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Rethinking and formalizing initial teacher training on learning design for and in uncertainty

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The paper analyzes the impact of uncertainty on teaching and proposes a method to rethink learning design and teaching action management and to renew future teachers' training paths. Specifically, the research focuses on how learning design can help future teachers deal with the unexpected. We propose design strategies, including modularity, anticipation, hierarchy, redundancy, and deviation formalized in the "Design for the Unexpected in Education" (DUE) method, and we present the results of research conducted on initial teacher education at the University of Macerata. The data analysis of future teachers' learning designs and post-action reflections shows meaningful changes. In fact, after specific training and introducing the DUE method, future teachers can deal more confidently with the unexpected and achieve planned goals. Future teachers also refer that anxiety is reduced through prior discussion of uncertainty and available regulation strategies.

KEYWORDS

uncertainty, planning for the unexpected, initial teacher training, learning design, regulation in action

1 Introduction

The polycrisis and postdigital frameworks are highly generative for analyzing today's society by capturing its unique problems and characteristics.

The postdigital culture becomes reified when uncertainty assumes an ontological status. This manifests itself in the dissolution of the analog-digital dichotomy (Jandrić et al., 2018; Peters and Besley, 2019; Cramer and Jandrić, 2021), continuous innovation, and the overcoming of the scale construct (Henig and Knight, 2023). Additionally, digital multimodality reduces the time required to implement changes in action and allows multiple choices, even if it requires a longer time to set up the system.

When referring to polycrisis (Morin and Kern, 1999; Tooze, 2022), we encompass the complex interdependence of political, environmental, economic, health, and social crises in the contemporary world. These emergencies no longer confine themselves to a specific time, space, or culture; instead, they blur boundaries (Hobson, 2022) and evoke widespread uncertainty that profoundly impacts reality (Lamnina and Chase, 2019).

By embracing these frameworks as reference points for analyzing contemporary reality, we acknowledge that linear processes cannot simplify complexity (Berthoz, 2009). The literature review (Capolla, 2024) underscores that our only option is to embrace complexity, addressing crises and unforeseen events as they unfold, without hoping for a return to normality (assuming normality ever existed) or predicting the evolution of innovative processes (Perminova et al., 2008).

2 Pedagogical framework

Although uncertainty has always characterized educational action (Dewey, 1938; Perrenoud, 1999), the current situation modifies the role assigned to unexpected events. It is no longer a swing around the equilibrium situation but an early warning and a prelude to reaching a new and different equilibrium that was initially unpredictable. This affects the relationship between design and orchestration, on the one hand, and teachers' practices, and thus their training, on the other. Current students in Primary Education degree programs, hence the teachers of tomorrow, face two main obstacles: having to train for an ever-changing school and the anxiety that this situation of structural uncertainty can cause them (Lamnina and Chase, 2019). Indeed, one of the main characteristics of contemporary society is that it is subject to continuous and rapid innovation that does not allow one to anticipate, predict, or often arrive prepared in the face of the unexpected (Capolla et al., 2023) that cannot be anticipated and managed by turning to standardized, old, improvised practices or simply relying on experience. Teachers no longer need detailed lesson plans and structures to support them in their practices, as was the case in the past with typical Instructional Design (ID) models such as ADDIE. On the contrary, they need to be supported in regulating, redesigning in action, creating or quickly adopting solutions appropriate to the situation and context that are grounded and meaningful and support them in managing anxiety (Pentucci et al., 2023).

The paradigm shift we aim to achieve with the proposal of our design method requires us to overturn the traditional perspective. In the past, design indicated a single, often loosely structured pathway created by the teacher before the lesson. This designed path was then regulated in the classroom by relying on improvisation or practices embodied through experience. Today, design and action are two recursively linked dimensions, as we have already mentioned. Design now involves a predisposition toward various possibilities in the initial step, followed by situational selection among those possibilities when constructing the path trajectory (Fawns et al., 2023). Our proposal aligns with these findings. The first step involves a predisposition toward multiple futures (Selwyn et al., 2020; Pischetola, 2022) and simulating actions (Gero and Kannengiesser, 2002, p. 19; Rossi and Pentucci, 2021). The second step of the method integrates designing as a choice-in-situation, consistent with how digital algorithms work (Manovich, 2020, p. 261). Digital algorithms, in fact, defer the moment of choice by making it coincide with the moment of action, enabling highly context-consistent decision-making.

In summary:

- a In the past, design in schools was external, guided by national directions and textbooks. It often remained implicit, with teachers not always formalizing design for each lesson. Regulation in action was improvised, relying on a background of embedded practices. However, today, design is needed internally, connected to the context, the classroom, and the teacher's habitus. It must be explicit and formalized in some way.
- b Effective planning should begin with an awareness of unexpected factors from the very outset.
- c Explicit planning cannot rely on classic ID models, that often failed to enhance teaching professionalism and limited decision-making spaces.
- d A design method can be developed based on simplicity principles: modularity, redundancy, deviation, anticipation, and hierarchy (Berthoz, 2009).

Our research hypotheses are as follows:

- a Designing for uncertainty promotes self-consistent and wrapped-up lessons.
- b Teachers need training from the initial stages to design for uncertainty and navigate within it.
- c The method should prioritize teachers' professionalism and allow space for decision-making in action.

Based on these assumptions, we proposed the DUE method.

The strategies upon which we built the DUE method were selected and proposed after analyzing the data from the 2021/22 academic year's designs and studying relevant literature.

Berthoz's work inspired the strategies we proposed. In his book on *Simplicity* (2009), Berthoz describes natural systems' strategies to tackle complexity.

Specifically, modularity refers to the need for design time-constrained and self-consistent activities. The issue of modularity and microlearning (Leong et al., 2021) is fundamental. Due to the ongoing crisis impacting society and schools, the educational path can no longer be seen as a chain of lessons strongly interconnected like links. The main challenge with this traditional configuration is that if an unexpected event disrupts educational continuity, the intended meaning of the proposed activities would be lost.

At the core of DUE lies the strategic proposal of hierarchization: we suggest labeling the activities students plan in the pre-action sheet as necessary or incidental. This distinction allows us to differentiate between activities crucial for maintaining the lesson's coherence and those available to the teacher for redesigning the lesson in action.

Two strategies, then, support the teacher during this redesign process: deviation, which involves implementing different activities and paths due to unexpected situations requiring goal and meaning adjustments, and redundancy, which arranges alternative activities using different mediators (to address learning difficulties) or devices (to handle technical issues) while maintaining the same learning objective. In addition to the above strategies, anticipation is also present, which was already part of the design method before DUE and consists of imagining students' dialogs and reactions to the educational proposal. By incorporating interaction during the initial design phase, we recognize that "the social and people aspects must not be addressed as afterthoughts" (Valckenaers and Van Brussel, 2015), and design becomes a simulated action (Rossi and Pentucci, 2021).

3 Research method

3.1 The experimental educational path

We conducted research with third-year Primary Education students attending the Theories and Methods of Educational Design and Evaluation (TeM) course at the University of Macerata, Italy. The objective of this course, among others, is to introduce future primary school teachers to learning design. In fact, during this course, lectures, workshops, and an internship in a primary school classroom

are alternated. Students are required to experience the proposed design method firsthand, implement it, and use it directly during a lesson.

Specifically, the research was conducted over 2 years: 2021/22 and 2022/23. While the core structure remained the same in both years, the academic year 2022–23 introduced a module on uncertainty was introduced. During the internship, students were asked to prepare lessons using the DUE method.

During both years' courses, in alignment with the formative objectives, each student was required to prepare, following the provided template, the learning design for a lesson they would subsequently teach themselves during their internship at a primary school. This practical application of the research ensured that students gained a hands-on understanding of the proposed design method.

In the design phase, students create two key documents: a descriptive document and a narrative sheet (narrative pre-action; Laurillard, 2012). The descriptive document includes all contextual information (such as class details, space and time constraints, lesson title, meaning, purpose, and objectives). It allows students to define a holistic overview of the context and provides a rationale by which the lesson will be conducted. On the other hand, the narrative document contains the sequence of activities that trainees plan to carry out during their lesson. Additionally, it includes a simulation [drawing from Schön (1984) and Bolter (2019)] of the dialogs and interactions they imagine will occur during the lesson [as envisioned by Rossi and Pentucci (2021)].

After the lesson has taken place, students complete a reflexive document. In this document, they report the actual unfolding of the lesson, describing the activities performed, dialogs that occurred, and their personal reflections.

During the end-of-course examination, the university professor discusses the three documents with the students after having read them. The final evaluation considers the documents' completeness and quality and the students' critical reflections.

3.2 Data analysis

The research analyzes student designs from 2021–22 to 2022–23. Designs created in 2021–22 were developed without the DUE method, whereas those in the academic year 2022–23 followed the DUE method. The study is based on analyzing three documents: descriptive design, narrative design, and reflexive-narrative post-action document. Students completed these documents in both academic years. The 2021–22 documents were used to fine-tune the DUE method. To evaluate the impact of DUE, we compared documents from the 2021–22 and 2022–23.

In the academic year 2022/23, we introduced the DUE method to the students with a specific module. During this module, students received a theoretical framework on the concepts of uncertainty and the unexpected. Additionally, we conducted workshops where students analyzed designs from previous years to identify unexpected events, assessed how their peers handled them, and engaged in collective reflection under the guidance of the course professor.

We analyzed documents from 428 students, 229 from 2021 to 2022 and 199 from 2022 to 2023. Each document had an average length of 30 pages. Enrolled students filled out a consent form and authorized the use of their work for research purposes.

The data corpus presented several methodological challenges. Ultimately, to avoid reductionism while making the work sustainable, we followed some of the directions proposed by Manovich (2020), which involve identifying complex indicators and performing data analysis through stratification (Pentucci et al., 2024).

The analysis focused on two moments during lessons: (1) when students analyze possible solutions and make decisions and (2) when they complete the lesson and debrief.

Decision-making is closely tied to the regulation required to respond to unexpected events or contingencies. By examining how students make decisions, we aimed to determine whether the DUE method increased awareness of the unexpected and improved uncertainty management. We searched the post-action reflexive document for syntagmas containing the token “*deci*,” derived from Italian words such as “*decisione*” for decision, “*decidere*” for to decide, “*deciso*” for decided. We conducted this token search using a digital application.

The software extracted sentences surrounding the token, which were read according to concordance analysis principles to understand the contextual background (Sprugnoli et al., 2019). After searching each document for the specified string, we excluded sentences that, although containing it, did not refer to decisions made by future teachers. The researchers reread and analyzed the remaining sentences using qualitative-semantic analysis. Another aspect we examined was debriefing—a complex indicator of lesson progress carried out by future teachers. Poor handling of unexpected events often leads to rushed, partial, or incomplete closures. Notably, in the academic year 2021–22, many lessons concluded without proper debriefing, hindering the overall coherence of the lecture. We compared the execution of debriefings in that year with those in the subsequent year.

4 Results

The set of all the extracts then formed our corpus of data, which, although partial to all the utterances in the documents, comprises fragments from the original data rather than interpretations by the researchers (Table 1).

Next, the obtained extracts were categorized (Table 2). The first category comprises the post-action documents that explicitly reference what was planned in the learning design (exp). The second category includes post-action documents that do not explicitly reference the pre-action documents (n-exp).

Another significant aspect of addressing our research hypothesis was the debriefing phase. This essential part of the lesson involves one or more final activities that help pupils reconstruct the meaning attributed by the teacher, review the activities, and formalize knowledge and skills. The importance of this phase was already emphasized in the course taught in the 2021/22 academic year. In the subsequent year, there was a shift in focus toward contingencies, leading to increased attention from students to the unexpected and its consequences. We observed how many trainees completed the debriefing as planned, how many omitted it, and how many made more or less substantial changes from the original plan (Table 3).

The results from various analyses performed on the data corpus yielded satisfactory and positive outcomes.

Digging deeper into the analysis by searching for the token “*deci*” (Table 1), we immediately notice a general increase in

TABLE 1 Token presence.

Academic year	Number of sentences containing "deci"	Average number of sentences per student	Number of designs without "deci"	Number of designs without "deci" in %
21–22	277	1,2	109	48%
22–23	541	2,7	44	22%

TABLE 2 Learning design references.

Academic year	Explicit reference to the learning design (exp)	%	Non-explicit reference to the learning design (n-exp)	%
21–22	77	30%	182	70%
22–23	248	51%	242	49%

TABLE 3 Debriefing completion.

Academic year	Not done	Partly done	Done
21–22	11%	31%	58%
22–23	3%	25%	72%

frequency from the academic year 2021/22 to the following year. This becomes even more intriguing when we consider the average number of sentences containing "deci" per student, which more than doubled from 1.2 to 2.7. The use of the verb 'to decide' and the word 'decision' suggest that students have become more aware of their roles and actions compared to their peers in the previous year. Here are examples for clarification:

"Due to 5 min lost during the reception phase, I decided not to proceed with this activity. Although it wasn't mandatory, it could yield interesting insights, but it did not seem crucial for the lesson's success or achieving the micro-goals."

"Compared to my initial plan in the simulation outline, I decided to approach the activity differently—no longer individually but collectively. The pupils' fatigue prompted this change after the notebook copying activity."

Their decisions are grounded and often reference the design or are justified by the anticipation of the consequences that could have been according to their mental simulation. Furthermore, the percentage of designs lacking the term 'deci' decreased from 48% in 2021/22 to 22% in 2022/23.

The analysis of explicit references to design during the regulation phase in the academic year 21/22 stood at only 30 percent (Table 2). However, the percentages for the following academic year, 22/23, are more positive: more than 50 percent of students explicitly referenced design. This allows us to observe how the introduction of the module on uncertainty and the DUE method have significantly improved the mindful use of design. Above all, it provides us with insights into the actual use of design during the unfolding of the lesson, especially concerning regulation or, better, redesign in action.

Data on debriefing performance are crucial for assessing increased competence in dealing with unexpected events (Table 3). In the

academic year 2021/22, 11 percent of students failed to conduct effective debriefing, and 31 percent failed to do so entirely or consistently with the meaning and objectives they had set for themselves in the design. However, in the academic year 2022/23, 72 percent of students effectively concluded their lessons by either performing the debriefing as designed or using the design as a basis to make appropriate choices. Two examples are proposed regarding this conscious redesign:

"In this final map, I had planned to write down what the pupils would say to me at the IWB to complete the slide in which I had left blanks. However, the program was not updated with the new versions and was rather slow. So, I decided to formulate the sentences verbally with the children and then dictate them."

"Given the short time available, the trainee, advised by the tutor, gave the students a photocopy with the constellation ready to stick on the left side. Although she had prepared three constellation pictures (Ursa Major, Cassiopeia, and Orion), she decided to focus on Ursa Major and Ursa Minor due to their connection. As she had not prepared the photocopy for Ursa Minor, she had the children create it, given its simplicity."

Regarding debriefing, the most critical data for assessing the effectiveness of our proposal show an eight percentage point decrease in students failing to carry it out in the academic year 2022/23. These data reflect positive outcomes for regulation, indicating that the ability to respond to unexpected events (and subsequently to regulate in action) increases thanks to DUE and uncertainty training. Additionally, the procedural approach to regulation allowed more students to cope with unexpected events and successfully complete necessary activities without succumbing to the dimension of uncertainty.

An essential reflection pertains to flexibility. Introducing the DUE method, particularly the hierarchy strategy, did not hinder students from exercising divergent thinking. While not all students used redundant or additional activities from their design, many built new pathways based on designed activities during action.

Lastly, after completing the TeM final exam, many students reported that DUE and its use significantly helped them manage anxiety. Having a range of pre-planned paths made them feel safer in the face of uncertainty. Although student voices were collected informally, this insight suggests further studies are worthwhile.

5 Conclusion

The hypotheses of our research are as follows:

- a Designing for uncertainty promotes self-consistent lessons and reduces anxiety in teachers.
- b It is necessary to train teachers from initial training to design for uncertainty and to act within uncertain contexts.
- c The method must be attentive to teachers' professionalism and allow room for decision-making during action.

The data collected and cited above enable us to address the first hypotheses. The DUE method has directly provided students with a range of possibilities that support them in regulating their action. Simultaneously, identifying possibilities during the design phase helps students develop divergent and flexible thinking. Even when initially designed possibilities are unsuitable for unexpected situations, this approach still supports effective regulation.

Regarding the second hypothesis, the traditional planning approach as a self-consistent phase with a well-defined beginning and end before the lesson is no longer functional. Instead, design and orchestration become recursive processes (Fawns, 2019, p. 140). Designing becomes a simulated action that allows for the arrangement of multiple possibilities. During the actual work session, decisions are made in real-time among these possibilities to shape an actual path.

Given the impact of polycrisis and the postdigital era on education, rethinking professionalization is crucial. Educating students to handle unexpected contingencies without feeling overwhelmed by anxiety is essential. Proceduralizing regulation and incorporating uncertainty into design training during university courses are successful practices. In light of the results presented, these approaches improve teacher training and teaching effectiveness and contribute to students' overall well-being, addressing the current challenges of teacher dropout from the profession (Flores, 2023).

6 Acknowledgment of any conceptual, methodological, environmental, or material constraints

One of the main limitations we recognize to the experimentation described in this article concerns the possibility that students, future teachers, have of actually implementing the designs they produce during the Theories and Methods of School Planning and Evaluation course and during the internship. Students have the opportunity to

develop only one design, which will then be actually carried out in class, and they have the opportunity to work on this design for an extended period, receiving feedback from both the university professor and the internship mentors. Despite the encouraging results described in this article, we see the need to reflect further on our proposal and try to experiment with in-service teachers. This will allow us to demonstrate sustainability in addition to the educational value.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

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