for coping with uncertainty proposes the Data Wise (DW) tool. DW is an eight-step process that supports teachers in detecting problems (whether concerning the student or their teaching practices) and in creating a subsequent action plan to address them. DW also supports implementing and regulating the original plan based on the data collected both in the short and medium term. Regarding the results obtained from their experimentation, the authors note that the DW method handled two types of uncertainty, illegibility and ambiguity of student achievement, well. At the same time, modifications were made to the model proposed by the researchers in order to address uncertainties related to teachers' practice. Questions meant to help teachers discuss teaching practices and student practices were personalized according to the team or group of teachers, and so were any suggestions for improvement. One positive finding concerns that using a shared model to address the dimension of uncertainty helped teachers engage in fruitful conversations concerning their own teaching practices.

4.2.3. Some Red Threads

Recurring themes emerge from the analysis of the selected papers. These include the notion that the perception and interpretation of uncertainty depend on the subject; overcoming the typical negative connotation of uncertainty in favor of a vision that can also seize the arising opportunities; the ineffectiveness of "stick to the plan", the need for flexible planning, and the centrality of meaning; and the positive role of awareness that emerges from uncertainty training.

From the contributions in economics, particularly from ([27,28,31,40,41,46] only 46 belongs to the educational field), the importance of the project manager/teacher's subjectivity on the perception of uncertainty is highlighted. When we talk about the subjectivity of the project manager, we refer to the combination of their professional background, personal identity, and the set of formal and informal experiences. The project manager/teacher might analyze a situation peculiarly and decide to manage the project in a certain way based on their interpretations of the circumstances and the suggestions provided by the people they work with [27], based on the knowledge and degree of awareness [28], based on the importance they decide to attribute to different epistemological dimensions [31], based on their perception of the changes they consider appropriate to cope with the uncertain situation [40], and based on their habits and patterns they are used to engaging in [46]. Those who analyze the situation of uncertainty to make decisions define the strategies to be undertaken and construct or restore meaning to the actions that will be taken following an unexpected event [41].

Simply having expectations regarding uncertainty and the occurrence of unforeseen events is already a significant starting point for approaching the project management process.

Several authors of the analyzed publications agree on this point [42,45,46,48,54]. Uncertainty training and awareness, already at the project stage, of the inevitable presence of unforeseen events are cited as positive elements, especially concerning anxiety management. This can be completed through the simple discussion and collective reflection of the actors involved in the project or real training on the dimension of uncertainty, its implications, and constraints. On the issue of uncertainty training, the research we conducted [9,60] tested the hypothesis that having expectations and information about the presence of the uncertainty dimension decreases the state of anxiety. The results were encouraging in this regard, suggesting that the proposal to train actors involved in project drafting and implementation on the unexpected has positive effects on anxiety and, more generally, on the concrete management of the process.

A third aspect, which is also recurrent, and to which papers from both fields pay close attention, is to overcome the negative connotations of uncertainty that are typical of the past, in favor of a view that can also seize the opportunities that arise from it. The usual practice in the past consisted of risk estimation, where an attempt was made to control if not outright eliminate uncertainty. There was the fallacious underlying belief that risks were predictable and needed to be made manageable through probability calculation in order to reduce their impact on the project as much as possible. The results presented by the papers show that unforeseen events do not always have negative effects, but can often take the form of the drive for innovation, as well as a stimulus to question the meaning of the project by adapting it to the context. In papers ([29,31] (economic), [45,46] (educational)), for example, the opportunities that an unforeseen event might open up are emphasized. The occurrence of unforeseen situations leads to a redefinition of goals or modes of action, introducing elements of novelty and opening up new perspectives from those assumed at the planning stage [29,31]. Opening oneself to uncertainty and, therefore, considering the possibility that something will happen that will alter the project as it unfolds stimulates curiosity [45] by fostering divergent thinking, deconstructing habitus, and promoting the imagination of new solutions to old problems [46].

From the discussions present in this essay [28,29,31,40,41,48,49], it appears impossible, or at least ineffective, to continue to manage projects by adopting the "stick to the plan" strategy because the project is constantly challenged by the situation, context, and unforeseen events, thus forcing the project manager to reflect on the meaning of what is being accomplished. Structuring a linear project in detail at the initial stage, while continuing to refer to it slavishly during the actual execution of the project, is not a functional attitude in the postdigital society. Unforeseen events lead, positively and negatively, to having to revise that project, continue with some parts of it, eliminate others, or change some aspects of what was initially planned. All the necessary changes during this process often lead to rethinking the meaning of what is being enacted in the course of implementation to maintain formal and substantive consistency between the elements of the project and the situation.

The selected papers suggest that projects should take the form of non-prescriptive anticipations that seek to direct actions, that they should be proposed as a guideline to follow that is highly flexible in order to allow the project manager to deviate from the imagined path and deal with an unforeseen situation, responding effectively to uncertainty. However, talking about flexibility without providing precise strategic directions may be unhelpful. According to the results of a recent research, we discussed how to modify educational designs in order to cope with the unexpected [45]; proceduralizing the path to build spaces for flexibility is one answer. With proceduralized flexibility, we move away from the traditional idea, which some of the authors reported here also propose, of laying out a loosely knit design in such a way as to accommodate any unforeseen contingencies, while leaving the practitioner to improvise during implementation. Instead, the idea we propose involves drafting a structured plan that proposes from the very beginning the presence of multiple possibilities, supporting the constant process of sense-making.

4.3. Future Directions: The Matter of Anxiety

Although elements on the issue of anxiety were not explicitly searched for during the writing of the review, this point emerged from several of the papers considered. Below is a summary of what emerged.

The essay by Huff et al. [27] intervenes on the issue of anxiety as it relates to uncertainty. Regardless of the type of uncertainty perceived, the very experience of uncertainty is defined as fundamental to sensemaking processes and is never addressed in an emotionally neutral manner. The inescapability of uncertainty is contrasted with society's tendency to estimate the probability of what it cannot predict with certainty. The tacit confidence one has in one's estimates leads to making decisions under conditions of risk, rather than under conditions of uncertainty, thus leading to poor or dangerous decisions. Ultimately, admitting the condition of uncertainty is arduous as it means admitting that one is not in control, which is a condition that naturally leads to stressful and anxious states.

The essay by Hajikazemi et al. [28] briefly mentions the issue of negative emotions relating to uncertainty, arguing that unexpected events could negatively affect employees' productivity as they might feel worried, insecure, or distracted.

The essay by Kvalnes [29] discusses the thoughts of Danish philosopher Søren Kierkegaard (1844/1980), who suggested that uncertainty is a source of creativity rather than an obstacle. He sees anxiety as a response to human freedom and the dizzying realization that there is an opportunity to develop and grow beyond the status quo. The unexpected creates anxiety in individuals, and anxiety almost always has a negative connotation due to its association with suffering and helplessness. Kierkegaard, however, describes anxiety as an experience that can fuel creativity; this is echoed by other authors who also emphasize the role of anxiety in giving rise to a point of rupture with past behaviors and habits. Anxiety becomes a natural component of working conditions that should act as a driving force for those called upon to execute a project, rather than a source of frustration.

The essay by Costache et al. [42] mentions, albeit very briefly and in a single passage, the frustration that trainees sometimes experience during interviews with teachers if they feel that they do not openly and directly address their uncertainties and dilemmas.

The essay by Lamnina et al. [45] suggests that, although uncertainty has predominantly had a negative connotation until now, as something that individuals try to reduce, it has significant positive effects on motivation and curiosity. However, as evidenced in the experimental group exposed to the effects of unexpected uncertainty, it can cause feelings of anxiety and frustration. The authors pointed out that providing even minimal expectations regarding uncertainty and its eventual presence could mitigate its effect on negative emotions. The authors defer to the future studies on individual tolerance of uncertainty that could reveal data that is than those collected in this first paper.

The essay by Yurkofsky [54] mentions the frustration that education practitioners feel, driving from the lack of a conceptual framework surrounding the issue of uncertainty and the lack of time deriving from the changing expectations that increased complexity places on teachers.

What has been found in the literature regarding anxiety as it pertains to the dimension of uncertainty is consistent with the feelings that trainee teachers often recount following their internship experience [45] and will be further explored in future research focusing on Primary Education faculty trainees.

5. Conclusions

The review analyzes the matter of uncertainty, aiming to settle on a definition of the terms "uncertainty", "unexpected", and "unforeseen".

Though there are no identical definitions of the terms analyzed, the review identifies some commonalities, even among different fields of inquiry, making it possible to propose practical intervention strategies in the area of education. In particular, some recurring themes include the possibility of seeing uncertainty as a resource and not an obstacle to avoid, using flexible strategies, and needing uncertainty training. From these points, on

which many of the reviewed authors converge, practical directions can be drawn, which will be summarized here. The intervention focuses on how the highlighted elements impact education at both the institutional and methodological levels.

The need to see uncertainty not only as a threat to processes but also as a possibility implies that, in practice, the (vain) attempt to eliminate it must be abandoned, instead focusing the project actors' efforts on the transformative and improvement elements that can affect both institutions and educational processes. Encountering unforeseen circumstances often catalyzes creativity and divergent thinking, allowing for the exploration of new perspectives and innovative solutions that may not have been otherwise considered. Embracing uncertainty in this context becomes a positive force, stimulating curiosity and encouraging individuals to remain open to the possibility of unexpected developments that can enrich the project's trajectory. This mindset fosters a dynamic approach, where the fluidity of the situation invites adaptation and encourages the discovery of novel paths going forward.

The need for flexibility that arises from the pervasive and constant presence of unexpected events can be met by drawing from Berthoz's theory of Simplexity [61] certain praxes that can be repurposed in practice both institutionally and methodologically. These praxes are modularity, redundancy, detour, and anticipation. The latter, in particular, leads to arranging specific organizational, institutional, and methodological changes in advance (technologies that are no longer thought of only as means, but also as mediators capable of creating renewed spaces and times of learning). For further discussions of how these practices may represent possible solutions to the emergency, see [45].

A partial confirmation of what was stated was observed with the DUE trial. At the same time that the review was undertaken, the procedure "Design for the Unexpected in Education" (DUE) and the related intervention focusing on educational design were trialed. Conducting these activities at the same time made it possible to deepen specific points and make cross-references between theory and practice that were mutually enriching. The study of the theory and the papers included in the review guided the construction of the "DUE" procedure [62]. In particular, it nurtured the awareness of the impossibility of predicting unforeseen events a priori, and it highlighted the need to work on addressing situations of uncertainty, rather than working to avoid or circumscribe the occurrence of an unforeseen event. At the same time, structuring the educational design procedure and testing it with teachers in training allowed us to reread the results presented by papers from wildly different contexts, finding some more general insights that we report below.

The need to train for uncertainty must be interpreted as a strategic aspect to guide future design practitioners in grasping the positive aspects of uncertainty and to enable a transformation of subjectivity, so that they become aware of and capable of effective decision making. In a complex and ever-changing society, continuous action and subsequent critical reflection both enable one to stay abreast of what is happening and modify one's modes of operation and self-training accordingly. One consequence of this premise is that today, it is impossible to think of a standard design procedure for a situation without uncertainty and to operate on uncertainty only in action. In other words, educational design is already a "design for the unexpected", so training for uncertainty is, in fact, the only possible training in the postdigital context. Training for uncertainty should focus on education in divergent thinking, a multiplicity of possibilities, redesigning, and an openness to opportunities. Thus, it should focus on something other than improving the skill of predicting the unexpected, but should rather use the tool of anticipating the teaching situation via the imagination to conceive the possible futures.

All the reflections in the conclusions of this review stem from the fundamental realization that the dimension of uncertainty is now a structural feature of the society in which we live. The gap between the knowledge and skills one possesses and what is happening in the world is widening more and more at an ever-increasing speed. Uncertainty no longer arises only from the occurrence of unforeseen events that intervene in the flow of life, but it is the flow itself that develops processes in every field beyond the reach of a small

number of specialists, processes that even the informed person with even a high level of education is not only unable to master, but unable to even grasp their essential elements. Consequently, in a society where uncertainty is the new normal, the need to rethink education in light of this becomes the real emergency.

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