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Fostering the Creative Process Using the Wallas Model: A Case Study Conducted Among Pupils in Craft Design Education

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ABSTRACT

Following on from the modeling of the creative process developed by Wallas in the early 20th century, this study examines the creative processes of pupils aged 10–12 and focuses on the sequence of various cognitive activities involved in school-based object projects. Drawing on theoretical models of the creative process and the multivariate approach, the aim of this study is to understand the relationship between the activities observed and the stages of Wallas' model, as well as how the type of task influences the outcome. Forty-one pupils attending school in French-speaking Switzerland were divided into two groups and carried out two separate projects over 6 weeks (a stop-motion film and a school box). To record their actual cognitive activity, the pupils completed the Creative Process Report Diary at the end of each lesson. This self-observation tool records both process activities and cognitive and emotional factors. The results of this longitudinal study reveal that the pupils' creative process corresponds to the stages of the creative process defined by Wallas. However, we observe certain specific features, such as dynamic and iterative sequences between stages. Furthermore, the analyzes highlight the influence of the nature of the task on the density (quantity) and variety (alignment) of transitions. These observations confirm the sustainability of the model proposed by Wallas and encourage future research on the development of the creative process in compulsory school education.

1 | Introduction

Tepper and Kuh (2011) remind us that creativity is recognized as a necessary and indispensable skill in the 21st century, as it helps to "revitalize" the economy but also various sectors of the public domain, including education. Furthermore, Miller and Dumford (2014) point out that the professional world requires the arrival of individuals who are creative, flexible, and competent, capable of tackling complex tasks without pre-established procedures. In terms of education policy, the OECD notes that, despite an increase in creative skills among pupils over the past 10 years, many still struggle to solve technical problems that call for innovative ideas (OECD 2014; Barbot and Kaufman 2025). Training individuals to come up with original solutions and adapt to complex tasks is therefore a major challenge for school systems. Creativity therefore needs to be developed in training and education contexts (Massy et al. 2025; McKay et al. 2024; OECD 2014; Sio and Lortie-Forgues 2024). Teaching creativity involves practice and reflection in the sense that learners must be given opportunities to put their ideas into practice and receive constructive feedback to improve their creative skills (Lin 2011). The development of creativity in an education context is a key part of the teaching process which needs to teach the creative process of learners (Lubart et al. 2015). The creative process that leads to productions can be described as 'a succession of thoughts and actions leading to original and appropriate achievements' (Lubart et al. 2015). It can be analyzed at two levels: the macro-process, which corresponds to the major stages of the journey (preparation, incubation, illumination, verification in the tradition of Wallas), and the micro-level, which focuses on the cognitive mechanisms involved, such as divergent thinking and convergent thinking (Rawlings et al. 2025). Recent models (Agnoli 2025; Botella et al. 2022) emphasize the dynamic and iterative nature of this process, in which the individual moves from exploration to evaluation depending on the constraints and opportunities encountered (Bonnardel and Lellouche-Gounon 2024). In this context this study examines pupils' creative processes in a school setting, with a particular focus on how they structure their cognitive activity when participating in craft projects. More specifically, it aims to identify the most frequent transitions between cognitive activities and to compare the dynamics of these processes across different types of projects. Building on the theoretical legacy of Wallas (1926), this study seeks to better understand how the stages of the creative process can be observed in students' activities within compulsory educations, while taking into account the dynamic and iterative nature of creative processes highlighted in contemporary research.

1.1 | Creativity

Creativity is often defined as the ability of a group or an individual to generate new solutions adapted to the context (Bonnardel 2012; Lubart et al. 2015), furthermore, the level of engagement of creative capacities in an activity (also known as creative potential) varies depending on the combination of four factors identified by the multivariate approach (Besançon and Lubart 2015; Bonnardel and Lubart 2019; Lubart et al. 2015); this approach distinguishes: (1) Cognitive abilities, which refer to information-processing skills (e.g., divergent thinking, convergent thinking, cognitive flexibility, etc.) and knowledge; (2) conative factors, which relate to an individual's personality, motivation, or cognitive style (Besançon and Lubart 2015); (3) emotional factors, which are linked to states of mind and moods: studies (Ivcevic and Brackett 2015) show, for example, that a positive emotional state facilitates divergent thinking by lowering the threshold for evaluating ideas; and (4) the physical and social environment of the activity can foster or hinder creativity by providing stimulation and cultivating a climate of trust conducive to exploration (Beghetto and Kaufman 2014; Besançon and Lubart 2015). In an educational context, it is through problem-solving situations, and particularly when faced with constraints (technical or conceptual), that students will tap into their creative potential, which can fluctuate throughout the creative process (Csíkszentmihályi 1996; Glăveanu 2020; Lubart et al. 2015; MacKinnon 1978).

1.1.1 | The Creative Process

The creative process refers to the set of cognitive and behavioral steps that an individual goes through to generate new ideas (Besançon and Lubart 2015; Botella and Lubart 2019). In the early 20th century, Wallas (1926) proposed one of the first models of this process, which he described in four stages: (1) *preparation*, during which the problem is explored in all its facets; (2) *incubation*, where the conscious mind moves away from the problem while associations are made unconsciously; (3) *illumination*, marked by the sudden emergence of an idea or solution; (4) *verification*, which consists of testing and refining the idea (Lubart et al. 2015; Wallas 1926). More recent studies (Botella et al. 2022; Lubart 2018) contribute to our understanding of the creative process by approaching it as dynamic and non-linear. Indeed, regarding the different stages of the creative process, these studies highlight the specificity of going back, skipping certain stages or repeating phases according to need (Jokiel and Jokiel 2025). During these stages, the individual draws on a variety of characteristics associated with creative thinking, such as: iteration characterized by unpredictable shifts in direction and emerging ideas throughout the process; the problem-solving process (through initial questions or those that arise during the task); divergent thinking, which consists of the ability to generate numerous ideas and potential solutions to problems; deadlock resulting from the futility of proposals; uncertainty caused by ambiguity and the uncertainty of the task (Lubart 2018; Lubart et al. 2025; Sawyer 2022). The fluctuation of these characteristics related to creativity involves both personality traits and environmental factors linked to the field of activity. While these phenomena describe the unfolding of the creative process, the multivariate approach (Lubart et al. 2025) specifies, at a complementary level of analysis, the resources that individuals mobilize during this process: cognitive, conative, emotional, and environmental factors (Sternberg and Lubart 1995). In this regard, the comparative study conducted by Glăveanu et al. (2013) models the creative process of different creators belonging to five complementary creative fields: art, design, science, scriptwriting, and music. To do this, an understanding of the creative process was developed, focusing on the use of creative action in which human action encompasses and articulates both "internal" and "external" dynamics and, in its psychological expression, integrates cognitive, emotional, volitional, and motivational aspects (Glăveanu et al. 2013). In this comparative study, artists, designers, screenwriters, and music composers begin by mentioning the idea, the "vision," or the client's specifications as the starting point for the creative process (ibid, 2013). Once this initial information has been addressed, other ideas emerge; within these creative processes, the material forms of creation revolve mainly around the physical properties of objects for fields immersed in the material world (art, design and music) (Glăveanu et al. 2013). With regard to the stages of the research conducted by Glăveanu et al. (2013), the following categories were proposed: impulse, obstacle, action, experience, and emotion; these were then explored in greater depth through subcategories.

In this study, we employ the multivariate approach (Lubart et al. 2025) as a theoretical framework for investigating the creative process. This systemic approach to creativity draws on various distinct resources related to intelligence, knowledge, cognitive styles, personality, motivation, and environmental context (Sternberg and Lubart 1995). This approach allows us to account for variations in the creative process that depend on the task at hand and the individual's characteristics (Lubart et al. 2025). The multivariate approach provides a broader perspective on the creative process, thereby contributing to the improvement of creativity training and the identification of potentially creative individuals (Lubart et al. 2025).

1.1.1.1 | The Creative Process in the Fields of Art, Design, and Craft. Creative process models may differ depending on the field of application. In the arts, Mace and Ward's (2002) dynamic model describes four stages: (1) conception; (2) development of the idea; (3) realization of the work and development of the idea; (4) finishing the work. This model of the creative process observed in artists shows subprocesses between the different stages (Botella et al. 2022). In the field of design, the design process has many similarities with the creative process (Bonnardel et al. 2018). Regarding the difference between creativity and design, we find the expression of an idea, a process, or the realization of a production with a view to achieving certain goals, which corresponds to adaptation to the situation or context. Design, on the other hand, mobilizes representation (Bonnardel 2012). Howard et al. (2008) propose a modeling of the design process in eight stages: (1) formulation; (2) synthesis; (3) analysis; (4) evaluation; (5) function of expected behavior; (6) documentation; (7) behavior; and (8) function. This highlights the dynamic and distinctive nature of the creative process in design. In the field of crafts, a case study conducted by Botella et al. (2023) with a sculptor proposes a modeling of the creative process in three stages: (1) conception or design; (2) realization or making the work; (3) post-production (the work of the artisan). While these studies focus primarily on professional creative practices, it is also important to examine how students engage with the creative process, particularly within school subjects centered on artistic and material practices. In the context of the present study, craft design education refers to a school discipline that combines the expression of ideas, sensory perception, manual techniques and cultural aspects. In French-speaking Switzerland, this subject has increasingly focused in recent years on the design and production of tangible objects using materials such as wood, metal, clay or cardboard. The introduction of the creative process through design activities within the curriculum (CIIP 2010) aims to support the development of pupils' creative abilities throughout compulsory schooling, from ages 4–15.

Unlike engineering-oriented design education, which generally emphasizes systematic problem solving and technical optimization, craft design education places greater emphasis on esthetic exploration, personal expression, and the experiential relationship with materials. In this context, creativity emerges through the interaction between ideas, gestures, tools, and materials during the making process (Didier et al. 2022). This perspective aligns with research on creativity in artistic and material practices, where the creative process is understood as a dynamic interaction between cognitive processes, embodied actions, and the constraints or affordances of materials (Bonnardel 2012; Botella et al. 2022; Glăveanu et al. 2013).

1.1.2 | The Pupil's Creative Process in School Context

In the school context, several models describe how pupils solve creative tasks. A frequently cited framework is that of Anderson et al. (2001), who argue that the creative process of pupils is frequently divided into three stages, namely: (1) problem representation, where the pupil understands the task and generates a range of solutions; (2) solution planning, which involves checking these solutions, planning the steps and choosing implementation strategies; (3) realization, which corresponds to the implementation of the measures outlined in the plan. This breakdown corresponds to the general phases of problem solving, which include planning, translating ideas into words or actions, and reviewing the product with a view to correcting it. However, in both adults and children, several cognitive pathways are possible.

Empirical studies on the creative process of pupils illustrate the diversity of possible trajectories. The study conducted by Vass (2007) with 24 pupils aged 7 to 9 in England as part of a collaborative creative writing activity in class reveals a model of the creative process with the following stages: Content generation—Reflection—Planning—Revision (proofreading, reflection, evaluation, modification)—Transcription. Chu et al. (2011) conducted a study of 10 pupils aged 8 to 10 in the state of Virginia. These 10 pupils were divided into two groups working on two separate projects: creating a storybook using digital tools and creating digital animations. The creative process observed during the development of the storybook revealed four main stages: generating ideas, entering them into the storybook, working on the esthetics, and linguistic correction. For the pupils involved in the animation project, their creative process involved the following stages: generating ideas, previewing the story, evaluating the story, correcting, and adjusting. These two studies show that, regardless of the task, pupils begin a phase of generalizing ideas and frequently return to their work to correct and improve it. Finally, the planning and revision phases remain central to the development of the products studied. In the present study, Wallas' model is used as a heuristic framework rather than as a rigid or strictly linear sequence. It allows us to examine, as do the studies presented in this section, how pupils' cognitive activities unfold and interact during creative tasks in a school context, while taking into account the dynamic and iterative nature highlighted by more recent models.

1.1.3 | Teaching the Creative Process Through Creative Teaching

While creativity learning refers to the processes through which pupils develop their creative abilities (Lin 2011; Patston et al. 2017), creative teaching refers to the pedagogical strategies used by teachers to support and stimulate this development in educational contexts (Lin 2011; Selkrig and Keamy 2017). To foster the learning of the creative process in the classroom, creative teaching needs to be used. Creative teaching is characterized by teaching that prioritizes strategies that engage the learner in learning creatively, taking into account learning strategies related to the learner's age, learning context, and individuality (Jeffrey and Craft 2004; Pazin et al. 2022). This approach encourages attitudes such as curiosity, mental flexibility, risk-taking, resilience, and collaboration, and supports the emergence of original and adapted productions (Pollard et al. 2018; Selkrig and Keamy 2017). Creative teaching is a pedagogical approach that aims to develop learners' creativity and encourage them to explore new ideas and new ways of solving problems. To encourage creative teaching, teachers can use strategies such as problem-solving, interdisciplinary projects, group discussions, critical thinking, exploration, and experimentation activities, as well as creative assessment methods (Lin 2011; Pollard et al. 2018). They can also encourage pupils to explore different artistic and cultural fields, develop their esthetic sensibilities, as well as collaborate with external partners and the community.

Learning the creative process means learning to develop the mechanisms of divergent thinking when searching for ideas, but also those of convergent thinking when selecting and implementing ideas (Jeffrey and Craft 2004; Lubart et al. 2015; Sawyer 2022). Learning the creative process in a training context involves the use of higher cognitive faculties (Anderson et al. 2001; Ma and Van Oystaeyen 2016). This taxonomy of cognitive processes proposed by Anderson et al. (2001) positions the act of creating as the highest learning strategy and informs us about the learning process and the higher cognitive processes involved. The act of creating is at the top of the cognitive hierarchy, above the levels of “remembering”, “understanding”, “applying”, “analyzing”, and “evaluating” (Anderson et al. 2001). Creating refers to solving, planning, and realizing (Anderson et al. 2001). In the field of creativity studies, some of the earliest researchers linked individual learning to the role that creativity plays in this process (Guilford 1967). For Runco (2007), learning requires personal understanding that is intrinsically linked to the transformation of knowledge by the individual, which therefore implies a creative act. According to Beghetto (2016), learning is a creative act. He clarifies the relationship between creativity in learning through the development of meaningful personal interpretation and understanding and learning in creativity by highlighting the role of sharing with others to enhance the collective creative experience (Beghetto 2016). In the relationship between creativity and learning, Valgeirsdottir and Onarheim (2017) mention the concept of creative awareness, which is limited to acts related to creativity and does not extend to other distinct cognitive processes. Creative awareness materializes when individuals are conscious of the different stages of their creative process, as well as the underlying cognitive processes that might influence their creative abilities (Valgeirsdottir and Onarheim 2017). For Anderson et al. (2020), creative learning is an integrated cycle of intrapsychological processes (personal, internal, embodied, cognitive, and expressed) and interpsychological processes (the environment's response to challenge or validate).

1.1.4 | The Creative Process in the French-Speaking Swiss Curriculum

The curricula focus on the development, education, or enhancement of creativity (Besançon and Lubart 2015), in our case, the teaching of the creative process (Lubart 2017). It includes the type of pedagogy but also the training programs or activities to foster creativity (Lubart and Thornhill-Miller 2019). In the French-speaking Swiss curriculum, the introduction of the creative process and design activities in the discipline of craft design attached to the field of the arts (CIIP 2010) gives a prominent place to the coupling of creativity and design in cycle 1 (pupils aged 4–8), cycle 2 (8–12 years), and cycle 3 (12–15 years) (CIIP 2010). As far as the general objectives of Arts training are concerned, the creative process is positioned as a major and priority learning (CIIP 2010). The mechanisms of motivation, research, choice, and action specify the different learning outcomes targeted in the development of the pupil (CIIP 2010). The various areas of knowledge formalized within the framework of the Craft Design curriculum (CIIP 2010) are structured into four axes that advocate the artistic training of the pupil in terms of design, perception, technique, and culture (CIIP 2010). The artistic representation and expression axis (CIIP 2010) aims to develop the pupil's creative process over the three cycles of compulsory schooling (cycles 1–2–3) (Arts Training, CIIP 2010).

The design activity taught in Cycle 2 (ages 8–12) aims to produce a personal project by discovering and then investing in the stages of the creative process (A21 AC&M, CIIP 2010). The design process and the creative process go hand in hand; these processes require the search for ideas and their implementation in order to solve a complex task (Bonnardel 2012).

According to the French-speaking Swiss curriculum (CIIP 2010), to develop learners' creative thinking through teaching, priority should be given to learning strategies adapted to the age of the learner, the context, and the individual himself (Valgeirsdottir and Onarheim 2017). The pedagogical aspects of developing pupils' creativity include learning strategies geared to the learner's autonomy, leading them to set production and learning goals (Runco 2023). Learning to assess one's own performance when carrying out a personal project fosters and encourages the learner's creative identity (Craft et al. 2001; Besançon and Lubart 2015). Furthermore, in order to develop pupils' educational progression, teaching must encourage the recognition of creative ideas, thoughts, and products, which refer directly to the creative process (Lucas 2001; Selkrig and Keamy 2017).

1.1.5 | The Creative Process Report Diary

In order to observe the pupils' creative process by identifying the stages that go into creating an object, the transitions between these stages and the multivariate factors involved in these stages, we used the Creative Process Report Diary (Botella et al. 2022; Didier et al. 2022). Which is an activity-centered ergonomic approach (Daniellou and Rabardel 2005). Consistent with this approach, we consider that activity cannot be understood solely on the basis of observation by a third-party analyst (Botella et al. 2022). The CPRD provides access to important information about the individual path followed by the creative process (Botella et al. 2017). This research tool offers a way of capturing the activities performed (easy for participants to respond to), and these activities reveal unconscious processes (Didier et al. 2022) (see Figure 1).

The CPRD is adapted from previous studies with adults (Botella et al. 2017). The introduction of images intended for children facilitates ecological use in the classroom (Botella et al. 2019). In this CPRD, 20 stages of the creative process are considered and reformulated in sentence form to allow students to understand these different factors: definition of the problem (I defined the problem), reflection (I asked questions), documentation (I documented), consideration of constraints (I took constraints into account), insight (I found an idea), associative thinking (I associated several things), divergent thinking (I did experiments and tests), inspiration (I developed my idea progressively), ideation (I explored new ideas), precision (I redefined an idea); convergent thinking (I selected an idea or

FIGURE 1 | Creative process report diary: Vignettes representing the multivariate factors of creativity (Didier et al. 2022).

documents), technique (I chose a technique or material), verification (I checked if my work was finished), hazard (I took hazard and risk into account), judgment (I evaluated my idea), organization (I organized my idea), realization (I realized my idea), finalization (I finished and explained my work), breaks (I took a break), and abandonment (I abandoned all or part of my idea); as well as 20 multivariate factors: perseverance, structure, patience, perfectionism, motivation, audacity, optimism, autonomy, intuition, knowledge, ask for help, communication with others, teamwork, fear, satisfaction, doubts, frustration, surprise, sadness, and anger (Botella et al. 2019, 6). The CPRD allows students to understand, both during and after the activity through self-assessment, the different stages of the creative process explored during the activity. This journal also helps students understand and become aware of cognitive factors (structuring, intuition, knowledge), emotional factors (surprise, anger, sadness, frustration, fear, pleasure, doubts), conative factors (perseverance, patience, perfectionism, motivation, audacity, optimism, autonomy), as well as environmental factors (communicating ideas, working in teams, asking for help). Initially designed for adults, this tool has been adapted for use in schools with children through the inclusion of illustrative vignettes and accessible language (Botella et al. 2017). The vignettes are tailored to pupils, neutral, and inclusive to respect the cultural and gender diversity of participants (see Figure 1).

1.2 | Issues

Research on children's creative potential often focuses on isolated measures of creative abilities dimensions such as divergent and convergent thinking (Besançon and Lubart 2015; Massy et al. 2025). This type of method does not allow for tracking the dynamics of activities (Botella et al. 2022). One reason for this decontextualized approach lies in the complexity of observing pupils' actual activity (Kupers et al. 2019). However, self-reporting tools such as the Creative Process Report Diary (CPRD) provide direct insights into the micro-processes students engage in during their creative process. Thus, through its ecological approach, this tool offers new perspectives for studying, in a school setting, the structure of pupils' creative process, the transitions between cognitive activities and the factors that influence them. One hundred years after Wallas' model (1926), this study aims to identify the similarities and differences among its components by analyzing the creative micro-process of students aged 10 to 12 engaged in two design projects (stop-motion and box making). More specifically, our research questions are as follows:

1. What cognitive activities do students engage in during two distinct projects, one focused on developing creative abilities and the other on technique?
2. How do these cognitive activities follow each other? In other words, what are the most frequent transitions between the stages of the creative process identified in the students, and how do these sequences reflect (or not) the structure proposed by Wallas?

1.2.1 | Research Hypotheses

H1. *Pupils' cognitive activities involve passing through different stages of the creative process modeled by Wallas* (Botella and Lubart 2019; Didier et al. 2022). *We therefore hypothesize that there is some correspondence with the stages of Wallas' model, while supporting the contemporary view that the sequence of these stages is not linear* (Bonnardel et al. 2023; Botella and Lubart 2019; Didier et al. 2022).

H2. *Given the non-linearity of the stages of pupils' creative process* (Bonnardel et al. 2023; Lubart et al. 2015), *our second hypothesis assumes a set of similar transitional structures in both projects (e.g., from problem definition to reflection; associative thinking to divergent thinking), despite their distinct pedagogical nature* (Chu et al. 2011; Vass 2007).

H3. *The mobilization of the creative micro-process identified in a creative task can also be mobilized in tasks that require a lower degree of taxonomic complexity. Thus, during a repetitive task focused on acquiring technical skills, the cognitive activity will be like a creative activity, but the intensity of the activities will differ* (Didier et al. 2022; Vuille et al. 2022).

2 | Method

2.1 | Participants and Context

The study was conducted with forty-one pupils aged 10 to 12 (M = 11.51 years; SD = 0.50; 41% girls and 59% boys) in a school in French-speaking Switzerland. The participants came from two seventh-year classes in compulsory education (out of 11 years). The four half-classes were divided into two groups of twenty and asked to complete two distinct complex tasks. Study participants were informed of the study's objectives and participated on a voluntary basis in accordance with the ethical requirements in effect in the country where the research was conducted.

2.2 | Implementation Context

In French-speaking Switzerland, the teaching of craft design is a compulsory subject up to the end of secondary school. Pupils, divided into groups of around 11, take part in a semester of craft design each year, at a rate of 1 h30 per week. Classes take place in workshops but also in a traditional classroom and aim to develop craft skills, perceptive learning, cultural knowledge, and creative learning through the creation of concrete objects or collective projects. A variety of materials are used (wood, metal, natural elements, plastic, cardboard, clay, etc.), and craft design generally encourages the acquisition of technical gestures and creative skills, as well as the reinvestment of knowledge from other disciplines.

2.3 | Device

This study was conducted during a subject-specific class held in a specialized room (technical workshop), under the supervision of a teacher trained to teach this subject. For the purposes of this study, the pupils were divided into two groups participating in two separate projects: (1) making a school box; (2) creating a stop-motion film. Each project, which we describe below, was structured in successive stages aimed at developing craft or creative skills.

2.3.1 | "Box" Project

The aim of this project was to make a small wooden box for storing pencils or pens. This sequence of activities took place over 6 weeks of teaching (see Figure 2).

2.3.2 | Stop-Motion Project

The second group engaged in the creation and production of a stop-motion short film. This learning sequence is structured into various iterative phases of design and production (see Figure 3).

2.3.3 | Common Ground Between the Two Projects

From a methodological perspective, it is important to revisit the commonalities between the two projects described above

Sequence phase	Summary of contents	Periods devoted to the sequence
Introduction and preparation	Presentation of the project, reminder of workshop safety rules, analysis of existing boxes and reading of the project file to understand the constraints, production and learning objectives.	2 periods
Technical manufacturing	Demonstration and use of tools (Hegner saw, sander, drill) to cut, assemble and sand pieces; exploration of engraving and finishing techniques (laser, dyeing, varnishing).	6 periods
Finishing	Preparation and experimentation of natural dyes, adjustment of grooves and holes, gluing, then aesthetic finishing of the box.	3 periods
Formative assessment	Self-assessment and teacher assessment of the quality of the object and technical choices.	1 period

FIGURE 2 | Structure of the teaching sequence developing technical skills. This program lasts 6 weeks, consisting of two consecutive 45-min periods per week. This project allowed pupils to strengthen their technical skills and knowledge.

Sequence phase	Summary of contents	Periods devoted to the sequence
Emergence and formation phase	Presentation of the project by the teacher, viewing of extracts (e.g., Wallace & Gromit) to immerse oneself in the genre, creation of working groups and definition of the rules of collaboration.	1 period
Idea generation and selection	Individual and group brainstorming sessions to find several possible scenarios, followed by convergent discussion to choose and formulate the chosen ideas; Documentary research (libraries).	2 periods
Development of the scenario and storyboard	Writing the common thread (narrative structure), building the storyboard then finalizing and validating it.	2 periods
Technical production	Introduction to digital equipment (iPad, stop-motion software), creation of sets and characters, filming using successive shots and sound editing (voice, sound effects, music).	5 periods
Finalization and presentation	Revision and final editing of the film, then screening in class and discussion on the project.	2 periods

FIGURE 3 | Structure of the teaching sequence developing creative abilities. This structure lasts 6 weeks in total, consisting of two consecutive 45-min periods per week.

(see Sections 2.3.1 and 2.3.2). As shown in the Figure 2 and the Figure 3, the "box" project, is structured in four stages: (1) introduction and preparation; (2) technical manufacturing; (3) finishing; (4) formative assessment, while the stop-motion project consists of five stages: (1) emergence and formation phase; (2) idea generation and selection; (3) development of the scenario and storyboard; (4) technical production; (5) finalization and presentation.

This comparison of the two projects reveals a similarity in the analysis of the situation (technical or design-related) and the pupils' consideration of constraints (Stage 1). A stage of concretizing ideas or choices, which consists of exploring and selecting techniques suited to the technical functions and uses of the artifacts to be designed and created (Stages 2 and 3). And finally, a socialization phase, reflected by a self-assessment phase in the "box" project, and a presentation and validation of the stop-motion project by the other pupils (Stage 4). Thus, although the two projects differ in their pedagogical objectives, the assessment of student activity and their interactions is not intended to evaluate the effectiveness of the teaching-learning situations themselves, but rather focuses on the dynamics of cognitive activities generated by these projects. Thus, the two projects offer contrasting contexts that allow us to examine how the sequences and transitions of creative activities can vary depending on the nature of the tasks.

2.4 | Procedure

Data were collected from the 41 participants throughout the six lessons for two separate projects, Stop Motion (21 pupils) and Box Project (20 pupils). Before each project, the teacher introduced the CPRD to the pupils and explained the meaning of each vignette. At the end of each lesson, the pupils individually filled out the CPRD by checking the icons corresponding to the activities and factors they had experienced. The data collected via the CPRD are therefore both temporal and self-confronted, offering a detailed understanding of the pupils' creative journey in real educational contexts.

The data were processed using RStudio software. Each response was encoded as a binary variable (1 for "checked", 0 for "not checked"). The collected data were converted into a long format to follow the order of the CPRD items. First, the analysis employed descriptive statistics to characterize the frequencies and patterns of cognitive activities within the studied cohort. Specifically, the proportion of pupils reporting each activity was calculated per lesson to visualize temporal trends. Second, the study of transition dynamics was measured by reconstructing activity sequences and the number of transitions between successive items. These transitions were visualized using weighted pie charts. To highlight the major processes, these were filtered according to a minimum threshold. Finally, the ten most frequent transitions were identified and analyzed comparatively between the two projects.

3 | Results

The data collected by the CPRD corresponds to the cognitive activities chosen and the multivariate factors reported by pupils during each lesson. In order to facilitate the descriptive analysis of the sequences of activities reported by pupils, these responses were treated as binary variables. The numerical representations presented in the results therefore correspond to descriptive indicators of the frequencies observed within the sample. It aims to better describe activity patterns during the different lessons of the project rather than to provide inferential or probabilistic conclusions about a larger population.

3.1 | Descriptive Statistics

The descriptive analysis of responses to the CPRD vignettes across all lessons reveals several general trends. The averages per lesson (Figure 4) show that, for both projects, a majority of pupils report beginning by defining the problem and reflection, then indicate engaging in more divergent thinking (associative thinking, documentation) in the middle of the project. Selection and verification activities are reported more frequently at the end of the sequence, which is consistent with Wallas's convergent phases.

With regard to the cognitive activities observed in both projects, we note variability in student responses. However, certain vignettes, such as documentation and abandonment, were identified less frequently by the pupils. The vignettes related to definition, consideration of constraints, definition of the problem, selection, implementation, insight, reflection, and verification were selected by half of the pupils over the six lessons. The vignette related to divergent thinking was also selected by the majority of pupils over the six lessons.

As part of the box project (see Figure 2), which is structured in four stages: (1) introduction and preparation; (2) technical manufacturing; (3) finishing; and (4) formative assessment, half of the pupils noted that they had ticked high cognitive activities such as definition, consideration of constraints, definition of the problem, divergent thinking, selection, implementation, and insight. We note the same observation in the stop-motion project structure into dive stages (see Figure 3): emergence and formation phase, idea generation and selection, development of the scenario and storyboard, technical production, finalization and presentation. The verification vignette shows an increase in Lesson 1 during the stage of introduction and preparation (box project) and the stage of the emergence and formation phase (stop motion project). This increase is also visible in Lesson 6 during the formative assessment for the box project and the finalization and presentation for the stop-motion project. Several cognitive activities, such as divergent thinking, implementation, insight, reflection, and verification, are consistently demonstrated by the majority of pupils throughout the six lessons. This reveals that these common cognitive activities are engaged in both projects, regardless of the differences in project stages.

According to Figure 5, regarding the multivariate factors present in the CPRD, the proportions per lesson indicates a consistently high report of pleasure throughout the projects; an increase in the reporting of perfectionism; and a notable decrease in reports of working in a team and communications of ideas compared to the first lesson. Furthermore, emotions such as fear, anger, or sadness were rarely selected.

Across the six lessons, a consistent core of multivariate factors was mobilized by approximately half of the cohort. These include cognitive resources (prior knowledge), conative traits (patience, perseverance, autonomy, motivation, perfectionism), and relational or emotional regulators (asking for help, doubt).

Overall, these descriptive findings suggest that pupils' creative activity fluctuates throughout the project, shifting from a higher level of engagement during the initial stages of problem definition and reflection to the later stages of selection, implementation, and verification, which correspond to the general phases described in Wallas' model of the creative process.

3.2 | Cognitive Activities and Multivariate Factors Within Two Projects

This section contrasts the cognitive and emotional dynamics of the two projects to determine how task nature (creative vs. technical) influences the creative process.

3.2.1 | Cognitive Activities

The separate analysis by the project reveals unique features and specificities. In the stop-motion project, the vignettes related to the idea generation (definition, reflection, consideration of constraints, ideation) and the gradual formation of the concept (precision, ideation) were reported by a higher proportion of pupils compared to the box project. This pattern suggests a more sustained mobilization of creative abilities (Figure 6).

In the stop-motion project, the vignettes related to associative thinking, divergent thinking, and verification were selected

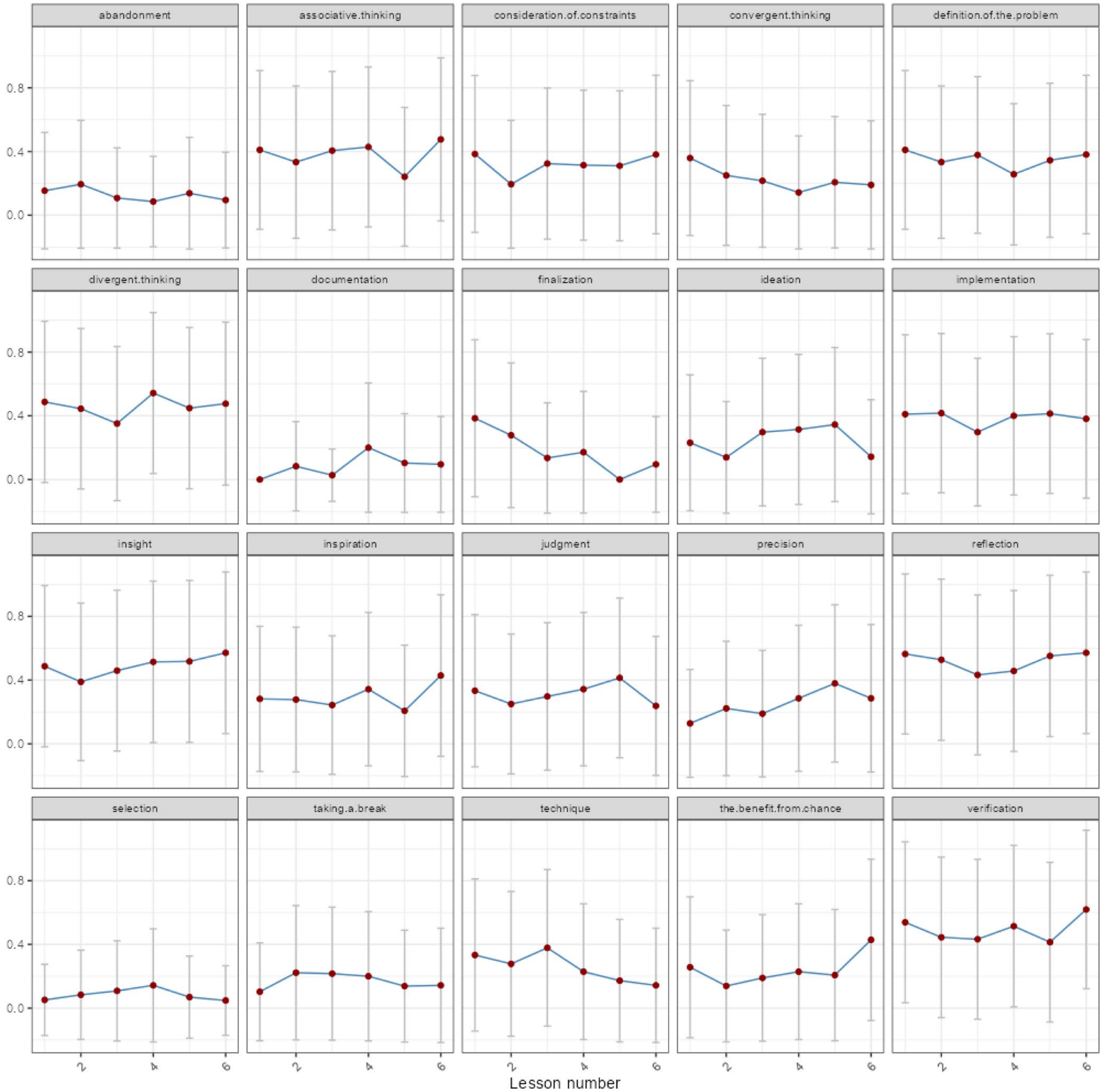

FIGURE 4 | Cognitive activities: Proportions of pupils reporting each activity per lesson, across both projects combined. The y-axis represents the proportion of pupils (ranging from 0 to 1) who reported each cognitive activity during a given lesson. The x-axis indicates the lesson number (1–6). The vertical gray bars represent the standard deviation of these proportions across the two project groups.

by more pupils than those in the box project. Furthermore, in the stop-motion project, during the first lesson, 75% of pupils reported: consideration of constraints, insight, associative thinking, divergent thinking, verification, and finalization. A comparison between the two projects' reports of technique, documentation, and taking a break appears similar across the six lessons.

Conversely, pupils in the box project similarly marked the vignettes related to concrete actions such as reflection, technique, taking a break, or verification. This distribution reflects the importance of certain technical aspects connected to the creative activity.

Several notable differences between the projects can be seen in Figure 6. The "definition of the problem" vignette was checked by more than 50% of the pupils in lessons 1, 2, 3, and 5 for the stop-motion project. However, this vignette was only checked by 25% of the pupils in lessons 1–3 for the box project. The "reflection," "consideration of constraints," "insight," "associative thinking," "divergent thinking," and "verification" vignettes also show noticeable differences between the two projects. The consideration of constraints vignette was checked by more than 50% of the pupils in lessons 1, 3, 4, and 5 for the stop-motion project. However, for the box project, this vignette was rarely checked by the pupils. The insight vignette was selected by more than 50% of the pupils throughout the stop-motion project over

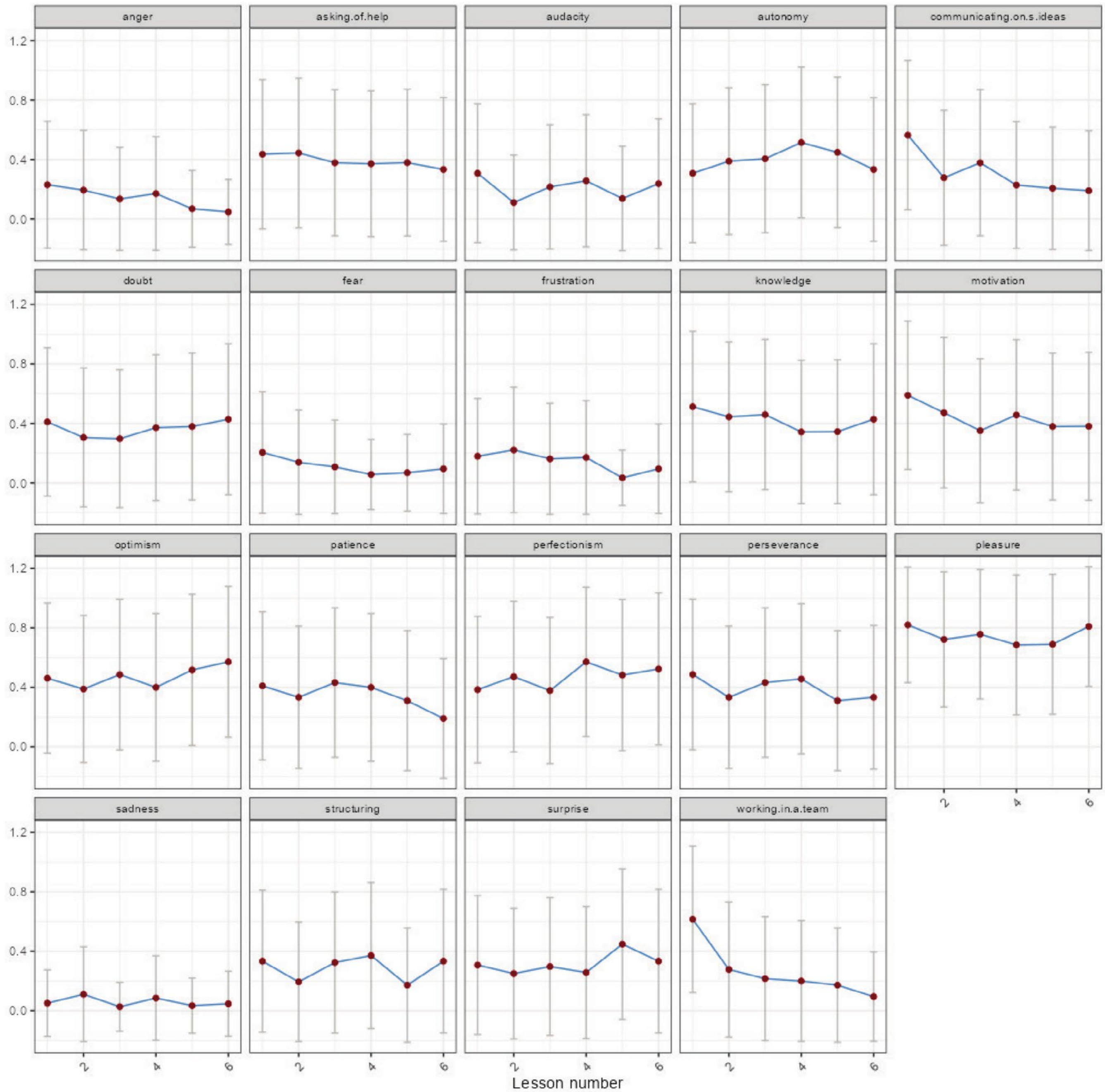

FIGURE 5 | Multivariate factors: Proportions of pupils reporting each factor per lesson, across both projects combined. The y-axis represents the proportion of pupils who indicated experiencingeach multivariate factor during each lesson, while the x-axis indicates the lesson number (1–6). The vertical gray bars represent the standard deviation of these proportions across the two project groups.

the six lessons. However, it was only checked by 25% of the pupils in lessons 1, 3, 4, and 5 for the box project. We also observed a trend that reversed depending on the project with regard to the associative thinking vignette. In lesson 1, 75% of pupils selected this vignette for the stop-motion project, while for the box project, this vignette was hardly selected at all (< 25%).

We can also observe several relationships between lesson structure (Figures 2 and 3) and self-reported cognitive activities in relation to the two projects (Figure 6). Lesson 1 of the stop-motion project is devoted to the emergence and formation phase (Figure 3) and was selected by 75% of the pupils for the following cognitive activities: reflection, consideration of constraints, insight, associative thinking, divergent thinking, verification, and finalization. These cognitive activities were therefore used by 75% of the pupils when discovering the project and in the design phase of the artifact to be created.

These patterns indicate that task nature shapes the temporal density of creative engagement. The Stop-Motion project fostered a sustained, explicit creative flow from the outset. Conversely, the Box project followed a more linear, technical trajectory, with lower reported creative activity during production.

FIGURE 6 | Cognitive activities: Evolution of self-reported proportions by project. The y-axis represents the percentage of pupils in each group who reported each cognitive activity during a given lesson. The x-axis indicates the lesson number (1–6). The lines illustrate comparative trends between the two projects. Data are derived from binary CPRD responses.

3.2.2 | Multivariate Factors

Regarding multivariate factors (Figure 7), perseverance, motivation, patience, and structuring show a decline at the end of the project, indicating variable pupil involvement. The vignette related to perfectionism reveals specific characteristics at the beginning and end of the project, remaining stable for half of the pupils involved in the stop-motion project, while we observe a decline at the beginning and end of the lesson in the box project.

Motivation-related factors (audacity, optimism, autonomy) show a slight increase in the middle of the project, particularly for stop-motion. However, the results indicate that negative emotions such as frustration, fear, anger, and doubt remain more frequent during the stop-motion project than during the box project. Finally, surprise and pleasure remained strong throughout both projects, with a reversal for the latter (pleasure) from the third lesson onwards. 75% of the pupils involved in the stop-motion project expressed doubts at the beginning of the project, but we observed a decrease in the other lessons (50% checked this box in Lessons 2–6).

Regarding communicating ideas and working in a team, these vignettes were checked by 75% of pupils in the stop-motion project and by 50% of those in the box project in Lesson 1, then we

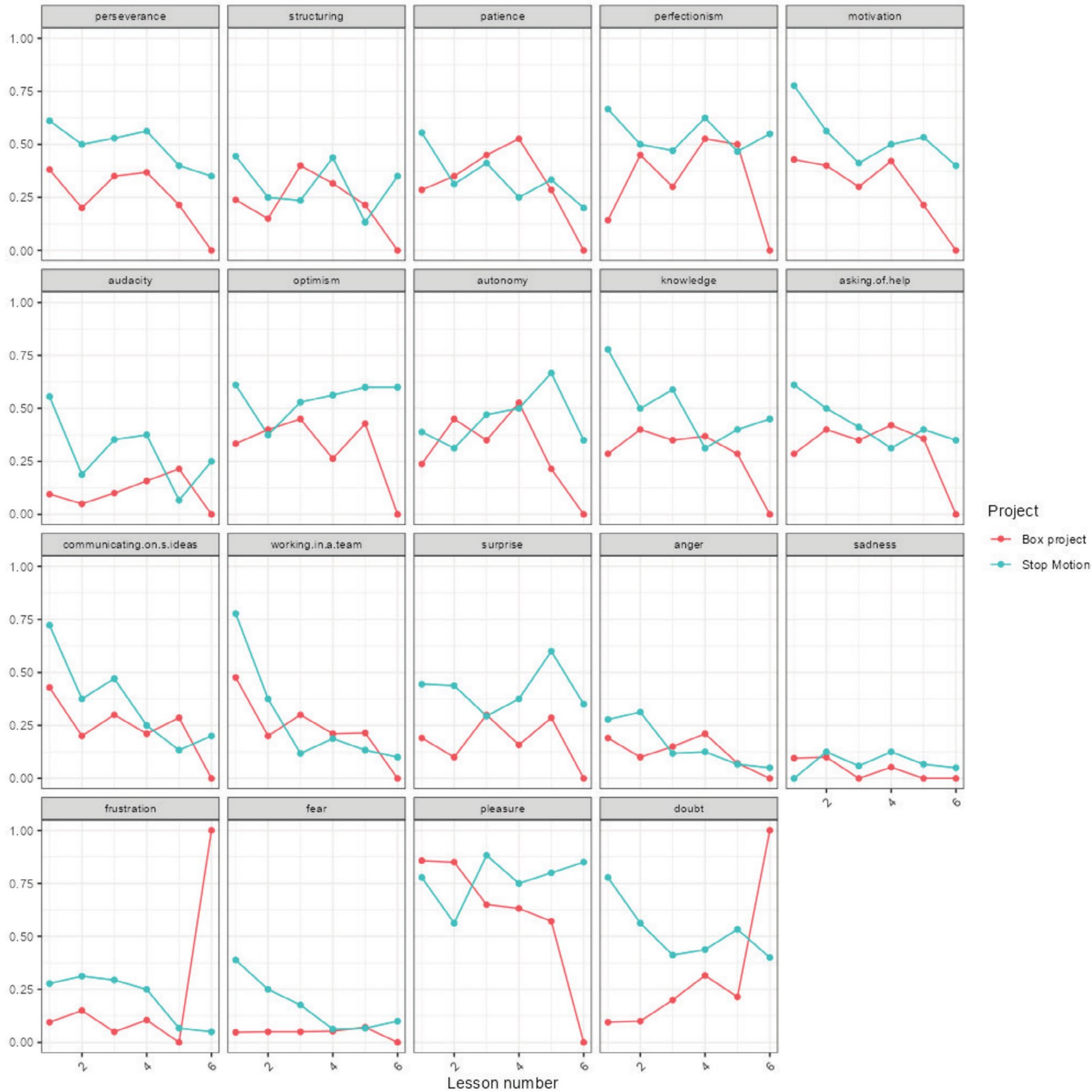

FIGURE 7 | Multivariate factors: Evolution of self-reported proportions by project. The y-axis represents the percentage of pupils who reported each multivariate factor during each lesson. The x-axis indicates the lesson number (1–6). The lines illustrate comparative trends between the two projects. Data are derived from binary CPRD responses.

observed a gradual decrease over the other five lessons. We also note that this first lesson revealed enjoyment and doubts for 75% of pupils for the stop-motion project. We also observe that in connection with this first lesson for this project, more than 50% of pupils selected the following vignettes: perseverance, patience, audacity, and asking for help.

These observations highlight the differences between the types of cognitive activities involved in the two projects.

While the stop motion project seems to stimulate a wider range of activities related to idea generation, the box project places greater emphasis on technical processes and implementation elements. Nevertheless, both projects demonstrate the coexistence of divergent and convergent cognitive movement throughout the stages of the creative process.

3.3 | Analysis of Transitions in Pupils' Cognitive Activity

Figures 8 and 9 illustrate the network of transitions between the cognitive activities reported by the pupils. Each node represents a type of cognitive activity identified in the CPRD, while the arrows represent the transitions observed between successive activities. The thickness of the arrows indicates the frequency of these transitions. These circular graphs therefore allow us to visualize how pupils move from one cognitive activity to another during the creative process.

3.3.1 | Stop-Motion Project

In the stop-motion project, transitions are more frequent (display threshold > 10). The network reveals complex sequences. Indeed, the most frequent transition is from problem definition to reflection (number of reflections). This indicates that pupils regularly return to the initial formulation of the problem to generate new ideas when they encounter one or more creative dead ends (see Figure 8). In view of the results, the following transitions (> 40 times): definition of problem ➔ reflection; consideration of constraints ➔ insight ➔ associative thinking ➔ divergent thinking attest to the frequency of transitions between these cognitive activities at the beginning of the project. These denser transitions reflect the stages proposed by Wallas (1926): preparation, incubation, illumination. The transitions observed between consideration of constraints, insight, and associative thinking, divergent thinking, inspiration, ideation, finalization involve moving back and forth between exploring and selecting ideas. Based on these loops, several transitions lead to concrete actions such as technique—verification—the benefit of chance, finalizing the work, and checking that it is complete. The following transitions (Figure 8) (> 20) technique—verification—the benefit from chance—judgment—convergent thinking—implementation—finalization refer to transitions that are less frequent than those observed at the start of the project (> 40). These transitions refer to the verification stage of the model proposed by Wallas (1926).

We also observe transitions leading to states of abandonment or perseverance, demonstrating the influence of the emotional and

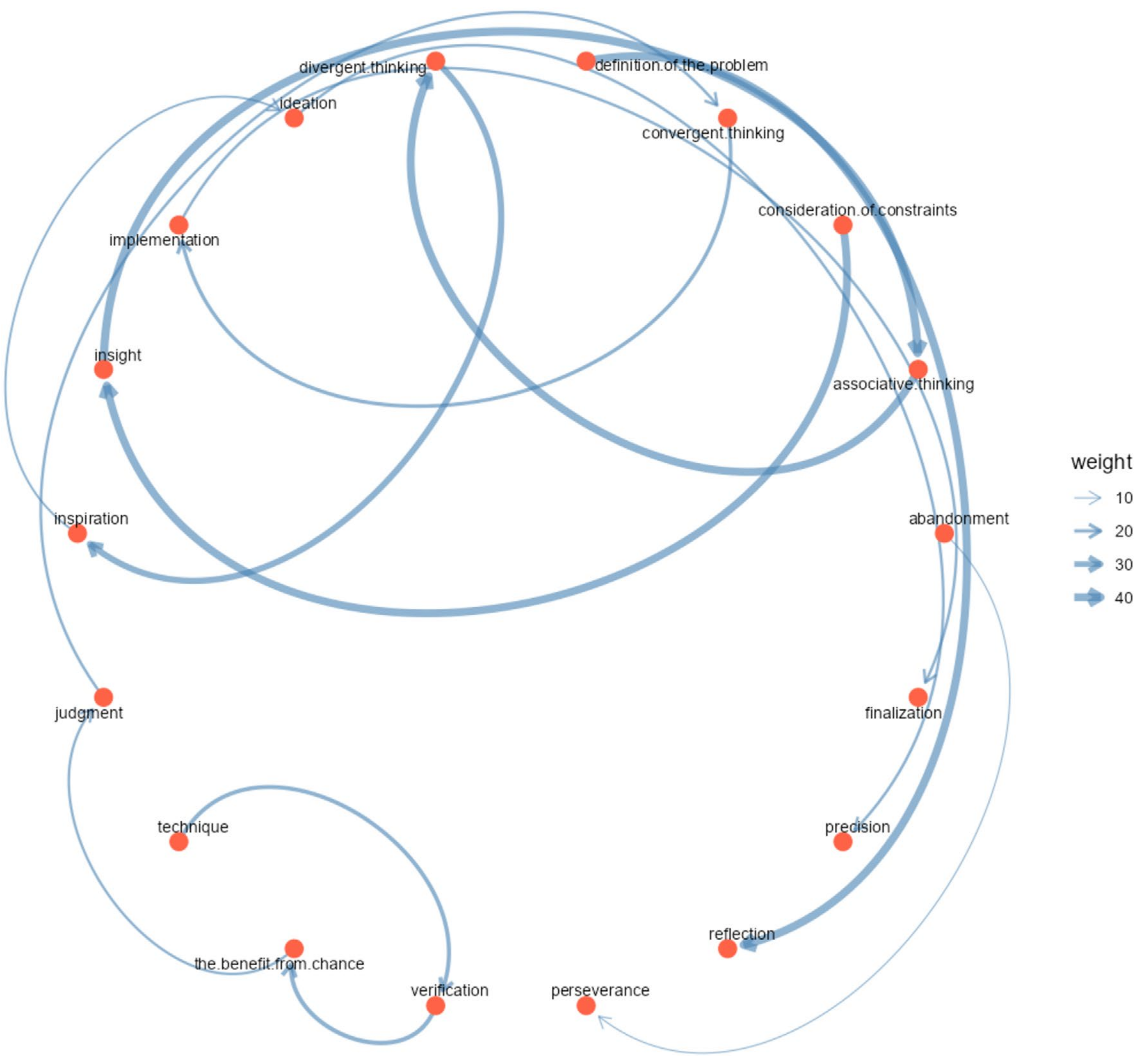

FIGURE 8 | Visualization of transition frequencies between cognitive activities during the stop-motion project. Each node represents a specific cognitive activity reported in the CPRD. Arrows indicate the direction of transitions between successive activities (from one lesson phase to the next). The thickness of the arrows is proportional to the frequency of that specific transition within the group (display threshold > 10).

motivational dimension of the project. This also allows us to observe the relationships between cognitive and emotional factors mobilized within a creative process.

3.3.2 | The Box Project

For the box project (Figure 9), we identify major transitions (> 15) between the stages of problem definition-reflection; insight-associative thinking-divergent thinking. Other transitions are observed (> 12) between the stages of divergent thinking-inspiration. These transitions continue (> 10) with these stages: inspiration ➔ ideation ➔ precision.

A second series of transitions (> 15) highlights the transitions between stages: technique—verification. This is followed by a series of transitions (> 10) between the stages of verification ➔ chance ➔ judgment. Following these transitions, we see a sequence between the stages (> 7) judgment ➔ convergent thinking ➔ implementation. Then a transition between the implementation and finalization stages (> 7.5); which continues with the finalization and taking a break (> 5).

3.3.3 | Comparison of Transitions Between the Two Projects

A comparison of the visualizations (Figures 8 and 9) highlights several differences. On the one hand, the transitions in the stop-motion project are more numerous and varied (often 10 to 40 times) than those in the box project (maximum of 15 times). For the stop-motion project (Figure 8), the density of the network reflects the complexity of the task (writing the script, creating the sets, filming and editing) and the need to coordinate several sub-processes. Regarding the similarities between the two projects, we note several identical transitions, namely: the problem definition and reflection stages; the associative thinking and divergent thinking stages. As for stages of verification, chance, and judgment, these appear to be similar and common, regardless of the specific nature of the projects. We also note the same transitions in the two projects (Figures 8 and 9): consideration of constraints ➔ insight ➔ associative thinking ➔ divergent thinking ➔ inspiration ➔ ideation ➔ precision.

The analysis of transitions confirms the dynamic and iterative nature of pupils' creative activity. Rather than following a strictly

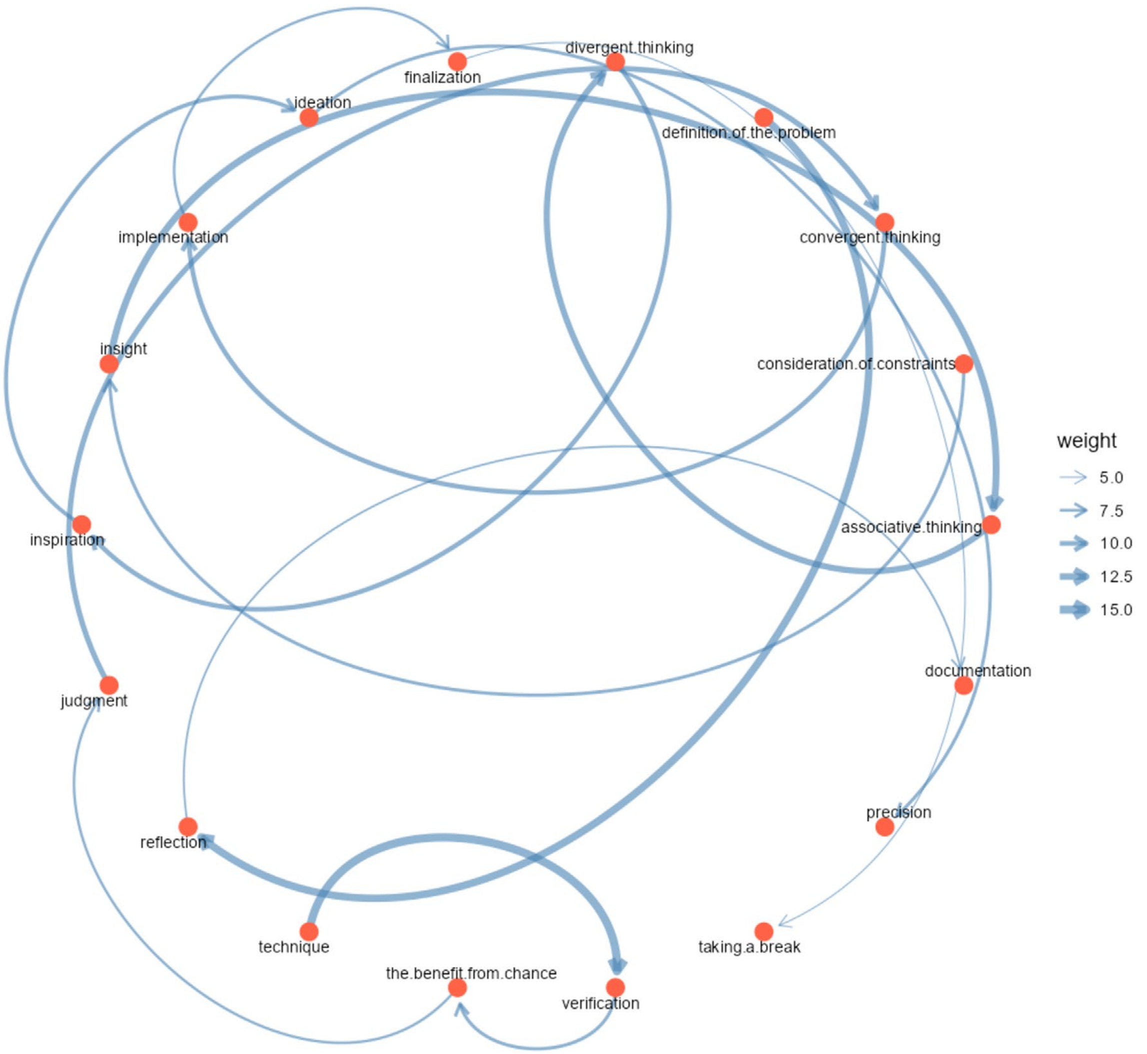

FIGURE 9 | Visualization of transition frequencies between cognitive activities during the box project. Each node represents a specific cognitive activity reported in the CPRD. Arrows indicate the direction of transitions between successive activities (from one lesson phase to the next). The thickness of the arrows is proportional to the frequency of that specific transition within the group (display threshold > 5).

linear sequence, pupils repeatedly move from one cognitive activity to another. This highlights, on the one hand, the flexible organization of the creative process described in contemporary models of creativity, and on the other hand, the presence of similar stages in children's creative processes compared with models initially developed from studies of adult creativity, such as the model proposed by Wallas. At the micro-process level, the most frequent transitions can be interpreted in relation to the macro-stages of Wallas' model: transitions such as problem definition ➔ reflection correspond to preparation and incubation, sequences involving insight, associative thinking, and divergent thinking correspond to illumination, and transitions linking technique, verification, judgment, implementation, and finalization correspond to verification. This articulation strengthens the continuity between observed activity sequences and the broader stages of the creative process.

4 | Discussion

Our first hypothesis assumed that there was a correlation between the pupils' cognitive activities and the different stages of the creative process proposed by Wallas (1926). The results show that, despite the divergent nature of the two projects, the pupils engaged in cognitive activities corresponding to the stages of preparation, generation, illumination, and verification (Wallas 1926). In both projects, the problem definition and reflection activities were carried out at the beginning of the process, which correspond to the preparation and incubation stages proposed by Wallas (1926).

As the projects progress, we observe a sequence of cognitive activities corresponding to Wallas's (1926) illumination stage. For the stop-motion project, we observe a sequence between the consideration of constraints, insight, and then the gradual formation of ideas (associative thinking, divergent thinking, inspiration, ideation). In both projects, we see a sequence between the consideration of constraints and insight, followed by associative thinking, divergent thinking, inspiration, ideation, and precision. Thus, in both projects, the consideration of constraints directly feeds into the insight phase (Wallas 1926), highlighting the structuring role of constraints in the creative process in schools. During the design activity, constraints contribute to the definition and redefinition of the problem, the development and evaluation of solutions, and the determination and evaluation of actions (Bonnardel 2012).

Within the projects, we observe similar sequences in terms of idea generation, involving the cognitive activities of progressive formation, exploration, and refinement of ideas. With regard to the verification stage (Wallas 1926), two similar paths are observed. Indeed, for both projects, this stage involves multiple complementary cognitive activities.

Regarding the non-linear nature of these stages of the creative process, we can also identify several similarities with more contemporary approaches. Indeed, the creative process observed among artists (Mace and Ward 2002) is structured into macro-stages: conception, idea development, and then the creation of the work, which leads to the development of new ideas. For the creative process observed among artisans, this corresponds to the macro-stages of conception, realization, and post-production (Botella et al. 2023). These more contemporary perspectives allow us to better understand the macro-stages of the pupils' creative processes within the two projects. For the stop-motion project, the following transitions: definition of the problem – reflection; consideration of constraints—insight—associative thinking—divergent thinking—inspiration—ideation—precision, correspond to a conception phase (Bonnardel and Lellouche-Gounon 2024; Botella et al. 2023; Mace and Ward 2002). As for the box project, this conception phase would involve the following transitions: definition of the problem—reflection—documentation; consideration of constraints—insight—associative thinking—divergent thinking—inspiration—ideation—precision. With regard to the macro-stage of realization observed in both projects, we note a logic similar to that modeled among artisans (Botella et al. 2023). Furthermore, in both projects, we also observe a non-linearity within this macro-stage of realization. For the stop-motion project, this corresponds to the following transitions: technique—verification—the benefit of chance—judgment—convergent thinking—implementation—finalization. Regarding the box project, we observe an almost identical logic: technique—verification—judgment—convergent thinking—implementation—finalization. Thus, these creative processes observed among pupils reflect common patterns linked to the modes of creative thinking observed in creative professions (Glăveanu et al. 2013).

4.1 | Nature of Projects and Transitions (H2)

Our second hypothesis assumed the existence of similar transitional structures in both projects, despite their divergent nature. Transitions between problem definition and reflection can be observed in both projects, despite their distinct content and pedagogical planning. These transitions refer to the preparation stage followed by the incubation stage (Wallas 1926). The same applies to transitions involving the choice of a technique, verification, chance, judgment, convergent thinking, implementation, and finalization, which appear in both projects.

The density of arrows in the circular graphs illustrates the presence of common transitions, particularly between the stages of problem definition and reflection stages, as well as between associative thinking and divergent thinking. Similar transitions in both projects are also observed, in both projects, particulary between the stages of technique, verification, chance, judgment, convergent thinking, implementation, and finalization. During the design phase, cognitive activities such as problem definition, reflection, divergent thinking, and associative thinking simultaneously contribute to opening up and restricting the space for searching for ideas or sources of inspiration, thus echoing the work of Bonnardel (2012).

In both projects, the transitions between associative thinking and divergent thinking involve reasoning by analogy, encouraging the search for and exploration of ideas that are both new and appropriate to the context (Bonnardel et al. 2023). At the macro level, they also provide information on the implementation and socialization phases of the Design-Realization—Socialization theoretical model (Didier and Bonnardel 2023), which follow the design phase. In both projects, after the object has been designed, the implementation phase allows ideas to be implemented, tested, and confronted with reality.

From the point of view of multivariate factors, the results indicate the presence of similar emotions (pleasure, doubt, anger) in both projects, regardless of the cognitive activities involved.

Thus, our second hypothesis, positing that the creative process of pupils can be broken down into different transitions between cognitive activities similar to those proposed by Wallas (1926), is partially confirmed. Indeed, several common transitions between cognitive activities involve similar micro-processes, regardless of the specificity of the projects, as also observed by Chu et al. (2011) and Vass (2007).

4.2 | The Nature of Projects and the Creative Process (H3)

Our final hypothesis focused on the presence of differences in the participants' creative process during two distinct projects. The results showed differences, with higher transitional density and variety in the stop-motion project. In this project, pupils engage more in problem definition, reflection, associative thinking, and divergent thinking. They also mentioned positive emotional factors, such as perseverance and pleasure, throughout the six lessons. These positive emotions highlight the motivational and affective role of enjoyment in highly creative tasks (Vuille et al. 2022). Furthermore, this project, which focuses on developing creative skills, elicits consistently positive emotions throughout the six lessons. Thus, creative tasks seem to promote motivation and pleasure in a school context (Vuille et al. 2022).

With regard to emotional differences, the box project reveals a predominance of negative emotions at the end of the process. The vignettes related to frustration and doubt were checked by all participants during the sixth lesson, corresponding to the formative assessment stage (Figure 2). Furthermore, this was accompanied by a decline in pleasure and motivation. However, when we consider emotions and cognitive activities within the same project, we find that the majority of pupils selected the "reflection," "associative thinking," and "verification" options. We therefore note that, although this self-assessment activity elicited negative emotions, it also required high-level cognitive activities (associative thinking, verification, reflection) for the majority of pupils who designed and carried out the box project.

In terms of knowledge, two thirds of participants mentioned using knowledge from the outset of the stop-motion project, confirming that creativity relies on mastery of knowledge within one or more fields (Besançon and Lubart 2015; Lubart et al. 2015). At the start of the project, the pupils were faced with an open-ended problem, requiring them to use their imagination, cognitive flexibility, and risk-taking skills to come up with original solutions adapted to the context (Pazin et al. 2022; Pollard et al. 2018). Thus, the stop-motion project, due to its creative nature and complexity, seems to engage more knowledge during the design phase, while the more technical box project appears to engage more procedural knowledge at other points in the sequence.

The findings of this study show that tasks with strong creative components lead to denser cognitive transitions (Didier et al. 2022). In the box project, transitions appear to be less numerous, but they mobilize high cognitive skills, involving the sub-processes of generation, planning, and implementation related to creation (Anderson et al. 2001).

Thus, our third hypothesis is validated, as the nature of the project influences the density and recurrence of the transitions identified, while maintaining a common basic structure. It also highlights the specificities of cognitive, conative, emotional, and environmental factors depending on the nature and purpose of the project, confirming the complexity of the creative process in a school context.

4.3 | Contribution to Research and Teaching Creativity

These results make several contributions to research on creativity in schools. Firstly, they shed light on the micro-processes involved in pupils' cognitive activities (divergence, convergence, association, etc.) when comparing two projects.

Second, in terms of observing creative activities, the results confirm the presence of the dimensions studied in a more technical type of project. Thus, even if the transitions between cognitive activities are less dense during a sequence aimed at developing technical skills, this type of teaching helps to mobilize the higher cognitive skills required for creation (Anderson et al. 2001). This teaching promotes both the mobilization and strengthening of pupils' creative abilities. Finally, from a pedagogical point of view, these results encourage teachers to design teaching and learning sequences that can be structured using the creative process proposed by Wallas (1926). The dynamic aspects of creative micro-processes (Botella et al. 2019; Lubart 2018) also help to better identify transitions in pupils' cognitive activities in relation to the specific nature of the projects. Pupils are led to go back to certain points in their process, depending on the constraints of their ideas, which leads to exploring new ideas and their implementation.

By promoting creative teaching (Besançon and Lubart 2015; Jeffrey and Craft 2004), teachers can encourage pupils to regularly reformulate their problems, explore alternatives after failure, or verbalize their emotions or strategies. This promotes the mobilization of the higher cognitive skills required for complex problem solving (Anderson et al. 2001). Furthermore, this study highlights the stages of problem definition and reflection as elements that promote the triggering of pupils' creative processes. These cognitive activities can be easily mobilized through a design activity in which constraints help to promote the generation of creative ideas that are new and adapted to the context (Bonnardel et al. 2018).

Finally, from an educational perspective, pleasure and perseverance should not be viewed as mere byproducts of creative activity. In this study, they appear to accompany sustained engagement in complex tasks and can support pupils' ability to remain involved in exploration, revision, and implementation over time. In both projects, the dynamics of enjoyment and perseverance come into play. Perseverance appears to be rated higher by pupils in the stop-motion project, which requires more imagination. At the same time, the box project, with its greater technical constraints, shows lower levels of perseverance than the other project, and this is evident from the very start of the project in Lesson 1. In both projects, starting in Lesson 4, we observe a decline in student perseverance. This corresponds to the completion of the artifacts. From an educational perspective, this stage involves pupils confronting the initial project design, the choices made during the manufacturing process, and the final result of the artifact. For pupils, this means grappling with the decisions made during the design and fabrication phases, which amounts to confronting the reality of materials that offer resistance (Boutinet 2020). In terms of pleasure, this aspect is present in more than half of the pupils' work across both projects, reflecting a learning approach that, in this context of idea generation, prioritizes technical exploration, decision-making, and implementation. These pedagogical elements are particularly recognized as essential for fostering pupils' attention, engagement, and perseverance during learning (Gregory and Kaufeldt 2015). Furthermore, in both projects, the perseverance observed is linked to positive emotions, which have already been identified in other educational contexts as essential components of the learning process (Yang et al. 2023).

4.4 | Limitations and Perspectives

In order to qualify the generalization of our results, several limitations must be highlighted. Firstly, the small sample size (41 pupils) does not allow the results to be generalized to other contexts or school levels. Secondly, the CPRD data is based solely on binary self-reports, which may be subject to social desirability bias or omissions. A specific instance of such data loss occurred during the final lesson (Lesson 6) of the 'Box project', where CPRDs were collected for only one pupil ($N=1$) compared to 14 to 21 in previous lessons. This resulted in extreme binary values (0% or 100%) in the descriptive statistics (Figure 6), preventing any representative analysis of the group's cognitive activity at the closure of the technical project. Furthermore, its use at the end of two periods of craft design teaching does not guarantee that the responses obtained accurately reflect the tasks experienced by the pupil. Regarding the limitations of this study, we also note the differences between the two projects, which share common mechanisms (analysis, constraint management, and implementation), but also distinct, even specific activities. The activities of the box project required creativity related to the crafts and design (designing and creating a box). In contrast, the activities in the stop-motion project, used creativity more related to the crafts of set design (designing and creating a short film with a set).

Finally, the graphs produced by the transition analyzes show frequencies but do not reveal the duration of micro-processes or the impact of multivariate factors on them.

In terms of prospects, the disciplinary orientation of the task toward the arts and technical subjects could be extended to projects in science, mathematics, or creative writing. It would be relevant to conduct future studies on the use of CPRD (Botella et al. 2017) in more complex tasks that incorporate sustainability constraints (Stables 2009) or are related to the inclusion of pupils with special needs. This would help to foster the development of a creative civic attitude (Runco 2023; Stables 2008).

5 | Conclusion

This study draws on the theoretical contributions of the multivariate approach (Lubart et al. 2013) to analyze the teaching of the creative process to pupils in compulsory education. The results of this research contribute to a better understanding of the role of cognitive, conative, emotional, and environmental factors used in creative teaching (Jeffrey and Craft 2004; Besançon and Lubart 2015). Through two separate projects (stop-motion film and box making), the research results focus on the dynamics of the creative process in 10- to 12-year-old pupils in relation to the stages of the creative process proposed by Wallas (1926). The use of the Creative Process Report Diary (Botella et al. 2017) provides an overview of the cognitive activities and multivariate factors mobilized by pupils in the context of object creation. Self-reported results show that pupils engage in activities that correspond to the major stages of Wallas's model (1926) (preparation, generation, illumination, verification), but these activities are intertwined in a non-linear manner. At the micro-process level, similar transitions between cognitive activities appear in both projects, regardless of the nature of the task. In fact, the differences observed between the two projects confirm the influence of context and task nature. The stop-motion project generates a denser transition network in terms of cognitive activities, as well as increased mobilization of positive and negative emotions. In the box project, the transitions between cognitive activities appear less dense than in the stop-motion project. However, the high cognitive skills associated with creation (Anderson et al. 2001) are also reported by pupils in the box project, showing that technically oriented tasks can also mobilize important components of the creative process. In fact, these results deconstruct the idea of a single mobilization of creative abilities in problem solving. On the other hand, this case study encourages all teachers to identify activities that are likely to mobilize their pupils' creative abilities in order to develop their creative process.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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