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RESEARCHING FOR A MATHEMATICS RHIZOCURRERE FOR CULTURALLY RESPONSIVE TEACHING

LEARNING OPPORTUNITIES FOR STUDENTS OF PRIMARY SCHOOL

PESQUISANDO PARA UMA MATEMÁTICA RIZOMÁTICA PARA O ENSINO CULTURALMENTE RESPONSIVO

Oportunidades de aprendizagem para alunos do primário

INVESTIGANDO UNA MATEMÁTICA RIZOMÁTICA PARA LA ENSEÑANZA CULTURALMENTE RESPONSIVA

Oportunidades de aprendizaje para estudiantes de escuela primaria

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RESUMO

Este artigo centra-se na reconceitualização do currículo de matemática com alunos ciganos, apresentando uma exploração nómada do ensino da matemática. É proposto um modelo alternativo, metodologicamente privilegiado, que identifica a oportunidade para um currículo alternativo de dentro, em vez de à distância. O principal objetivo da pesquisa é indicar como a pesquisa para uma reconceitualização curricular pode ser iluminada por pensar rizomaticamente onde espaços comuns de entres são construídos por uma conversa confabulativa entre estudantes ciganos e o pesquisador que assume uma posição nômade. Os alunos ciganos, o devir educativo e as subjetividades ao nível dos indivíduos e das situações envolvidas interagem como elementos de um rizoma em evolução imprevisível que consiste em descontinuidade, ruptura e multiplicidades em constante emergência.

Palavras-chave: rizomática. rizoma. estudantes ciganos. matemática.

ABSTRACT

This paper focuses on the reconceptualization of the mathematics curriculum with Roma students presenting a nomadic exploration of the mathematics teaching. An alternative, methodologically privileged, model is proposed which identifies the opportunity for an alternative curriculum from within rather than from a distance. The main aim of the research is to indicate how researching for a curriculum reconceptualization might be enlightened by thinking rhizomatically where common spaces of in-between are constructed by a confabulative conversation between Roma students and

the researcher who takes up a nomadic position. Roma students, educational becoming and subjectivities at the level of individuals and situations involved both interact as elements of an unpredictably evolving rhizome which consists of discontinuity, rupture and constantly emerging multiplicities.

Keywords: rhizocurrere. rhizome. roma students. mathematics.

RESUMEN

Este artículo se centra en la reconceptualización del currículo de matemáticas con estudiantes gitanos presentando una exploración nómada de la enseñanza de las matemáticas. Se propone un modelo alternativo, metodológicamente privilegiado, que identifica la oportunidad de un currículo alternativo desde dentro y no desde la distancia. El objetivo principal de la investigación es indicar cómo la investigación para la reconceptualización del currículo puede iluminarse mediante el pensamiento rizomático donde los espacios comunes intermedios se construyen mediante una conversación confabuladora entre los estudiantes gitanos y el investigador que adopta una posición nómada. Los estudiantes gitanos, el devenir educativo y las subjetividades a nivel de los individuos y las situaciones involucradas interactúan como elementos de un rizoma en evolución impredecible que consiste en discontinuidad, ruptura y multiplicidades en constante emergencia.

Palabras clave: rizomática. rizoma. estudiantes gitanos. matemáticas.

Introduction

Current pandemic experiences can be treated as a critical point in the trajectory of mathematics education. The relationship between mathematics education and students' feelings of hopelessness when trying to adjust to returning to school normalcy after many months of quarantine is an opportunity to find a tangent path with critical ethnomathematics education. As students return to school they are faced with severely restrictive measures which affect their sociability and their need for interpersonal contact which is insurmountable for this particular population and cultural group.

As a result, returning to school is characterized by a large outflow of students, intensity during their stay at school. The educational process ended up degenerating into an attempt to keep students safe at school. It is often the case that students choose to stay at home and in distance education in relation to school reality. These specific incidents acquire a special meaning in the case of the socio-cultural group of the Roma since its interpretation assumes almost from the beginning racist characteristics that maintain and reinforce the social stereotypes for the Roma. In particular, teachers and educators, seeing the empty schools and students wandering around the area around the school, interpret this behaviour as a constant need of the Roma for freedom, inability to comply with school rules, indifference to the educational process. This behaviour of students is interpreted as their desire to remain in "community confinement" marginalizing thus, the school and the educational becoming.

This research mentions the need for socially-distanced and remote education as a "teachable moment" that can leap beyond the crisis and become and educational opportunity (Ulmer et al., 2020). This paper proposes that the actual situation of crisis and failure needs to be embraced; embracing dystopia makes it possible to incorporate the best aspects of critical ethnomathematics, the one subfield of mathematics education that has already tread this path, by embracing the complexities and paradoxes of colonialism and its legacies (Appelbaum et al., 2021). Bringing critical ethnomathematics from the margins to the center while decentring mathematics curriculum for culturally responsive teaching, is proposed. A key concern for mathematics education is that of Roma students coming from a marginalised group; these learners were left outside the educational process, enlarging the gaps in opportunities and outcomes between privileged and less-privileged students.

Theoretical framework

A rhizome is a non-linear and non-hierarchical network which develops and evolves in contrast to the humanitarian tree and its influence in the field of mathematics education. Rhizomatic thought (Deleuze & Guattari, 1987) and creating a rhizocurrere orients the research to the study of social interaction in educational contexts to the deconstruction of mathematics curricula models that seeks to provide the student with a mathematical education which encompasses a body of knowledge, skills and procedures that is developmentally appropriate (Schoenfeld, 2016). Rhizomatic thought aims neither to provide a better research model nor to reject the conventional humanistic research. Instead, it leads to a commitment to forms of knowledge that are not linear by creating multiple entry points (Colebrook, 2021) and a multitude of pathways of the lived experience of the mathematics curriculum. Research examines the educational process and becoming at both the level of individuals and the situations involved. These processes and becomings interact as elements of a labyrinthine and incalculable (Lather, 2016) rhizome characterized by discontinuity, rupture and constantly emerging multiplicities. Such a standpoint requires a radical reconsideration of the methodological approach to the reconceptualization of the ethnomathematics curriculum, because conventional research efforts end up imposing codifications similar to those of linear models in research environments.

An alternative methodologically privileged model was proposed, identifying the particular from within rather than from a distance (St. Pierre, 2018). According to Deleuze and Guattari (1987, p. 387) the researcher may act as a nomad without history, territory, or goals as he travels between points without ever stopping. The main aim is to indicate how researching for an ethnomathematically oriented curriculum reconceptualization might be enlightened by rhizomatic research where common spaces of in-between are constructed by a confabulative conversation (Johansson et al., 2021) between Roma students and the researcher who takes up a nomadic position. Deleuze and Guattari (1987) use another concept of subjectivity to trouble the concept and the field. They suggest that a nomad "operates in an open space through which things-flows are distributed rather than plotting out a closed space for linear and solid things" (p. 361). In fact, St. Pierre (1997) affirms that "nomads deterritorialize space that has been territorialized, charted, ordered, and then shut down. Nomads search for mobile arrangements of space where thought can settle for a time and then multiply and recombine, always displacing the sedentary and unified". A researcher who practices nomadic inquiry, an "itinerant" (Deleuze & Guattari, 1987, p. 373) science, can never be sure of the field and thus has trouble locating it because "deterritorialization constitutes and extends the territory itself" (Deleuze & Guattari, 1987, p. 372). The field grows; it erupts in some strange, new place; it refuses to be coded; and it advantageously invents itself outside interiority (St. Pierre, 1997).

This is hard to understand if knowledge is thought of as a binary concept such as right/wrong, is/is not, or proven/unproven. To the Roma students, mathematical knowledge is not a static component to be obtained, but rather a flexible changing element to be alchemically interacted with, and the only goal of which is further pursuit. Roma students experience freedom by being unconstrained and through constant movement.

Nomadic wandering in the discursive fields of education is "not as 'losing one's way' but as losing the way – as losing any sense that just one 'way' could ever be prefixed and privileged by the definite article. Like rhizomes, nomads have no desire to follow one path" (Gough, 2005, p.13). "The space of [nomad] thought is qualitatively different from State space. Nomad space is "smooth," or open-ended. One can rise up at any point and move to any other. Its mode of distribution is the nomos: arraying oneself in an open space (hold the street), as opposed to the logos of entrenching oneself in a closed space (hold the fort)" (Deleuze and Guattari, 1987; p. xiii).

Research methodology

This research took place in the region of Acharnes which is a suburb of Athens, in Greece. A primary school where 3rd grade Roma students attend and the local community become the research setting.

Roma students return to school after the pandemic quarantine and this is the motive for a series of activities that obtain mathematical substance and become an occasion for interaction with real-life mathematical situations. The set of activities originates from the students who, being dissatisfied with the provision of the positions imposed by the legislation in order to observe the social distances, examine and explore possible provisions which will comply with the conditions set by the law and will be accepted by all the students. This occasion offers the possibility for interaction between mathematics knowledge and examination of the issue of discrimination of Roma students as it arises while the research evolves.

The activities which will be presented in this paper are part of a mathematics rhizocurrere. This rhizocurrere is structured by a series of activities that touch students' funds of knowledge, explore issues of social inequality and are transformed into mathematical activities through everyday life. These activities could not have been structured and organized in advance as they arise unexpectedly and spontaneously during the research process. However, they are organized in a rhizocurrere and acquire meaning and substance for the life of the students as well as for the promotion of mathematical knowledge and mathematical skills.

Drawing on the work of Deleuze and Guattari (1987), everything contributing to a research process exists on a plane of immanence without hierarchies or predetermined orders. Ulmer (2017) mentions that “thinking differently about methodology is an ethical, political, and intellectual imperative (p.12)” so the education of mathematics is seen as a political action which may be able to transform the lives of the persons involved. Contrary to what might be assumed, postqualitative inquiry such as rhizomatic analysis is not a qualitative methodology with a twist (St. Pierre, 2021). Rather than offering a new kind of method, it instead expects the researcher to step outside of the safe methodological steps into the exploration of the post-human societal condition, focusing on matter and its contributing role in the production of our worlds (Spyrou, 2019; p.316). In its own rhizomatic direction, this article creates or maps new possibilities for educational growth and inspiration—new possibilities for knowing and being both as a learner and a teacher (Ontong & Le Grange, 2018).

Educational reality requires mathematics teachers identify the learning objectives in advance and the teaching strategy they will adapt to achieve them. Moreover teachers are asked to evaluate this teaching process in terms of whether or not they have achieved the goals and objectives. Mathematics curriculum tends to degenerate into a failed representation of the desperate efforts of educational stakeholders to capture topics and turn them into useful and validated knowledge. The researcher, in this perspective, has dominant knowledge of the student's world and seeks to impose a change on that world. Post-qualitative inquiry and rhizomatic thought suggests such a mathematics curriculum should be deconstructed. This deconstruction can be achieved when the curriculum is treated as a tentative possible proposal, a reality that emerges in a way beyond our control without frames, but in the mix of various tracings on a map of possibilities (Deleuze & Guattari, 1987). Reconceptualized mathematics curriculum is written neither on a “butchers’ paper that reminds us of the pedagogies of the slaughterhouse (Pederson, 2019), nor on an immigrant paper that has come on a ship from London as packing material, yellowed by window sun” (McKnight, 2017, p. 11).

Deconstruction does not reject what it deconstructs but rather overturns and displaces a lived curriculum experience in order to create space for something different else. Deconstruction is accomplished when “something in the world forces us to think” (Deleuze, 1994, p. 139), when the given, the dogmatic image of thought, no longer suffices (St. Pierre, 2018). Deconstruction as an approach seeks to highlight important deconstructive moments by looking for sources of tension and disruption (Derrida, 1967/1997).

The present research was carried out in an area located on the outskirts of Athens, Greece, a short distance from the city center where Roma communities live. Conducting the research involved seven different Roma students of 3rd grade as well as important family and community members. Participants agree to participate in this research; they know the subject and the substance as well as the collection of

relevant material by the researcher. Consent was obtained both formally through a relevant consent form and substantially as community members allowed the researcher and students to access their space and action during their daily activities. Students and community members were on track to acquire a culture of locating mathematics within everyday life activities and to cultivate thinking in a mathematical way. Opening a space for agency and linking mathematics to students' foregrounds becomes the basis for a more meaningful mathematical experience (Andersson & Valero, 2009).

This paper's post-qualitative turn in mathematics education focuses on the differences, the contradictions and the setting in which students' funds of knowledge are explored, instead of looking for truths. Roma students do not have stable and unchanging experiences that can be studied in advance and approached with predetermined steps. Learning situations and opportunities arise in response to the students' lived experience. Deconstruction identifies and highlights (non) data which lead to the reshaping of the mathematics curriculum, incorporating, with critical stance, political, cultural and historical elements that will in turn reveal how these students experience mathematics through their lived experience. Mathematics curriculum develops as an impressive rhizome of activities, where any node can be connected to any other to give meaning to the learning process, and in this manner enriching student's mathematical experiences (Januario et al., 2020).

Research (non) data

Due to the school's reopening after the restrictive measures for Covid19 pandemic, the students recalled their existing knowledge by trying to implement the restrictive measures in practice. According to the directives of the disease prevention center, the distances between the students within the school classroom should be 1.5 meters.

The way the desks were placed initially caused the students discomfort, as they were located one behind the other. As a result, the children did not have eye contact with each other and came in direct contact exclusively with the teacher and the blackboard (placement of desks for traditional frontal teaching). Thus, the students were asked to place their classroom chairs in an appropriate manner in order to apply the necessary precautionary measures for the virus' spread.

Initially, the students counted the number of desks in each classroom and began to think about different placements so that each student has a distance of 1.5 meters from his/her classmates. Students were deliberately asked to separate the chairs in two classrooms. This happened because the first classroom consisted of eight chairs and the second consisted of eleven chairs. So, while the students tried to separate the eight students they were expected to form two groups of four chairs. Thus, they placed the chairs into a square formation as they easily recognized that the square has equal sides. They use a measuring tape in an auxilliary way, with which they were now familiar, after their previous contact with this measuring instrument during the activity of measuring length and using the map.

Picture 1: Placing the chairs at equal distances

In our attempt to reveal the reason why the students immediately thought of placing the chairs on a square's tops, Valantis explains, "I thought of the television. If you put them like the TV set, one side is closer, the other is farther, so you cannot do it. Then you think of the triangle, like a little piece of cheese pie. This can be done but eight chairs do not fit in a triangle because some are left over". At the same time, Stavros said in order to comment on the triangle formation "the little piece of cheese pie does not always do, it can be pointed – meaning triangular – without every piece being equal. It only fits sometimes. My mother has some towels hanging that fit equal distances".

Thus, we understand that students use objects of their daily life such as television or handmade embroidery to guide their thinking to the appropriate mathematical arrangement.

At this point, we must analyze the fact that students informally recognize perfect and imperfect division. The perfect division, for example, has to do with the placement of the eight chairs in two squares, while the imperfect division has to do with "the eight chairs which do not fit in a triangle because some are left over". Children make this distinction even though they have not been taught division at all at school. At the same time, students recognize the innate qualities of triangles as far as their sides are concerned since they realize that a pointed formation can sometimes fit and sometimes not fit, that is, sometimes an equilateral triangle can be formed and sometimes a scalene triangle.

Picture 2: Creating a triangle with chairs

Picture 3: Examining equilateral triangle properties

The students' attempt to form an equilateral triangle is particularly interesting since the goal is to place the three chairs one and a half meters apart from each other. At the beginning, they easily place the two chairs and form one side of the triangle. However, they find it difficult to put the third vertex in such a way that it is equidistant from the other two.

They do several tests and talk to each other for a long time until they realize that "in order for the third chair to be two away from the other two we have to find 75". When the researcher asks them how the number 75 comes about they say "I have one and a half. Half of one is 50 while half of 50 is 25. So 75. There, the other chair should step on 75". Thus, they use the measuring tape to measure 75 cm. That is the middle of one of the straight sections, which happens to be right on the til's joint.

This joint forms a straight line that runs through the tiles and becomes the reference point. As soon as the students realize that the middle is on the til's joint, they are very happy while George says "Come on, it is nothing. Now it is easy that it has fallen right up here. Take it all straight. The chair should be put in this line here."

Picture 4: Calculating half of a distance

In fact, the students place one foot of the chair on this straight line, that is, on the perpendicular bisector of the line segment of the equilateral triangle's base. Then measurements begin on both sides of the triangle to create the equal distance by moving the chair properly. However, after a short time of testing, they find it difficult to mark accurately the distances as they find that, although their measurements are based on the line of the perpendicular bisector, the two sides of the triangle continue to be unequal.

Then, Valantis, who until then observes, tells them "the chair is not like the lines you draw with the pencil that do not catch centimeters, the chair catches centimeters. Half of the chair must step on half of the line. We cannot do it by putting the foot that is at the chair's end". Indeed, the other students accept his point of view and measure the chair's length. Then, they place its middle on the line of the perpendicular bisector, as it is marked by the tiles' joint. That is, the student at this point realizes that the reason why the triangle does not become equilateral is the chair itself that has dimensions. Therefore, he suggests placing the middle and not the end of the chair in the perpendicular bisector in order to achieve the desired result.

Picture 5: Finding the perpendicular bisector

At this point, we observe that students have an understanding of the dimensionless character of a triangle's point and vertex as well as its different innate quality in relation to an object that has dimensions such as the chair in this case. They finish this assignment by measuring exactly the equal distances on the equilateral triangle's sides. Finally, when asked how to place the eleven children into formation, they easily state they will form two squares and a triangle, thus making an Euclidean division using geometric terms.

Picture 6: Understanding the difference between a point and an object

Discussion

During this research we began to reexamine the mathematics curriculum in order to provide Roma students with an understanding of mathematics as a living and growing field which has the potential to bring about real-life changes in responding to power issues. Research quickly discovered that this kind of reconceptualization of the mathematics curriculum cannot be accomplished through conventional humanistic research or qualitative research methodologies. The research then pursued, and which is reported in this paper, is grounded in post-qualitative inquiry. The goals of post-qualitative research are not directed at representing something that exists in the real world, but instead to reorient thought toward experimentation, and toward the creation of new forms of thought and life. Rhizomatic analysis offered the opportunity to co-create an emerging, alternative, mathematics rhizocurrere together with Roma students in order to respond to their refusal to adapt to the new conditions at the school.

Similar to qualitative approaches, the rhizocurrere is based on real-life experiences; the difference is in the outcomes, which are not an ideal curriculum, or set of concrete pedagogical recommendations, but instead a prototype story of new relationships with teaching, learning, and research that can be shared by other teachers and students co-creating their own rhizocurrere in their own unique settings.

Rhizomatic analysis entailed the mapping of relations and differences as they emerged, during performance-in-motion. This mapping generated potential pathways and directions, plateaus or planes of immanence among theories, mathematical ideas, moments of interaction, pieces of qualitative data, etc., pathways or directions of connection or difference that could be followed and extended as potentialities. Through this mapping process emerged a vibrant, evolving and dynamically adapted mathematics rhizocurrere that has such a dynamic for Roma students that, on the one hand, helps them to acquire substantial and comprehensive mathematical knowledge related to real life, and on the other hand, becomes a vehicle both for emancipation and for changes in their daily life.

Re-examination of the students' reality and the breaking down of existing stereotypes created potential plateaus with the ultimate goal of restoring social justice. During the research process, there was a reduction in school dropout rates, an increase in student participation in mathematics activities, a spontaneous implementation of interventions that contribute to the improvement of everyday situations

that make life difficult for Roma students, and extension of the school curriculum to include interaction with the outside community within mathematics lessons. Research created the opportunity to reconsider relationships and interactions constituting students' experiences in relation to socialization processes within the Roma community, and to a softening of power relations between school and Roma culture.

Finally, the rhizocurrere cultivated a spirit of searching for mathematics involved in the simple events of everyday life, so that Roma students demonstrated evidence of acquiring an active mathematical identity, of learning to think mathematically, and of respect for people with whom they interacted, as they tried to change their daily lives for the better.

The research reported in this paper intends to lead to further innovation, to participate in a new way of thinking in a mathematical way of seeing the reality of Roma students through mathematics. It focuses on specific 'actualities' which shape the sociocultural reality of the Roma community and draws on them as a response to the neoliberalization of mathematics education (Heimans & Singh, 2016). This research seeks to produce ideas and to make conclusions that counter quicker, easier practices that categorize schools, students and teachers.

Change to students' life described how the research gave them the confidence to encourage them to think mathematically and change their lives trying out new ideas. They experienced a wave of interest in the research, with ideas adopted by students in the research context being transported, discussed and fermented in the community. There was enthusiasm amongst students for collating the ideas in a resource that could be shared with the Roma community who wished to develop their practice in a similar direction.

During the course of the research, Roma students recognised that their engagement in research had led to a greater understanding of mathematical knowledge while solving real-life problems. Their experiences of the research were in stark contrast to their previous limited or complete lack of engagement with mathematical tasks. The apparent willingness of students to engage in this research project challenges the notion that Roma students are naturally resistant to change and are indifferent to the educational process. Instead, it suggests that Roma students' lack of engagement with mathematical education can be attributed to the constraints they face in the classroom, which can be overcome through the adoption of collaborative and participatory research on methodologies of rhizomatic thinking. Through rhizomatic thinking the problem situation—that is, the one requiring mathematical learning—is by nature a real experience of Roma students that forms "an intrinsic genesis, not an extrinsic conditioning" (Deleuze, 1994, p.154).

In order to facilitate Roma students to learn mathematics teacher researcher encouraged them to take a 'do with me' approach, and be able to show them how to modify and reproduce what they do in different and diverse situations, rather than only allow us to copy them (Deleuze, 1994; p. 23). In rhizomatic learning, knowledge can only be negotiated in an experience that is collaborative and contextual. The metaphor of the rhizome represents a reframing of knowledge in order to deal with the unavailability of canonical knowledge and disciplines on the bleeding-edge, where knowledge does not exist and needs to be discovered (Cormier, 2008). "Rhizomes grow and propagate in a nomadic fashion, the only restrictions to growth being those that exist in the surrounding habitat. Seen as a model for the construction of mathematical knowledge, rhizomatic processes hint at the interconnectedness of mathematical ideas as well as boundless exploration across many fronts from many different starting points" (Sharples et al., 2012; p.33)

Teacher researcher becomes a nomad researcher through working collaboratively in a group with Roma students, sharing ideas and experiences with the Roma community, jointly planning, and interacting through mathematical activities and circumstances. This process has a significant impact on their thinking and classroom practice, apart from being a thoroughly enjoyable experience. Participants were encouraged to take risks, overcome constraints, and experience the mathematical rhizocurrere, the vivid experience of the mathematics curriculum. There was general acknowledgement that the role the researcher played in the Roma group was crucial in promoting collaboration and facilitating the sharing

of ideas, and that drawing on fieldwork is a form of inquiry that requires the researcher to be personally immersed in the ongoing social activities of an individual or group helped the development of the rhizomatic thinking in order to challenge previous views and assumptions about teaching mathematics (Stathopoulou & Kalabasis, 2017).

The mutual support and the sense of common purpose developed with Roma students is essential for the establishment of a 'community of inquiry' in which the cultivation of critical understanding, and meta-cognitive awareness of the Roma students, serves to challenge, rather than perpetuate, the status quo. Teacher researcher described how the initial conceptualization of teaching mathematics for social justice and the discussions with the Roma community which preceded the research, helped participants and important others to develop their thinking and to broaden their perspectives (Xenofontos et al., 2021). The initial interaction with the Roma community is seen as essential for encouraging participants to critically appraise their own practice in relation to the theories, in order to bring about effective change.

The curricula are based on the fundamental question of what values, attitudes, skills, strategies, and knowledge must be acquired by modern students in order to be able to live creatively in the world of the future? Based on this specific question, the theoretical framework for curriculum development may be related to the effort to identify mathematics in the real world which may become critical factors that will make a student an active and equal citizen of social life while experiencing a positive learning experience. The rhizomatic theory of Deleuze and Guattari helped the teacher-researcher to facilitate the students' thinking in a way that goes beyond disconnected mathematical tasks. The approach creates deep foundations and opens up new horizons for meaningful learning. The choices for meaningful knowledge seek to guarantee the validity of the general acceptance of the decisions of the dominant ideological-political group of society. Through a postcolonial approach to competency-based curriculum (re)design, we propose a framework that centers the knowledge and voices of Roma students as a way to dismantle oppressive systems in higher education (Parson & Weise, 2020). In such an approach, the theory of Deleuze and Guattari helps the researcher to develop the existing position as a teacher able to transform daily experience into mathematical knowledge by applying these ideas in the classroom. Culturally sensitive mathematics-ethnomathematics- becomes in this way a useful framework for classroom philosophy of education.

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