

ERRORS FOR LEARNING



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STUDYING STUDENTS' ERRORS: AN INNOVATIVE PROCESS TO ANALYZE YOUR METHODS AND TEACH BETTER

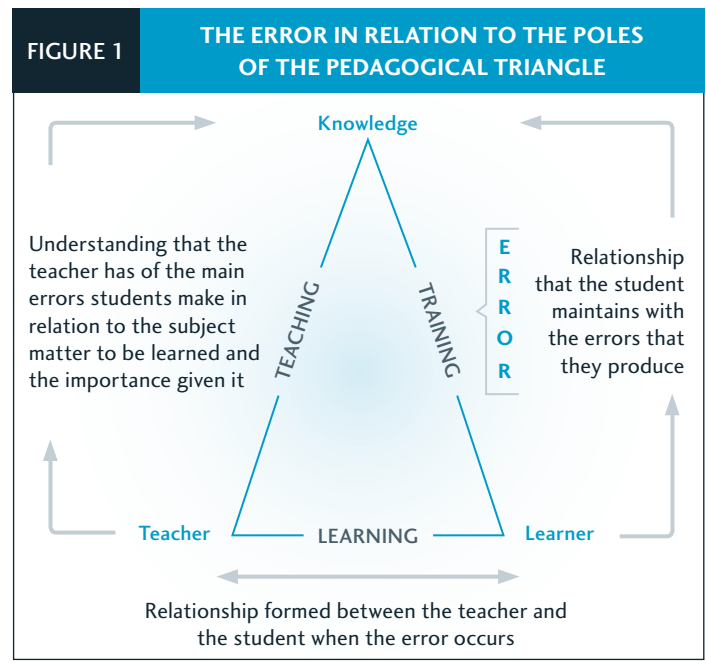
Errors, whether they are unusual or recurring, are an invaluable tool for teaching and learning. They are the substance, the base upon which the dialogue about learning is built between students and their teacher. “Error, through the discussion it triggers, through the message it returns, through the markers it creates, is truly the primary vector of communication about what essentially shapes the educational relationship: teaching, learning... and sharing what we know” (Ravenstein and Sensevy, 1993, p. 83, free translation).

This article¹ introduces a theoretical framework to analyze students' errors and determine their sources more precisely than just by surmising. Issuing from exploratory research I conducted as part of my master's degree in college-level teaching, (Brière, 2015), this error research process provides the teacher with a concrete tool for exploring the causes of student errors that goes beyond the teacher's acquired views and experience. Guided by targeted questioning regarding recurring errors in their discipline, the teacher will be able to determine the most appropriate didactic and pedagogical strategies to implement in order to overcome the obstacles to learning. This dimension, still underexplored at the college level, will be of interest to all educators who care to reflect on the role of errors in the learning process in order to better adapt their interventions.

THE SOURCE OF AN ERROR

Errors enable us to differentiate between the concepts learned by students and those to review in order to consolidate learning. They inevitably introduce insecurities and doubts in the teacher. “Why is this, why has the concept not been grasped?” the teacher might wonder. Thus, the teacher's intervention can be limited to intuitive action in response to the error: guided by their perceptions, experiential knowledge, judgment and disciplinary expertise, the teacher will endeavour to search for clues as to the students' sources of difficulty. However, in order to differentiate between the strategies that work and those that require revision, with the goal of improving their teaching practices, Reuter (2013) invites teachers to take a closer look at the causes of an error. This involves addressing several contextual elements, notably disciplinary epistemology, the relationship to the error, personal values and institutional values advocated by policies (Cohen-Azria *et al.*, 2013). Some of these aspects may be too subtle to grasp during the analysis of possible causes of errors. Nonetheless, it is possible and easier for the teacher to consider the error in the context

of the interactions that exist between the various points of Houssaye's (2000) educational triangle (see Figure 1): their own relationship with knowledge (understanding that there are errors in their discipline and the importance given them), the students' relationship to knowledge (the relation that students maintain with the subject and the errors they make) and the teacher's relationship with the students (the relation that is established between the teacher and the student when the error occurs). Viewed in this way, it is the teachers' teaching skills that are found at the heart of the analysis of the error (Bizier, 2010).



Source: Figure based on Houssaye (2000)

¹ I would like to thank Nicole Bizier for her valuable collaboration as a college teaching consultant, and Maureen Hillman for her judicious support in revising the text.



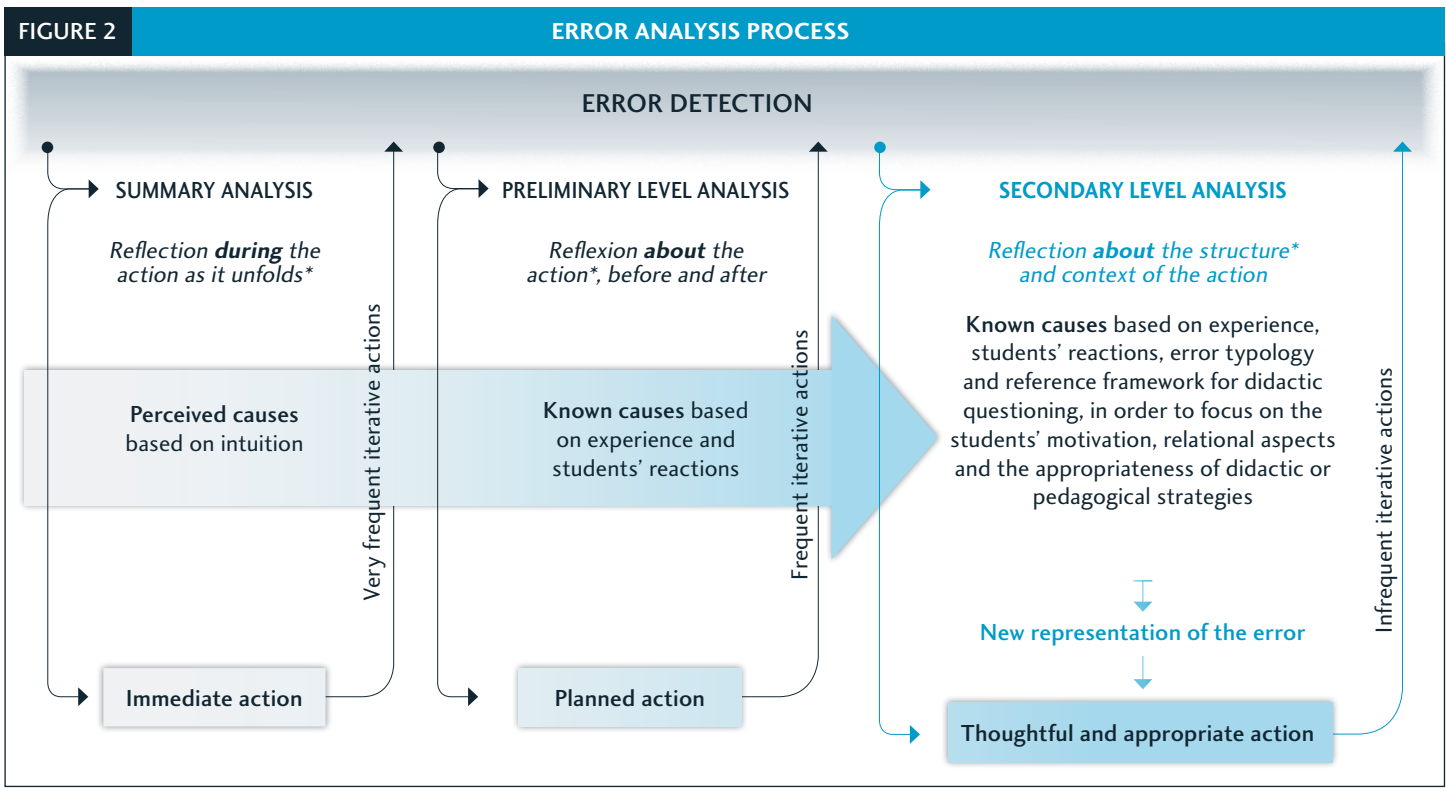
THE PROCESS OF STUDYING THE ERROR

As part of my exploratory research, I asked college professors to describe the steps they implemented with regard to their students' errors. According to their discipline, they began by identifying frequent and recurring errors. Then they assessed the importance they placed on them in the learning process. Finally, they elaborated on their interventions that involved intuitive, questioned or thoughtful steps that either followed the observation of errors or preceded anticipated errors. This exercise revealed that some errors warranted specific treatment, particularly those hindering the achievement of learning objectives. The analysis of these teaching practices allowed me to develop an error analysis process (EAP) (presented in Figure 2), the purpose of which is to study errors through step-by-step didactic questioning, and conduct an in-depth situational analysis, if necessary.

The EAP begins the moment an error is detected. The teacher then either conducts a spontaneous summary analysis, or a more in-depth analysis requiring them to draw upon their

years of experience. During the summary analysis drawn from their perceptions, the teacher looks for clues that will help guide their choice of didactic or pedagogical strategy to intervene immediately, generally in class: their action is intuitive and immediate. The teacher reflects *while* acting and makes a decision hastily and without certitude (Perrenoud, 2012). This technique usually forces the teacher to experiment with various methods before finding the one that will prove most suitable, thus devoting significant effort to this iterative process.

Otherwise, the teacher can elect to conduct a preliminary level analysis, taking the form of a brief study of the cause of error, whilst keeping in mind the students' reactions to said error. Based on their teaching experience, the teacher recognizes an error because it occurs frequently, expectedly or repeatedly, and can then guess the cause of the error. Based on this preliminary level analysis, the teacher takes steps to improve their teaching methods. The teacher then reflects on the action "before or following lively involvement in a task or interaction" (ibid., p. 32, free translation). However, once again this could lead the teacher towards an iterative process



* Perrenoud (2012)



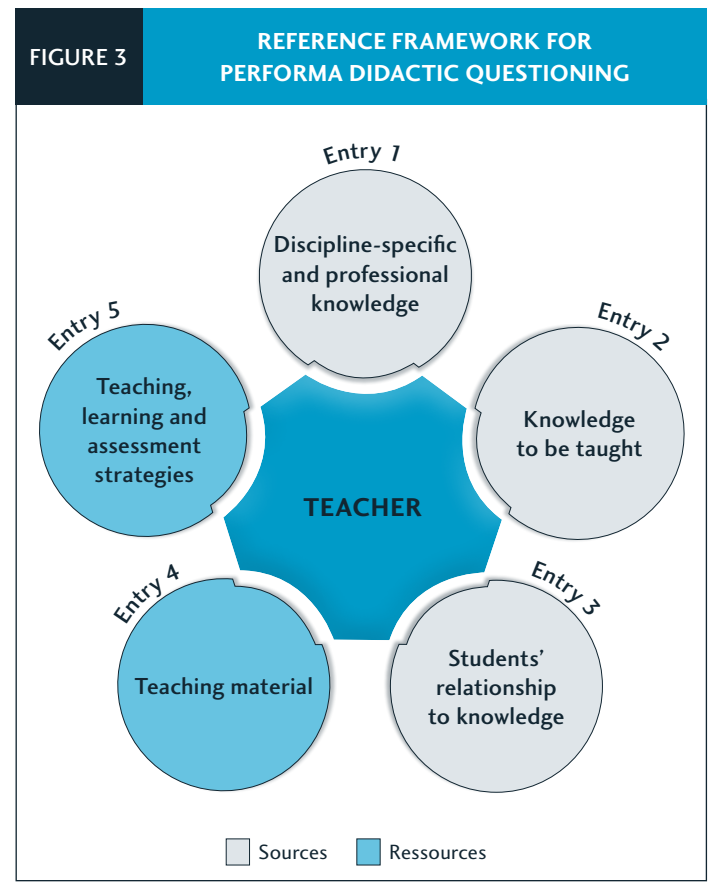
if the error was repeated in spite of everything. Participants in the research and the resulting workshops² confirmed that experience is often the best ally to test various strategies that promote learning. For this reason, it may seem inconsistent that intuitive reactions, based on the teacher's experience, do not result in an accurate analysis of the error. And yet, the error and its cause are often interpreted without truly being understood (Brière, 2015). Teachers who contributed to the research realized in the end that an error analyzed more in-depth before taking any action reduced the iterative process.

It is vital that teachers move beyond the intuitive stage to develop a reflexive process based on the foundations of their disciplinary learning. A secondary level analysis gives rise to a new, more precise representation of error and its possible causes.

Thus, if the teacher takes the time to reflect, they can (and should) elect to continue their investigation with a more detailed secondary level analysis, which includes a systematic study of the cause of the error and focussed didactic questioning to determine and plan a course of action best suited to the targeted learning. Under these conditions, Perrenoud (2012) would consider that the teacher in fact acts as a reflexive practitioner by using their ability to reflect on the organization of action in their context. This level of analysis that involves studying students' motivation, the relational aspects to favour and the students' accountability for the error gives rise to a new, more precise representation of the error and its possible causes. In this perspective, the EAP is framed by the relationships of students' knowledge, constituting the third entry of the reference framework for PERFORMA didactic questioning (presented in Figure 3).³

Studying errors entails mastering subject knowledge by teachers just as much as their resourcefulness to design teaching situations that encourage the learning of this same knowledge. Falling within the field of didactics, planning to offset errors comes with challenges relating to the core content to be taught, associated exercises and problems specific to the subject (Reuter, 2015). As errors call into question the teacher's knowledge, students' knowledge, perceptions of the role of error as well as the teaching strategies and knowledge involved, the study of errors necessarily leads to an in-depth

didactic questioning (Brière, 2016). Thus, it becomes essential for teachers to go beyond the intuition stage to develop a reflexive approach based on the foundations of their disciplinary content expertise (Bizier, 2010).



Source: Prud'homme (2015, p. 40)

² Two workshops: *J'enseigne, j'évalue: co-construire une réflexion à partir d'un vécu d'évaluation. Un scénario gagnant pour l'étudiant et l'enseignant*, Collège Ahuntsic, January 2016, in collaboration with the PERFORMA GT-DID group, and *J'enseigne, j'évalue et je m'interroge sur les erreurs de mes étudiants*, AQPC, June 2016.

³ Editor's note: This reference framework is presented in the following articles « Apprendre de ses expériences professionnelles grâce à une démarche de résolution de problèmes » (Prud'homme, 2015, p. 40-41) and « Choisir des contenus reconnus et pertinents : un geste professionnel didactique majeur » (Bizier, 2008, p. 15), published in *Pédagogie collégiale* and in *L'impératif didactique au cœur de l'enseignement collégial* (Bizier, 2014).



▶ ERROR CLASSIFICATION TO GO BEYOND INTUITIVE ANALYSIS

In order to better target the cause of an error, it is useful to have a few benchmarks to guide the investigation. Cohen-Azria and her collaborators explain that,

“indeed, the concept of error [...] remains relatively vague, undoubtedly for two main reasons: the impression of obviousness that is initially attached to it, and its highly complex nature for those who attempt to accurately define it” (2013, p. 99, free translation).

These authors specify that a typology then becomes necessary to lay down benchmarks as to the causes of the most frequent errors. However, a typology must serve as a starting point for a broader examination and not to point to a single possible solution, as Reuters qualifies (2013), since the error can come from several sources.

The typology of error proposed by Astolfi (2015) appears to be the most interesting to target the possible causes and to guide college teachers in their didactic questioning. I adapted the terminology to take into account the results of my research and to encourage its application at the college level. **Table 1** presents possible causes for errors and, for each error, different examples of didactic questions that a teacher can ask to identify the source of a difficulty.

▶ ANALYZING ERRORS TO EMPOWER AND MOTIVATE STUDENTS

Error analysis makes it especially possible to glimpse the cognitive process of the student during the learning process, allowing the teacher to better guide or shape the cognitive activity of the learner with regards to the comprehension of concepts, the intellectual approach to adopt and the processes of knowledge construction. Moreover, it can also help students by inviting them to review their learning strategies, modify their behaviour or focus more on certain notions (Portuguese, 1995, in Flückiger, 2006).

Students' empowerment vis-à-vis their learning would moreover be facilitated by formative evaluation, which somewhat plays the role of an antidote to error. In fact, the teachers interviewed who often use formative evaluation note a decrease in errors during summative evaluations, because they promote progressive learning and encourage dialogue among students about their progress and their challenges. In doing so, they help to create a motivational dynamic that manifests itself when the

student “feels that they are being held accountable for the progress of their learning” (Viau, 2014, p. 241, free translation). As a result, error analysis is as much about adjusting the teacher's strategies to teach as it is about empowering and motivating the student to master the targeted skill.

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▶ PERCEPTION AND REPRESENTATION GAPS TO BE MINIMIZED

As much for the teacher as for students, perceptions as well as representations of error interfere in the appropriation of knowledge (Descomps, 1999). Surely,

“our beliefs and our way of representing the role error plays from the point of view of knowledge acquisition speaks volumes about our perception of the learning process” (Brière, 2015, p. 41, free translation).

The results of my research, however, suggest differences in perceptions and representations between teachers and students, which affect the didactic relationship at stake. If all negative representations of errors prove to be almost identical for both groups, the difference appears to be greater with regard to the positive representations of error. After all, it must be remembered that errors are beneficial. Astolfi wrote about this concept:

“Learning means [...] taking the risk of making a mistake [...] in this perspective, it can even happen that what we call an error may only be so in appearance and in reality hides any progress being made” (2015, p. 22-23, free translation).

An in-depth analysis of the cause of the error would reduce the gaps in perceptions and representations regarding the primary role played by error in the learning process (Brière, 2015). These gaps usually affect the resources to be mobilized to pass the course and the meaning to assign the error in the learning process. The didactic questioning that the teacher uses when analyzing the error must therefore take into account the perceptions and representations of each, since they influence the actions to be taken.



TABLE 1		TYPOLOGY OF ERRORS
CAUSES OF ERRORS	EXAMPLES OF DIDACTIC QUESTIONS TO PINPOINT THE CAUSES OF ERRORS	
1 INSTRUCTIONS	<ul style="list-style-type: none"> • Could expectations regarding a task during an activity or assessment have been more clearly explained in the instructions? • Could the wording of the instructions (like analyze, explain, interpret and indicate) have been misunderstood? • Did the instructions contain subject vocabulary not familiar to the students? • Did the instructions involve several sub-questions or subtasks that might have confused the students? 	
2 UNDERSTANDING OF EXPECTATIONS	<ul style="list-style-type: none"> • Could the expectations about my subject and learning objectives have been more clearly explained at the beginning of the course? • Would students have been confused about the different expectations formulated by all their teachers? • Would students have had difficulty decoding the implicit aspects of the situation? • Could I have omitted to specify the expected way to complete a task, from among the various possibilities? 	
3 ALTERNATIVE CONCEPTS OR ERRONEOUS REPRESENTATIONS	<ul style="list-style-type: none"> • Could there have been incorrect/false beliefs or knowledge among students that may have hindered learning a given concept? • Could students have been confused by a similar concept? 	
4 LEARNING PROCESS	<ul style="list-style-type: none"> • Could students have been confused by various logical operations involved in the requested task? • Could students have been bothered by the level of difficulty of a text to read or by the novelty of an operation to perform? • Might students not have had sufficient opportunity to practise before an assessment? • Was the teaching material used adapted to students' needs and the learning context? 	
5 APPROACH	<ul style="list-style-type: none"> • Was there a step that always seems to pose a problem for the students? • Was there diversity in the possible procedures to resolve a problem or perform a task, while I was expecting a specific approach, the «canonical» strategy? • Was the approach taken by the students really an error? 	
6 COGNITIVE OVERLOAD	<ul style="list-style-type: none"> • Might I have explained this concept too quickly, hindering the students from clearly understanding or practising it? • Could I have introduced several similar concepts in the same course, thus confusing the students? • Could I have given a talk that was too long for the students' attention level? • Did the task required of students contain too many separate actions, resulting in some confusion? • Could the students have missed opportunities to assimilate new information or draw upon their memory in search of information? • Could learning have been made easier by synthesizing concepts, a schematic, network of ideas, etc.? 	
7 PRIOR KNOWLEDGE AND TRANSFER OF LEARNING	<ul style="list-style-type: none"> • Could the students have been confused by superficial similarities with the concepts of another subject? • Might there have been a perception gap between a student's intentions to learn the concept and those I envisioned to encourage their learning? • Could students have generalized concepts unduly or outside of their context? • Could the students have lacked opportunities or support to assist in transferring their learning in different situations? 	
8 COMPLEXITY OF CONTENT	<ul style="list-style-type: none"> • Could the teaching strategies implemented to teach course content not have been adequate with regard to their complexity? • Could the exercises and activities have been poorly prioritized according to their degree of complexity? • Might the content presented fall outside the students' zone of proximal development? • Could the assessment target concepts that were not taught or that were more complex than what the students practised? 	

Source: Typology based on Astolfi (2015, p. 96-97)



▶ EXAMPLES OF ACTIONS REQUIRED TO DEAL WITH ERRORS

When the teacher detects an error in class, through a question from a student or following a formative activity, for example, they can make immediate adjustments to deal with it. Thus, based on their intuition and perception, following a summary analysis where they reflect *in action*, the teacher could take various steps, such as:

- slowing down the pace of teaching;
- rewording explanations;
- reassuring the student.

If the error occurring appears familiar, given that it is frequent or recurring, either in class or during the correction of an assessment, the teacher can introduce a planned action. This could be based on their experiential knowledge, following a preliminary level analysis where they reflect *on the action*. It can be summed up as:

- producing a flow diagram to clarify complex content;
- simplifying the procedure proposed to students to conduct the approach;
- modifying an activity, taking into account the specific error.

In the context where they consider it important to focus on errors and target the real causes, the teacher, as a reflective practitioner, can conduct a secondary level analysis using didactic questioning, which will allow them to implement different actions that are well thought out and adapted to the situation. There are several possible examples of actions available to the teacher to adjust their didactic and pedagogical practices, such as:

- establish the core content required to acquire the competency or competencies;
- streamline content and schedule more time to teach complex concepts;
- drastically reduce the time allotted for theory so that students have more opportunities to work on content;
- choose another pedagogical approach;
- review the didactic material used;
- clarify instructions for activities or assessments;
- specify the expectations with regard to the course or task;
- identify preconceptions or misconceptions that hinder the learning of new concepts

- introduce diagnostic formative assessments;
- inform students about the usefulness of training exercises and review with them the relationship between formative and summative assessments;
- provide effective feedback on a formative assessment, placing emphasis on learning objectives;
- have students create a diagram of concepts that allows them to review concepts and discuss their views on complex content;
- modify the type of summative assessment to better attest to the skill level attained by each student;
- use a criterion-referenced, scalable assessment grid, where the error margin is reduced as learning progresses;
- build a relationship of trust with students to encourage their motivation and empowerment; interact with them more often;
- with colleagues, discuss the difficulties encountered regarding complex content and the impact of these concepts on student motivation;
- ask students to justify the answers they feel are an obstacle to their learning, in order to change perception;
- consider the possibility of gaining new skills in order to acquire new teaching aids.

▶ CONCLUSION

Reuter sums up the view to adopt:

“thus we learn *with* our errors and not simply *against* them, and it is *with* them (by making and considering them) that we give ourselves the means to avoid them” (2013, p. 131, free translation).

By allowing students to risk making a mistake (Astolfi, 2015) and by authorizing the error without defending it (Reuter, 2013), the teacher will appreciate the fundamental role of errors in the learning process. Moreover, the student who is made aware of errors will also recognize their great utility for learning. The teacher can then consider errors as a novel instrument to analyze their methods, and even more so, as a tool that can be used to discover different ways to teach, better adapted to the subject matter to be learned.

The error analysis process, in combination with a typology of the possible causes of errors, favours an in-depth methodical analysis and a modification of actions to the sources of difficulties. In particular, this process opens the door to an analysis of the cognitive process of students that hinders learning.



A secondary level analysis, through better comprehension of the cause of the error, thanks to didactic questioning, uncovers information that had remained in the shadows, revealing new knowledge about the error. Once better equipped, the teacher will then be able to implement more appropriate teaching, learning and assessment strategies, and more relevant teaching materials; the teacher could also voice their own needs for training, from a perspective of reflexive practice. ●

Holder of a Master's in College Teaching (MEC) from the Université de Sherbrooke, during her studies Manon BRIÈRE focused on the educational component of the role of errors in a college teaching framework. A teacher with Collège Ahuntsic in their Medical Archives program since 2002, she has been leading error study workshops since 2015. Ms. Brière is a member of the educational work group (GT-DID) at the Université de Sherbrooke and an educational resource person for the Microprogramme de 2^e cycle en insertion professionnelle en enseignement au collégial (MIPEC) and the PERFORMA Diplôme de 2^e cycle en enseignement au collégial (DESS).
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