

Animated short films: connecting Ubuntu to prime number decomposition in Countryside Education

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Abstract: This research aims to understand how experiences with short films in mathematics classes contribute to students' understanding/constitution of the act of projecting life in the Countryside Education Licentiate Degree (CELDT) – Natural Sciences. Therefore, we consider mathematics as a possible support for reflection on the act of projecting life experienced with Cinema. Thus, in a class titled “Mathematics for the Education of Countryside Educators: Natural Sciences,” lessons included animated short films at five different points. We focus on the moment that discusses belonging, community, and prime factorization. Our results show that the experience with short films in mathematics classes proved to be a movement of (self)-education through mathematics. It's an education in the teaching profession about the need to wait and pay attention, while students' self-education articulates their filmic perceptions grounded in the Ubuntu philosophy.

Keywords: Mathematics Education. Cinema. Cultural Studies. *Praxis*. Factorization.

Curtas-metragens animados: articulando Ubuntu à decomposição em números primos na Educação do Campo

Resumo: Esta pesquisa objetiva compreender como a experiência com curtas-metragens em aulas de matemática se manifesta no diálogo sobre a vida entre docentes e discentes da Licenciatura em Educação do Campo (LEdoC) – Ciências da Natureza. Diante disso, assumimos a(s) matemática(s) como possibilidades de sustentação para a reflexão sobre o ato de projetar a vida experienciada no cinema. Assim, em uma turma de “Matemática para a formação de Educadores do Campo: Ciências da Natureza”, foram ministradas aulas que experienciaram, em cinco momentos, curtas-metragens animados. Focamos no momento em que se discutiram o pertencimento, a comunidade e a decomposição em fatores primos. Nossos resultados evidenciam que a experiência com curtas-metragens em aulas de matemática mostrou-se um movimento de educar(-se) pela(s) matemática(s). Um educar da docência em precisar esperar e ter atenção, ao passo que as/es/os estudantes articulam suas percepções filmicas, baseadas na filosofia Ubuntu.

Palavras-chave: Educação Matemática. Cinema. Estudos Culturais. *Práxis*. Fatoração.

Cortometrajes animados: conectando Ubuntu con la descomposición de números primos en la educación del campo

Resumen: Esta investigación busca comprender cómo la experiencia con cortometrajes en las clases de matemáticas se manifiesta en el proceso de proyección de la vida del alumnado de la

Licenciatura en Educación Rural (LEdoC) – Ciencias Naturales. Partimos de la premisa de que las matemáticas pueden apoyar la reflexión sobre el acto de proyectar la vida, experimentada como cine. Así, en la serie "Matemáticas para la formación de educadores rurales: Ciencias Naturales", el alumnado experimenta a través de cortometrajes animados en cinco etapas. En este artículo, nos centramos en la etapa que aborda la pertenencia, la comunidad y la factorización en primos. Nuestros resultados muestran que la experiencia con cortometrajes en las clases de matemáticas fue un proceso de (auto)formación a través de las matemáticas. Es una educación para la profesión docente sobre la necesidad de esperar y prestar atención, mientras los estudiantes articulan sus percepciones fílmicas a partir de la filosofía Ubuntu.

Palabras clave: Educación Matemática. Cine. Estudios Culturales. Práctica. Factorización.

1 Introducing cinematic possibilities

According to Gordeeff (2023, p. 52), "animations are an art form that predates what we know as cinema." This author argues that they are not necessarily tied to mundane reality and can therefore easily transcend aspects associated with that realm. Technically, however, many authors consider animations to be the imitation of movement. "Instead of filming an action in real time, animators create a series of images by filming one frame at a time" (Bordwell & Thompson, 2013, p. 580). In addition to being transcendent and conducive to the detached temporality of teaching, in this case, in math classes, we believe that animations can evoke feelings and emotions experienced when reflecting on reality itself. Thus, we understand that animations constitute cinema and are a cultural technology through which "*actions, situations, visions, utopias, or enchantments*" are revealed (Rosa, 2024a, p. 1).

Given this, we initiated a project to introduce short films into the mathematics classroom to investigate how they shape students' lives in the Bachelor's Degree in Rural Education – Natural Sciences program. The alternating model, a pedagogical approach that aims to prevent young people and adults from entering higher education and reinforce the idea of leaving rural life while facilitating access to and retention in the program for practicing professors (Molina & Sá, 2014, p. 468), imbued with socio-ecological possibilities through training in natural sciences, reinforces the need for an educational environment that highlights opportunities to integrate mathematics¹ with cinema in terms of cultural studies (Mascarello, 2009) and life.

To produce the empirical material for this research, five pedagogical sessions were conducted from October 2024 through January 2025 with future students in the field. These sessions used animated short films to facilitate knowledge construction, giving participants a central role in developing their critical thinking skills while sparking discussions that linked mathematics to their lives.

In light of this, the act of designing also emerged in this *praxis* (Vázquez, 2007)—in this case, an act grounded in experienced mathematics. Furthermore, this intentional act moves toward life by becoming its own through launching itself into life and the world. It is linked to subjectivities and, at the same time, to human, worldly, and environmental collectivities.

In this article, we discuss the territorial, environmental, social, and collective *praxis* of preservation and respect for the world, in the interest of a mundane, intersubjective collective. Thus, we present the guiding question that we investigated: "*How does experience with short*

¹ In using the term "mathematics(es)," we draw on Matos and Quintaneiro (2019) and Rosa and Giraldo (2023), noting that we refer to the plurality of mathematics and their relationships and existences in the world, connected to realities rather than as something separate from them. Furthermore, the "s" in parentheses conveys the idea that there is a collective, a plurality of mathematics, but there is also the possibility of understanding a form of mathematics that the reader recognizes within their own culture. Therefore, our approach is to respect this as well.

films in mathematics classes manifest in dialogue between teachers and students in the Bachelor's Degree in Rural Education (LEdOc) — Natural Sciences regarding life?" In this study, we discuss the manifestation, materialization, presentation, and unfolding of experiences with cinema, specifically animated short films in mathematics classes in rural education, to highlight the projection of life and its mathematical underpinnings.

The critical character necessary for teaching *praxis*, an amalgam of theory and practice, is evident in teaching practices that present themselves as mature, reflective, and philosophically grounded. These practices are evident in discussions about the lives of people who will educate in and are from the countryside. In this study, we also cast our gaze beyond the immediate by embracing the idea of transposing problems as a means of questioning, problematizing, and queering realities. In other words, the practices of rural education for students in this territory can emerge from problems that are, a priori, politically, pedagogically, and culturally transported from short films situated as means of revelation, grounded in the mathematics of life in cultural terms, and in accordance with the training practices for rural education graduates. In our view, this transposition leads to a way of acting that favors a way of thinking. In this study, this way of thinking is grounded in the African philosophy of Ubuntu, which sustains ways of life. Ultimately, this may constitute a *praxis* of the countryside full of collective life and critical future teachers who challenge the ills and impositions of a capitalist society.

We now turn to our theoretical framework, which is based on critical assumptions and embraces the idea of teaching as a foundation for shaping the lives of pre-service teachers. Furthermore, this *praxis* is exposed to the structure of capital as a system involving future teachers that needs to be problematized.

In this case, we address the problems that arise in reality and are expressed/revealed by cinema. Thus, theoretically, we move toward overcoming the egoistic character of capital through collective action based on Ubuntu ethics. In this sense, let us follow the movement.

2 Critically drawing on frameworks for life 1 Critically drawing on frameworks for life

As we examine *praxis*, we understand, drawing inspiration from Freire (1987, p. 149), that "we will be true critics if we live the fullness of *praxis*. In other words, we will be true critics if our actions involve critical reflection that continually organizes our thinking and leads us to transcend a strictly naive understanding of reality." In other words, *praxis* is an action that intrinsically contains reflection and implies a transformation of reality. Thus, it also connotes the need for a critical stance toward the world, in our view.

Furthermore, according to Vanini and Rosa (2012, p. 4), *praxis* "marks the conditions that make the transition from theory to practice possible and ensures the intimate unity between the two." In the context of this study, *praxis* is understood as the harmonious relationship between action and reflection—that is, action grounded in philosophical premises, open to continuous reflection and critical engagement with the world. We understand teaching *praxis* as the set of theoretical foundations that underpin and enable action regarding the reality of everyday school and educational life. This involves engaging with that reality, particularly about minorities, excluded people, and subjugated individuals. Reflecting on *praxis* means reflecting on teaching theory and practice in harmony with one another in the interest of life and the collective.

Given this, it must also be clear that "in the realm of socioeconomic structures, the most critical knowledge of reality, which we acquire through unveiling it, does not bring about a change in reality by itself" (Freire, 1997, p. 16). We understand that this lack of change is

conditioned by the system in which we live. Our daily lives and society, in educational and mathematical terms, are embedded in a capitalist system that often conditions us to act unempathetically. Capitalism as a life goal requires individualism, possession, and self-interest while setting aside empathy, which is the process by which an individual places themselves in another's shoes and is affected by the emotional state of others. Empathy involves understanding feelings and sharing the perspective of that other person, with reactions that express such understanding (Moitoso & Casagrande, 2017).

Furthermore, regarding capital as a structure, which also manifests in education when schools are treated as businesses, we follow István Mészáros (2008, p. 15), who offers a critique of this structure in his book *Education Beyond Capital*.

Institutionalized education, especially over the past 150 years, has served—on the whole—the purpose of not only providing the knowledge and personnel needed by the expanding productive machinery of the capitalist system, but also of generating and transmitting a set of values that *legitimizes* the dominant interests, as if there were no alternative to the way society is managed [...].

Thus, we believe it is necessary to uphold a teaching *praxis* attuned to its operating context. In other words, reflecting on and understanding the capitalist system may catalyze meaningful social change. This requires reflecting on the system itself to challenge discourses that perpetuate capitalist values. We agree with Freire (1987, p. 169) who states: "The antidote to this manipulation [by the ruling classes] lies in critically conscious organization, whose starting point, for this very reason, is not to instill revolutionary content in the masses, but rather to problematize their position in the process."

We understand problematization as engaging individuals in the process of becoming aware; it is a process to be lived through. In this context, inviting a constant critical stance and challenging what is imposed as the sole correct way of knowing, doing, or understanding mathematics ultimately aims to modify the contested reality. With this, we move forward and explore the possibility of transposing problems—that is, problematizing them *a priori*. With this, we extend an invitation to

[...] We want to go beyond the initial form of the problem, reflect on it, transform it, and understand its position in another place or in-between space. We want to problematize the problem itself by questioning it and probing what is revealed at first glance. In other words, we need to consider the different perspectives that the problem reveals *a priori*. For us, this act of problematizing the problem is what distinguishes problematization from other forms of criticism. *We must transpose the problem*, challenge its target, and question the context and details rather than simply accepting the initial conditions through structured argumentation (Rosa & Giraldo, 2023, p. 18, emphasis added).

Therefore, reframing the problem requires questioning the problem itself, refusing to be stifled by empirical results, and challenging oneself to seek information, contexts, and different perspectives. This proposition aligns with Freire's (1977, p. 86) view that "it is necessary to encourage questioning, critical reflection on the question itself, and consideration of what is intended by this or that question, rather than passivity in the face of the professor's discursive explanations—which are, in a sense, answers to questions that were never asked." Thus, this act of stimulation constitutes a movement toward problematizing *praxis* in mathematics education, rural education, and life itself. It leads one to question what is imposed as a "norm" or "rule" without discussion.

According to Mészáros (2008, p. 51), we justify the need to transpose problems.

[...] “maintenance” is only *active* and beneficial to Capital as long as it remains active. This means that “maintenance” has (and must have) its own basis of rationality, regardless of how problematic it may be in relation to the hegemonic alternative of labor. That is, it must not only be produced by the structurally dominated classes of individuals at a given moment in time, but it must also be *constantly reproduced* by them, subject (or not) to the permanence of its original basis of rationality.

Thus, in addition to challenging the subject’s worldview, addressing the problem must highlight, expose, and challenge the rational framework that perpetuates privilege, oppression, and favoritism toward a specific class. Perception in *praxis* engages with lived processes in the transposition of problems. These processes are typical of mathematics and are considered lived activities involving measurement, comparison, relation, argumentation, rationalization, and demonstration. Thinking about mathematics in this way diverges from the notion of a single, ready-made, finished, supposedly universal, white, Eurocentric, mercantilist, content-driven, individualistic mathematics (Matos & Quintaneiro, 2019; Rosa & Giraldo, 2023). At the same time, problematizing what is taken for granted is a mathematical process and a premise evident in the original conception of rural education. In our view, this cannot be overlooked in the field’s *praxis*.

Regarding the spelling “Mathematics,” we emphasize that it refers to an academic, sovereign mathematics imposed as unique, universal, and superior (Rosa & Giraldo, 2023). Without detracting from its advances and contributions to society, we recognize its importance while also seeking openness to and awareness of other possible epistemologies. Despite the importance of its historical advances, which result from its internal logic defined by axioms, theorems, and corollaries, there are other possible mathematical practices.

Although we acknowledge this, our critique of mathematics focuses primarily on the idea that producing knowledge means organizing and chaining statements. The more error-free these statements are, the closer they are to “true mathematics.” Giraldo and Roque (2021) and Rosa and Giraldo (2023, p. 2) regard this conception as unproblematized mathematics. The latter state that unproblematized practices are “[...] practices that rigidly follow the order of the structure, are decontextualized from the problems that give rise to the ideals, and are not oriented toward the production and mobilization of meaning by the subjects involved.” Thus, a distinctive feature of this mathematics is the idea that “knowing mathematics” is directly associated with the ability to reproduce it in a technical, quasi-mechanical, or even mechanical way.

In this sense, the critique lies in viewing error as a lack of “knowledge” or a gap. Consequently, someone who “knows mathematics” is someone who can reproduce a given algorithm from start to finish, whether it be a demonstration, proof, or exercise.

In this regard, we oppose this understanding of “knowing” because it concerns reproduction rather than creation, invention, or discovery. Moreover, it concerns that which does not stem from the student’s mathematical thinking and doing but rather encompasses rules and the mechanics of what is said to be done and reproduced. According to Freire (1997, p. 30), “If it is not possible to defend an educational practice that revolves around ‘common sense,’ then it is also not possible to accept an educational practice that nullifies ‘knowledge gained from experience’ and starts from the systematic knowledge of the educator.” Therefore, we understand that students are not blank slates waiting for the “banking” educator—in this case, the mathematician who deposits formulas and exercises to be repeated and tested based on

whether they are correct or incorrect. We believe it is necessary to reframe this "error," as the same author states: "Whoever observes does so from a certain point of view, which does not place the observer in error. The error is not having a point of view but absolutizing it" (Freire, 1996, p. 15). We also understand that the mistake would not be in disregarding the historical and cultural contributions of dominant European mathematics, but rather in considering them the only path.

Following this line of reasoning, as Rosa and Giraldo (2023, p. 11, emphasis added) state.

This framework [when viewed as a single entity], therefore, fails to give consideration to mathematical thinking itself—*the multitude of ways to relate, compare, order, locate, measure, and so many other actions that constitute this thinking*. It fails to recognize that the heart of education is people, not a commitment to content. It does not take into account the social contexts of schools—the slum engulfed in gunfire and the school caught in the crossfire, the hunger and social vulnerability of students, among so many other aspects—because, from this perspective, what matters is “knowing the content.”

Nevertheless, neither the territories where students live nor rural realities are taken into account. Therefore, these authors advocate for situated mathematics. This mathematics, written with a lowercase "m" and in the plural, explores the cracks and in-betweens and is grounded in a *praxis* for change. In short, it is mathematics that seeks the meaning of what is being done, knowledge open to the new, to creation, to invention, to imagination, and to revelation. Thus, the origin of knowledge, ways of doing, culture, and politics influence this type of mathematics" (Rosa & Giraldo, 2023, p. 3).

We assume that this movement toward understanding mathematics can foster welcoming environments open to dialogue, affections, the constitution of knowledge, and life itself and its unfolding. In fact, it is an approach that is antagonistic to ways of thinking that categorize themselves in relation to a power dynamic and do not admit what deviates from the established order or what is understood as "error," or a deviation from the single path toward fixed, a priori knowledge (Rosa & Giraldo, 2023, p. 8). This movement characterizes educating oneself through mathematics as "what is learned and allows each person to produce meanings within their collective, which is humanitarian and non-exclusionary" (Rosa, 2008, 2018, 2022). Thus, mathematics can be understood as a process of life.

Thus, educating oneself through mathematics is challenging. According to Freire (1997, p. 37), "Starting from 'knowledge gained from experience' to overcome it is not to remain within it." This process is anchored in vivid experiences that shape life, culture, and society by challenging and problematizing them. By extension, "it is these mathematics that we wish to unveil, teach, and produce—mathematics with decolonial foundations; mathematics that recognize and legitimize the voices of peoples and groups rendered invisible by coloniality; mathematics that recognize and legitimize the voices of those excluded from the structural order in all its aspects" (Rosa & Giraldo, 2023, p. 22).

Furthermore, creating tension constitutes *praxis*. In our view, educating oneself through mathematics and cinema can reveal a fruitful space in mathematics education and education in/of the countryside.

Among other things, cinema portrays pivotal situations that highlight financial concepts and critical debates about exorbitant profits. An example is the film *The Wolf of Wall Street* (Scorsese, 2013), in which Jordan Belfort (the wolf) is a daring Wall Street broker with a lot of

money and a life marked by parties, drugs, and greed. Belfort defies the FBI, embodying the heyday of financial capitalism and neoliberal policies of the 1980s. Neoliberalism endorses free-market practices, individual freedom, and self-management to consolidate the power of the dominant, individualistic, ego-driven class.

Similarly, but in a different direction, films such as *M8: When Death Saves Life* (De, 2019) embody the collective and ancestral spirit. These films present the reality of a young Black man who enters medical school through affirmative action and embraces the idea of the collective. This idea emerges from his encounter with a cadaver during his first anatomy class. In other words, he meets M8, the cadaver that will serve as a subject for study for him and his classmates. However, the mystery of the body's identity is solved only after he confronts his own anxieties alongside his peers and ancestors.

In the face of films like *M8: When Death Rescues Life* (De, 2019), we examine what the films reveal and link these aspects to underlying philosophical reflections and perspectives. In this case, we refer to Ubuntu philosophy, which encompasses ways of envisioning life that resonate with the student's reality. This culminates in the final scene depicting M8's funeral. Named after the African philosophy ubuntu, this concept can be translated as "what is common to all people" (Nogueira, 2011, p. 148). Thus, the etymology of the word informs us that "ubuntu" indicates "everything around us, everything we have in common. 'Ntu' means the essential part of everything that exists, everything that is being and transforming." In other words, Ubuntu aligns with the Xhosa and Zulu maxim: *Umuntu ngumuntu ngabantu* (a person is a person through other people). This is evident when M8 takes responsibility for the burial of dozens of deceased Black boys who were never given a proper funeral and were reported missing.

Regarding the Ubuntu philosophy itself, Nogueira (2011, p. 148) emphasizes.

Even within the African diaspora, societies that speak languages of the Bantu linguistic family share the notion that the community comprises three dimensions: the ancestors, the living, and those yet to be born. Ethics must consider all three dimensions, since a person's fulfillment lies in their interactions with others. It is essential to take into account the ancestors and those yet to come.

Thus, Ubuntu takes shape through our ancestors and those yet to come. In this way, we understand that the idea of an ancestral future involves moving forward with a steadfast desire to engage with the world, to use concrete strategies, and to respect the three dimensions. This projection involves dreaming of the future, taking responsibility for our ancestors, and being guided by today's political hexis (Rosa, 2022a). All these dimensions encompass an act of projection because it is not enough to think only of being with those present, those who share this space-time with us, or those who will come. We must also think of those who have passed and no longer have a physical presence on Earth but have left us a legacy. We must respect, listen to, and be with our ancestors.

According to Ubuntu philosophy, I have no future if you have no future. This idea transcends the ontology of human nature, prompting us to reflect on our actions as a global community, as Krenak (2020) guides us. In this sense, Krenak (2020, p. 10) further corroborates this idea by strongly criticizing the capitalist system.

It's as if they've chosen a caste—humanity—and deemed everyone outside of it subhuman. This mindset encompasses not only the *caíçaras*, *quilombolas*, and indigenous peoples but also every life we have deliberately left by the wayside. The path is progress, the forward-looking idea that we are heading somewhere. There is a

horizon, and we are heading there. Along the way, we leave behind everything that doesn't matter—the leftovers, the subhuman—and some of us are part of it.

This reflection relates to envisioning an ancestral future. We understand that such a future is not possible until differences are legitimately respected on a collective level. For Ubuntu, "I am because we are" (Rosa, 2023c). Thus, one can mathematically address possibilities that encompass an understanding of the necessity of the other in our own lives within this collective of the self—with oneself, with others, and with the world. Next, we will discuss the methodological process of this investigation to demonstrate how we explored the act of designing life through cinema.

3 Methodological Research Process: Designing Research Possibilities

Through an analysis of students' experience with animated short films in the Bachelor's Program in Rural Education – Natural Sciences, we investigated the understanding/construction of the act of designing. We found that the study's research methodology has a qualitative bias, as qualitative research does not seek to establish laws or generalizations. Rather, it seeks to deepen the understanding of social phenomena by valuing the subjective aspect of social action (Goldenberg, 2011). Thus, our study seeks to investigate and understand social facts rather than engage in the positivist search for a single "truth," which can be obtained without the researcher's subjectivity.

We analyze the act of projecting oneself, or launching oneself forward into the world. In this case, we examine the launch of a program for future rural educators. Specifically, we conducted our research in a class of the Bachelor's Program in Rural Education—Natural Sciences at a public university in the southern region of the country. The class was chosen because one of the researchers is a faculty member there. The class consented to the research by signing Informed Consent Forms, and the program coordinators authorized the research through a Letter of Consent. The University's Research Ethics Committee (CEP) approved the research with the Certificate of Submission for Ethical Review (CAAE) No. 76748723.2.0000.5347.

According to the Pedagogical Project of the Special Undergraduate Program for the Bachelor's Degree in Rural Education – Natural Sciences 2023 (CLASS 5), one of the three general objectives of the Bachelor's program is to "develop training strategies for interdisciplinary teaching within a curriculum organized by areas of knowledge in rural schools and other educational settings." To this end, the program has adopted an alternating schedule of school and community time. School Time, which accounts for 70% of the program, consists of in-person training sessions at the university or, in this class, at a rural public school in the city where the students live, through a partnership with the city government. Community Time, the remaining 30%, is delivered through training and activities in rural communities.

Based on this, in the 60-hour course "Mathematics for the Training of Rural Educators: Natural Sciences," we plan to address models and situations in this area. We will interweave concepts such as number sets, exponentiation, root extraction, scientific notation, factoring, and functions with socio-ecological issues.

Our pedagogical proposal reflects on mathematical thinking, emphasizing the knowledge necessary to study the natural sciences (particularly environmental sciences) and life in the countryside from a social perspective. It also reflects on the different forms of collecting, interpreting, representing, and presenting mathematical data, primarily through reading and interpreting situations revealed by the animated short films chosen for five discussion sessions.

To produce the empirical research data and address the stated research question, five sessions featuring short films were conducted from early October 2024 through late January 2025, as mentioned. The sessions used resources for data storage and production, including three tablets as audio recorders, the classroom's digital whiteboard, the Moodle platform, and the university's MConf distance learning platform. The group of 13 participants consisted of people from different age groups, most of whom were women. All participants came from rural backgrounds and had diverse realities and histories. In this study, their real names were preserved through pseudonyms that they chose.

Additionally, at the beginning of each discussion and interaction session, participants were asked to divide into three groups. Then, tablets were distributed so that there was one per group. Based on the animated short films, the groups reflected on five mathematical activities designed by the researchers, divided into two parts. The first part of the questions aimed to provide an opportunity to reflect on the short film's possible messages. The second part of the questions aimed to bridge the gap between the mathematical concepts outlined in the course syllabus and participants' diverse levels of knowledge. With this in mind, we will proceed to describe and analyze an excerpt from the research data that directly addresses the research question of this article. Thus, to understand the act of planning one's life, we will delve into the philosophy of Ubuntu and how the mathematics presented in the short film supports planning one's life from a perspective that highlights the collective, or the "we."

4 Description and analysis of the empirical data: toward designing one's life

In this article, we will analyze an excerpt from the animated short film *The Angler* (Jang, 2021), which offers food for thought on the concept of factoring. The film is set in a coastal village. The main character, Noah (Figure 1, left), is a fisherman who experiences misfortune when a fish eats his pendant. Since the pendant was a gift from a loved one, Noah embarks on a fishing journey that prevents him from socializing with others, such as the lamplighter Ivo (Figure 1, right). He is an active community member who rings the church bells in the morning and lights up the city at night. Furthermore, he shows empathy by helping others. One example of his helpful nature is when he cleans a citizen's glasses after the citizen was unable or unaware of the need to clean them himself. After several failed attempts to contact Noah, Ivo paints a fish on a wall to catch the fisherman's attention. This is a gesture of peace, and Noah begins to notice Ivo's presence. Tragically, however, the lamplighter suffers an accident and dies. Shocked by the character's sudden absence and its impact on the town, which now lies dark and silent, Noah decides to abandon his solitary journey and become a more active member of the community.

Figure 1: The characters Noah and Ivo

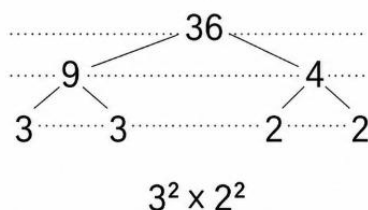


Source: Jang.

In this context, we aimed to achieve two things with our pedagogical approach to the animated short film: (1) discuss design through the lens of Ubuntu—"I am because we are"—to highlight collective consciousness, and (2) explore prime numbers and prime factorization. In light of this, Chart 1 presents the second set of questions administered to participants in this activity.

Chart 1: Questions from the third day, part two

- 1) → A decomposition of a number in a tree is a visual way, using a tree diagram, to show the decomposition of a composite number. The trunk is the number to be factored and the factors are the leaves, as shown in the example below.



- a) → Suppose fisherman Noah “is” the number 64. What would be a possible decomposition of this number in a tree?
- b) → Suppose candle maker Ivo “is” the number 60. What would be a possible decomposition of this number in a tree?
- c) → Thinking about numbers that “are” Ivo and Noah, how does Ubuntu philosophy connect them?
[Discussion about the philosophy that occurs in the first part of the activity]
- d) → Discuss how the Fundamental Theorem of Arithmetic “Every number can be written as a product of primes” from the perspective of Ubuntu philosophy.

Source: The survey.

To preserve the anonymity of our participants, we asked them to list the names of animated works with which they identified and explain their choices. These works could include anime, animated series, cartoons, films, and other cinematic productions.

Figure 2 shows the discussion of question “c,” Chart 1. This excerpt is from an in-person session (P), specifically the third meeting (E3). It was transcribed from a recording on tablet 1 (A1) on November 13, 2024. During this session, the participants (Frango, Moana, Mitsuri, Nala, and Snoopy), the professor, and the researcher discussed the mathematical activity. The transcription begins at 1 hour, 38 minutes, and 47 seconds and ends at 1 hour, 45 minutes, and 19 seconds.

Figure 2: Excerpt – Breakdown of Ivo and Noah – (P, E3, A1, GG, 12/13/2024, 01:38:47 ~ 01:45:19)

[01:38:47] **Teacher:** Let's move on to the third question. Thinking of the numbers as Ivo and Noah, in their decomposed form, how does Ubuntu philosophy connect them? What do you think?

[01:39:00] **Frango:** They are equal.

[01:39:02] **Teacher:** Equal how?

[01:39:03] **Frango:** When both are decomposed. Right? So, thinking about the numbers that represent Ivo and Noah, 64 and 60, one for each person, how does Ubuntu philosophy connect them? According to the philosophy, they became the root of existence, so to be the root of existence, they have to be equal.

[01:39:34] **Teacher:** But are 60 and 64 equal?

[01:39:37] **Frango:** They are not equal. That's why there is that question: mathematically different, but statistically equal. They are different in mathematics, 60 and 64, but not statistically.

[01:39:51] **Teacher:** They are not equal statistically either.

[01:39:57] **Frango:** Well, that's what we did.

[01:39:59] **Researcher:** Folks, what is it that...

[01:40:00] **Teacher:** Not just a little bit, otherwise we'll skip over it...

[01:40:05] **Frango:** We are wrong, and we want to correct it.

[01:40:08] **Teacher:** No, we are going to go deeper.

[01:40:10] **Moana:** One fits inside the other. They are not equal, but one can fit inside the other. Sixty can fit inside sixty-four.

[01:40:24] **Teacher:** But sixty-four cannot fit inside sixty. “Fit” in quotation marks?

[01:40:27] **Moana:** No, it cannot. That's why they are similar, but they are not equal.

[01:40:30] **Teacher:** Now let's see. We can come back to that later. What is interesting is that I think you focused only on the numbers, 60 and 64. I emphasized at that moment that it was “*in decomposed form.*” Think about the

numbers the way you considered them here: three times two times two times five times four.

[01:40:54] **Frango:** Ah, yes. In decomposed form, they are different.

[01:40:55] **Teacher:** No. Both in one form and in the other.

[01:40:57] **Frango:** Yes, but...

[01:40:59] **Teacher:** So, they are not... 64 and 60 are different. In decomposed form, they are also different. But how does Ubuntu philosophy — "I am because we are" — connect them? Girls, what do you think?

[01:41:18] **Nala:** We said that Ivo is not alone. He is in the exponent six. Two plus two plus two...

[01:41:27] **Teacher:** Not plus.

[01:41:28] **Nala:** It is times. Noah. And... he has an exponent... well, it's easier this way.

[01:41:41] **Snoopy:** Ivo is not alone; there are more exponents with him, accompanying him so that he becomes who he is. Two times two times three times five. He has other exponents that make him up.

[01:41:56] **Researcher:** There are other factors.

[01:41:58] **Snoopy:** Other factors. Exactly.

[01:42:01] **Teacher:** Exponents are this here [pointing to the board, to the numeral corresponding to the exponent symbol]. That's why I wasn't understanding.

[01:42:04] **Snoopy:** Okay. Other factors. Noah has only one factor, which is the number two, repeated six times, so that he can be who he is. Ivo is composed of several factors, while Noah is made of only one.

[01:42:27] **Mitsuri:** Very cool!

[01:42:28] **Teacher:** Did you understand what they said?

[01:42:29] **Mitsuri:** Yes.

[01:42:31] **Teacher:** Then explain to me what they said. Give it a try.

[01:42:38] **Mitsuri:** Ah, I understood that because [Ivo] is a composite number, unique... that's what I understood, unique. Being composite, he is different from the others. The other is composed of a repeated number, while the remaining factors are...

[01:42:57] **Frango:** They had more relevant factors that made him different from Noah.

[01:43:05] **Researcher:** Right, but they are composite numbers. Period.

[01:43:08] **Frango:** Exactly.

[01:43:08] **Researcher:** The issue being raised here is that this one [pointing to the number] has other things that make him different. He has other factors.

[01:43:19] **Frango:** Exactly, that's what I understood. Yes, other factors. Factors that make him different.

[01:43:23] **Researcher:** That's right. Exactly. Ivo is different because 60 is different from 64, but he is not composed of only one prime factor, which is 2. Two, two, two, two.

[01:43:37] **Frango:** He is made up of only one factor.

[01:43:40] **Teacher:** Yes. But let's go back. Remember the previous question? What is Ubuntu?

[01:43:48] **Nala:** We are all one. All for us. All of us... for us.

[01:43:56] **Frango:** I am because we exist.

[01:43:59] **Teacher:** Because we are. So, look, you said that Ivo represented Ubuntu. Why? Because he had a representation within a community. Community means other people. Therefore, the number 64 exists because there is the number 2; because there is the number 3; and because there is the number 5.

[01:44:29] **Researcher:** Sixty. [Correcting the teacher's slip]

[01:44:31] **Teacher:** Sixty, yes. I mean, 2, 3, and 5. Two and two make four. Four, three, and five. These would be different people. Therefore, Ivo is who he is and only exists because other people exist. Yes or no?

[01:44:52] **Frango:** Yes, because one was a community and the other...

[01:44:57] **Teacher:** The other one, you said, was individual. Right? Up to a certain point, and then it became... You said it became a community spirit...

[01:45:11] **Frango:** Ah, now I understand the phrase.

[01:45:17] **Researcher:** Which phrase?

[01:45:19] **Frango:** "I am because we are." Now I understand, yes. He did not see himself as part of a community; that is, he was isolated. Right? And the other one was not. He lived in a community. He was isolated, too, but he had one additional factor. Then, when the other one passed away, he learned.

Source: The survey.

We will begin our analysis of this excerpt with the professor's question about how the philosophy of Ubuntu connects Ivo and Noah mathematically—that is, in relation to their decomposed forms. At [1:39:00], Frango states that Ivo (the lantern-lighter) and Noah (the fisherman) are "equal" in that they can both be decomposed in the same way. However, this understanding is not guaranteed, as the professor asks at [1:39:02]: "Equal in what way?" At 1:39:03, Frango replies, "When both are decomposed. Right?" At this point, the professor's

understanding aligns with ours. Frango understood that Ubuntu manifested as *praxis* by articulating the theory and depicting the practical lives of Ivo and Noah (Vázquez, 2007). This understanding is reinforced when Frango adds, "According to the philosophy, they became the root of existence. So, to be the root of existence, they have to be equal." We understand that Frango's reasoning is flawed mathematically. If both "became," then "they are equal." It is as if we were to say: "If two numbers squared result in 9, then they must be equal." This would be a false generalization because it fails to consider the particularities of what is being squared. While we can square two numbers, 3 and 3, to get 9, we can also consider 3 and -3, which, when squared, both result in 9 but are not equal. Thus, mathematically, the professor's statement when he asked, "But are 60 and 64 equal?" at [1:39:02] also seems to corroborate this understanding. However, the approach is not erroneous. In our view, Frango allows the situation to reflect what Freire (1996, p. 23) reveals: "There is no teaching without learning; the two explain each other, and their subjects, despite the differences that characterize them, are not reduced to the status of objects of one another."

Furthermore, the professor's question at 1:39:02, "But are 60 and 64 equal?" prompts reflection on what was said and on the meaning of "equal."

In this vein, we understand the merit of living with the certainty that part of one's teaching task is to not only teach content, but also teach how to think (Freire, 1996, p. 27). Here, education (and self-education) is provoked by mathematics through reflection on the statement. Thus, Frango is prompted to think about prime factorization and its relationship to Ubuntu. However, at [1:39:37], he quickly presents an argument that relies on a common-sense fallacy without reflecting on what was said: "They are not equal. That's why the question is: mathematically different and statistically equal. They are different in mathematics: 60 and 64. But in statistics..." The professor asserts that they are not equal, even in statistics, to prevent the dialogue from veering toward another issue. At [1:40:00], the professor says, "Not just a little bit, or else we'll skip...", and Frango promptly jumps in at [1:40:05] and says: "Yeah, we're wrong, and we want to correct it." The professor, in turn, states at [01:40:08]: "No, we're going to get to the bottom of this." This reveals an attempt to point out an "error" while seeking to understand Frango's statement.

In this case, we understand that the professor's prompt statement was motivated by the fear that the class might take the statement about statistics as absolute. After all, "whoever observes does so from a certain point of view, which does not place the observer in error." The error is not having a point of view but absolutizing it" (Freire, 1996, p. 15). The information provided led the professor to disregard the quantitative difference between 60 and 64, even though they differ. This interpretation, in our view, emerged alongside a critical inquiry into why the numbers were considered equal even though they were different. In other words, the professor did not express Frango's statement as an "error" to give legitimacy to his position in the social hierarchy, but rather as a way to deepen understanding. In any case, Frango recognizes that he and his group were wrong, as evidenced by the professor's affirmative response, even though the professor did not explicitly state that it was a mistake.

In any case, this issue persists, prompting further discussion. At [01:40:10], Moana makes her own attempt to approach the object of cognition, stating that "one fits inside the other; they are not equal, but one can fit inside the other. 60 fits inside 64." This argument also considers the mathematics related to set equality.

If two sets, A and B, neither of which is the empty set, are such that A is contained in B and B is contained in A, then $A = B$. When asked, Moana expresses an important application of logic: "No, it doesn't fit. That's why they're similar but not the same." In other words, 60 fits inside 64 (A is contained in B), but 64 does not fit inside 60 (B is not contained in A); therefore,

60 and 64 are different. We consider Moana's argument understandable, but it does not guarantee numerical recognition of equality. A complement related to the Ubuntu philosophy was also missing, which was part of the question. We believe that seeking reflection in different ways contributes to the collective realization of education through mathematics, with respect for different points of view. As Krenak (2020, p. 33) writes, "The fact that we can share this space, that we are traveling together, does not mean that we are equal; it means precisely that we are capable of attracting one another through our differences, which should guide our life's journey."

Continuing the dialogue, Snoopy attempts to finish his classmate's thought at [01:41:41]: *"Ivo is not alone. There are other exponents with him, accompanying him so that he becomes who he is: Two times two, times three, times five. He has other factors that make him who he is."* Although the professor/researcher pointed out that Snoopy replaced the term "factor" with "element," he still expresses the concept of factorization and the ideas associated with it. He uses the short film as the basis for his perspective. In addition to presenting a coherent argument about Ubuntu ("I am because we are"), he states that "Ivo is not alone; there are other exponents with him, accompanying him so that he becomes who he is." We also understand that, in addition to correctly performing the prime factorization of 60—"Two times two, times three, times five"—Snoopy notes that, although they share common factors, Ivo "has other exponents [factors] that make him up," that is, factors that constitute him and make him who he is.

Similarly, Snoopy highlights another meaning of prime factorization at [01:42:04]: "Noah, on the other hand, has only one factor: the number two. It repeats six times to make him who he is. Ivo is composite; Noah is one in a thousand." Thus, we note that Snoopy can structure his argument using mathematics because he can distinguish between factors and exponents. He also affirms the uniqueness of the individual, even though Ivo and Noah share certain factors. "Noah is one in a thousand," he says, "since only he is decomposed in that way." In our view, this highlights the collective learning that occurs through mathematics, since Nala and Snoopy discussed and arrived at the connection between factorization and the Ubuntu philosophy together. One concept serves as the basis for understanding the other.

At 1:42:38, Mitsuri presents an argument that we infer has a similar meaning to that revealed by Snoopy when she states, *"Ah, I understood that because he [Ivo] is a unique composite number. That's what I understood: unique and composite. He's different from the others. The others are composed of a large number, and the rest of the factors are..."* Although her essay contains key elements for understanding the underlying mathematical concepts (factors, composite numbers, and large numbers), she is unable to articulate the relationships among them clearly. This leads Frango to step in at 1:42:57 and try to help her. He articulates and establishes the relationship between factor and relevance: *"They had more relevant factors that made Ivo different from Noah."* Given this, we understand that Frango associates different factors with the term "relevant," attributing to the term the idea of being different. This is confirmed later, at 1:43:37, when Frango states: *"Exactly. That's what I understood. Yes, other factors. Factors that make him different."* In this case, the dialogue and collective expression reveal to us the materiality of educating oneself through mathematics, in perceiving the idea of being with others like the "being" of a number, which exists only because the numbers that compose it exist in the same way. For us, this occurs through the short film that "challenges students to engage critically with the world so they can act upon it" (Giroux, 2016, p. 298).

Continuing the discussion, when asked at [01:43:48] what Ubuntu is, Nala states: *"We are all one. All for us. All of us...for us."* At [01:43:56], Frango replies: *"I am because we exist."* The professor adds at 4:43:59: *"Because we are. So, you said that Ivo represented Ubuntu."*

Why? Because he played a role in the community. Community means other people. The number 64 only exists because there is a two, a three, and a five." Frango returns to his idea of Ubuntu, stating at [01:44:52] that *"yes, one was community."* Thus, they both assume that a person is defined by their relationships with others—in the case of decomposition, by the presence of other numbers—to understand that: *"If a person's fulfillment always lies in interaction with others, it's essential to consider the ancestors and future generations"* (Nogueira, 2011, p. 148).

This can be seen in what Frango expressed at 1:45:11: *"Ah, now I understand the phrase."* His inclination toward revelation gradually unfolds with each challenge as he critiques himself. This culminates in his explanation at 1:45:19: *"I am because we are."* Now I understand. He didn't feel part of a community. In other words, he was isolated, like the fisherman. Right?" The other one wasn't isolated; he lived in a community. But there was an additional factor. The moment the other one passed away, he learned." Therefore, we agree with Freire (1996, p. 31) that the learner "by critiquing oneself—thereby developing epistemological curiosity—methodically 'tightens' one's approach to the object, thereby making one's findings more accurate." In this way, Frango, through dialogue with others, weaves together considerations that allow him to understand more and more. Thus, through his curiosity, he weaves together important comments on the common factors that unite us in community. "[...] and the case of the other was different. He lived in a community and was also isolated, but he had one additional factor." That factor was living together, sharing, caring for others, and being with people at all times.

5 Our vision... Toward a process of self-education, because we exist only because others exist

This article investigated how experience with short films in mathematics classes manifests in dialogue between faculty and students in the Bachelor's Degree in Rural Education (LEdOc)—Natural Sciences program regarding life. We emphasize that this study presents only a snapshot of this context, since we have highlighted only one moment experienced with the selected short films.

Throughout the presentation, the experience with the animated short film emerged as reflective empirical evidence, grounded in mathematics, of the collective need to educate and to educate oneself for a better world, as portrayed in the discussion of the lives of Ivo and Noah. In other words, teachers must pay closer attention to what students express to move beyond a system that defines the math classroom by error. Similarly, educating ourselves through students' mathematics—understanding it in different ways or using it to comprehend the world and life—allowed us to realize that numbers need one another to be what they are. That, in the same way, we need other people to be who we are. Thus, future educators developed arguments that employed various forms of rationality through mathematics. During the group discussion, mathematics educated them as they gave meaning to what they were learning in mathematical terms and Ubuntu philosophy. One perspective supported the other.

Finally, we highlight that the experience was relevant because it required critical thinking. This was achieved by approaching the object of knowledge in various ways, which gave it meanings beyond "right" or "wrong." Thus, we emphasize the educational process of mathematics that challenges this dichotomy and emphasizes collective thinking and action.

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Conflicts of Interest

The authors declare no conflicts of interest that could influence the results of the research presented in this article.

Data Availability Statement

The data generated, collected, and analyzed in this article will be made available upon request to the authors.

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