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## Assessing the Role of Education in Limiting the Negative Effects of Gold Mining on Young People in Dangassa's Rural Community in Mali

Drissa KANTE<sup>1\*</sup>

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### ABSTRACT

This paper presents the findings of qualitative research that explores education as a means to reduce the negative effects of artisanal gold mining on youth in Dangassa, Mali. Artisanal and small-scale mining has changed rural livelihoods and it's exposing youth to dangerous working conditions, environmentally damaging practices, and educational disruption. Based on social resilience theory and education for sustainable development, this study reveals youth and community perspectives of the impact of mining as well as educational outcomes. Data were collected using in-depth interviews, focus group discussions (FGDs), and participant observations with youth, educators, community leaders and NGO representatives. Results indicate that, although formal schooling regularly cannot compete for time over immediate and lucrative returns from mining operations, experience-based vocational-environmental hybrid education built into local sociocultural structures appears to be valid mechanisms of fostering resilience. The study identifies economic pressures, cultural tensions and resource limitations as major barriers and the partnerships between government and NGOs and the sharing of knowledge across communities as major opportunities. In some sense, education works best not as a substitute for mining but as a building block for better practices, more diversified livelihood avenues tenable without new mines, and collective community protection from the harms caused by resource extraction.

### INTRODUCTION

Artisanal and Small-Scale Gold Mining (ASM) activities have rapidly expanded in the rural community of Dangassa, Koulikoro region of Mali over two decades leading to profound changes in local livelihood structures and socio-economic dynamics. In this area, the expansion of informal mining activities, emblematic of Mali's more widespread gold rush phenomenon, has led to significant youth migration toward and between agricultural production systems and mining sites, exposing young people to dangerous working conditions, serious environmental degradation processes and interrupted educational trajectories. Artisanal mining has also been linked to school enrollment rates, reports of higher rural household income but lower enrolment in mining-concentration areas (Keita, 2020), highlighting the tension between economic survival and human capital in resource-dependent communities like Dangassa.

Gold mining is the only industry of note and accounts for 8-10% of GDP and more than 70% of export earnings in Mali, transforming rural communities such as Dangassa where artisanal mining offers young people an alternative to subsistence farming. But this practice is highly damaging to the environment—including deforestation, mercury poisoning, and water contamination—and it disproportionately affects young people in terms of health risks (Maconachie, R., & Hilson, G., 2016) and educational interruption. It is important, therefore, to explore how education systems can mitigate these impacts through equipping youth with the environmental

literacy and sustainable livelihood skills that are necessary to thrive in this new era.

For rural mining communities such as Dangassa, Mali, youth populations are particularly vulnerable to the harmful effects of artisanal gold mining: from high-risk working conditions and mercury pollution to school dropouts and the lack of viable livelihoods (Banchirigah, S. M., 2008). These vulnerabilities are further compounded by systemic factors poverty, weak regulatory enforcement, and insufficient social infrastructure that cumulatively threaten young people's physical health, cognitive development, and long-term socioeconomic mobility. Exploring and understanding the interlocking risks is critical to devising effective responses that can protect youth while also promoting sustainable community development.

### Problem Statement

Artisanal gold mining in rural Mali places like Dangassa, raises significant concerns for youth due to the health risks associated with mercury exposure, injury and psychological trauma. These dangers are compounded by education disruptions, with evidence from neighboring Burkina Faso showing that proximity to mines reduces school enrollment through shifts in household labor and falling perceptions about school returns as mining provides low-skill high-wage alternatives (Guirking, C., & Stoeffler, Q., 2025).

Mali's legal obligations to ban child labor and guarantee free schooling are largely ignored, while obstacles

<sup>1</sup> College of Education at Zhejiang Normal University, China

\* Corresponding author's e-mail: [kantedrissa25@gmail.com](mailto:kantedrissa25@gmail.com)

including school fees chargeable in cash or kind continue to keep children out of the classroom. Education could be a powerful, potential solution to ending this cycle of mining wilted poverty and spread wealth in poor regions but education faces structural challenges in informal economies, limited infrastructure and economic pressure which limit its effectiveness. This study seeks to investigate how education can be used as a shield for youth in Dangassa, considering its potential benefits and the hurdles preventing access (Human Rights Watch, 2011).

### Research Significance

This knowledge is critical in formulating effective measures to address the adverse effects of gold mining on youth in Dangassa's rural community. This work provides invaluable insights for policymakers, community leaders, and development practitioners by demonstrating that education can empower youth with the knowledge, skills, and alternatives to dangerous mining activities. It highlights the need for education initiatives to be part of wider community development and sustainability-oriented activities aimed at building resilience, addressing vulnerabilities, and ensuring long-term socio-economic viability as a result of mining.

### Research Objectives

1. These focused on the perceptions of youth and community stakeholders regarding how gold mining has affected their communities.
2. To understand the impact of educational programs on youth awareness and resilience.
3. To explore barriers and opportunities for educational interventions

## LITERATURE REVIEW

### Mining Gold and Its Socio-Ecological Effects

ASGM in Mali and throughout West Africa poses serious multidimensional crises to youth populations, including grave health hazards, environmental degradation, and severe social disruptions. For us, using a recent paper by Watts *et al.*, (2023) as an example: In Mali about half a million people work in the artisanal gold mining industry and almost 40000 of them are child miners, beginning to work at six years old and thus exposed to mercury and cyanide contamination causing neurological diseases, respiratory diseases and developmental impairments.

The environmental impacts are also catastrophic; studies show that Mali's major water systems, such as the Falémé and Bafing rivers and, were heavily polluted with toxic chemicals used in gold extraction which have made fish and water resources unfit for consumption as well as disrupting natural draining systems damage which is estimated to take almost two decades to recover from even if all mining activities ended abruptly (Mines Actu., 2023). Similar to ASGM reviews from Africa, the same studies indicate social challenges faced by villages, such as child labor, school dropout, violence, and increased

HIV/AIDS, which in turn lead to poverty cycles and rural findings (Banchirigah, S. M. *et al.*, 2010).

### Youth Vulnerability in Mining Communities

Recent studies of youth vulnerability in West African mining communities are tapping into the multidimensional crisis facing young populations in artisanal gold mining contexts, where intersecting educational disruption, health hazards and social marginalization threaten to compromise human capital development. Finally, drawing on nationally representative Demographic and Health Survey data and first-hand household surveys from Burkina Faso, Guirkinger and Stoeffler (2025) show that proximity to artisanal gold mines is associated with enrolment in primary school falling by as much as 15.8 percentage points among boys due to children replacing parents as agricultural laborers because of reduced perceived returns to education effectively demonstrating how mining economies unintentionally derive the opportunity costs of schooling upwards through indirect channels and reinforce inter-generational poverty traps.

Adding to these macro-level observations, Sulemana (2025) draws on qualitative methods in Ghana's Upper West Region to show how hazardous child labor in small-scale mining results not only in debilitating educational deprivation but also health challenges including respiratory ailments, musculoskeletal injuries and mercury exposure among youth who either try to balance work with education or drop out of school altogether and argue that the weak enforcement of existing laws against child labor as well as household economic precarity generates cycles of vulnerability that undermine SDGs 4 (Quality Education) and 8 (Decent Work).

Collectively, these studies demonstrate that in rural mining communities including Dangassa, Mali, youth experience considerable systemic barriers to educational attainment coupled with serious occupational health hazards, emphasizing the urgent need for integrated policy responses addressing both the economic determinants of child labor and structural deficits in school entry and health safeguarding.

### Importance of Education in Community Development

It is not only a social intervention catalyst for socio-environmental degradation, but rather the education as a transformative factor of empowerment to youth and behavioral change in mining-impacted communities. Modern contributions highlight that education focuses on initiating greater community awareness of both environmental and occupational hazards linked with artisanal and small-scale mining, while simultaneously equipping the youth with skills for sustainable livelihoods to reduce dependence on extractive industries (Merem, E. C. *et al.*, 2017).

Targeted education and social programs have demonstrated success in empowering youth voice and agency through educational advancement, as evidenced

by knowledge toward health safety measures, master ICT tools, law on environment, and sustainable practices of resource management in various contexts, including West African mining regions (Alotaibi, O., 2024). In addition, other approaches to compulsory education like ensuring kids stay in schools instead of gaining access into mining camps show significant impacts upon reducing child labor exposure and the antisocial proclivities associated with unregulated mining economies (Mukamana, A., 2025). Such educational interventions lead to pathways for youth empowerment on a broader level where it goes behind behavioral change and drives collective community action towards environmental stewardship & sustainable development.

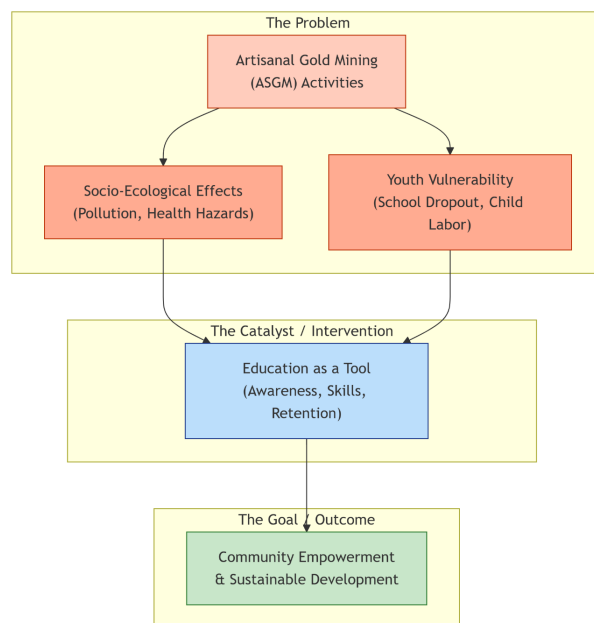
### Previous Qualitative Studies

It builds on relevant qualitative research from similar mining contexts in West Africa, offering insights into this complicated and nuanced relationship between artisanal gold mining and youth education (Besana, M. G., & Hinlayagan, K., 2024). A 2023 qualitative study of industrial gold mining communities in Burkina Faso conducted key informant interviews with community leaders, healthcare providers and mining officials across three mining sites that highlighted the different perspectives of stakeholders regarding the effects of this industry on educational institutions. Although

mining officials were keen to promote corporate social responsibility programs like construction of schools and scholarships for students, the community leaders/health care providers spoke against the encroachment of artisanal mining that once provided crucial sources of income for women's economic empowerment and parental financing of their children's education (Mazumdar, S., 2023).

Alongside these findings, a 2025 qualitative study in Ghana's Nabdum District sought to explore the dual implications of informal gold mining on educational achievement among young people through in-depth interviews and focus group discussions with 62 participants. This study revealed the paradoxical potential that artisanal mining represented for educational access: although mine profits gave youth resources to finance their own education as well as that of relatives, digger students often faced discordant academic experiences in which the demands of mining activity disrupted schooling, leading to decreased contact hours, tiredness-related lapses in attention and less classroom engagement (Arthur-Holmes, F., & Yeboah, J., 2025).

Together, shown by figure 1, these studies illustrate that education can be both an avenue for mitigation yet a casualty of gold mining activities which requires new community-based norms to the regulation sector alongside understanding of economic survival and educational continuity in rural mining communities.



**Figure 1:** Relevant literature vision

This diagram outlines that artisanal gold mining leads to environmental and social problems, especially affecting youth. Education is presented as a solution to raise awareness and foster skills, ultimately breaking cycles of poverty and environmental harm to achieve community empowerment and sustainability.

### Theoretical framework

#### Social resilience theory

According to the Social Resilience Theory, the social capital and local knowledge can help a community adapt and recover from both social and environmental disruptions (Adger, 2000). For instance, in a rural community in Mali

where gold mining has been linked to problems like child labor, disruption of education and health issues, this framework would indicate that strengthening education is a crucial means of building resilience (Bhounikh, 2019). Education provides youth with knowledge and skills enabling them to fight exploitation, gain better opportunities, and develop sustainable practices that will reduce the negative socio-environmental impact of gold mining. Educational program would empower social resilience and also cushion the impact of negative impacts of mining.

### Education for sustainable development

This study is based on the educational theory of Education for Sustainable Development (ESD), which acts as a guiding philosophy in integrating aspects of sustainability into early childhood practices. Against the backdrop of socio-economic challenges, ESD works towards empowering youth and local communities to take part in addressing environmental degradation induced by activities including gold mining that create undue socio-environmental impacts like pollution, land degradation and social global dislocation.

Indeed, this framework suggests that with education oriented to their context, the youth of Dangassa rural community can recognize the harmful effects of gold mining and the importance of alternative livelihoods

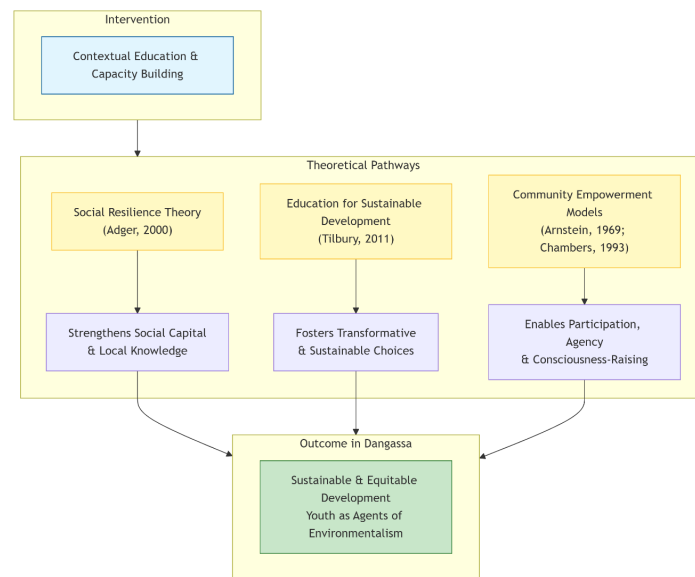
that ensure sustainability and resilience. This approach would mirror that of Tilbury (2011), in that education is an essential transformative tool to permit communities to make sustainable choices, and mitigate environmental degradation through proactive participation.

### Community empowerment models

This study is anchored in community empowerment frameworks the paper argues for participatory mechanisms that increase local agency and resilience (Arnstein, 1969). In particular, the model suggests that education is a crucial means of empowering youth in rural communities by raising their consciousness to socio-environmental concerns from gold mining, capacity-building and active engagement towards both sustainable practices. Introducing education initiatives on the negative impacts of mining activities will mitigate knowledge gaps and prepare youth for effective participation in environmental management and advocacy roles contributing to more sustainable and equitable community development (Chambers, 1993).

In figure 2, these frameworks highlight that equipping the youth with education generates social change by shifting from passive receivers of active interference to agents of environmentalism within their local Dangassa community.

These theories' intervention offers education and capacity



**Figure 2:** Explanation of theoretical frameworks

building for youth, which through social resilience, sustainable development, and community empowerment, enables them to become active agents of sustainable and equitable development in Dangassa.

## MATERIALS AND METHODS

### Research Design

Qualitative methods were utilized to examine the role of education for youth, as a means of mitigating some of negative socio-environmental consequences associated

with gold mining in Dangassa's rural community within Mali. Data collected through in-depth interviews and focus group discussions, as well as observational data involving the participants aims at providing not only contextual insights into how educational initiatives and community perceptions shape youth engagement, awareness, and resilience surrounding the challenges attributed to gold mining. Results were thematically analyzed to understand education as a mechanism linking youth experience(s) in gold mining areas, and contributing

to community resilience against the negative implications of gold mining.

### **Study Setting**

#### **Sample Size and Participants**

The research has included around 15-30 members of the community, local educators, community leaders, local NGOs, and environmental experts whose children are directly impacted by gold mining. The exact number depends on data saturation when no new information is coming from additional interviews.

#### **Sampling Technique**

Key informants and focus groups' purposive sampling and participants' observations to make sure they have related experiences and knowledge regarding gold mining, education practice in the area, socio-environmental impacts endangering lives.

#### **Data Collection Methods**

Participant observations and Focus group discussions  
In semi-structured interviews with key stakeholders in Dangassa's rural community, we investigated perceptions and experiences regarding the potential for education to address youth-related socio-environmental impacts of gold mining. These interviews, then, were intended to provide insight into the ways that educational programs and community awareness shape resilience in youth and adaptation strategies to live amongst gold mining operations. Analyzing qualitative data yielded rich insights into community views, challenges, and opportunities to harness education as a mechanism for socio-environmental mitigation and youth development.

#### **Document analysis**

The data collection process followed a qualitative method, involving an extensive examination of policies, institutional documents, and pertinent texts to understand how educational efforts and frameworks engage with the socio-environmental effects of gold extraction on youth in Dangassa's rural community. Strategies, reforms and narratives in these documents were interpreted through content analysis to understand how education may be used to remediate adverse effects, raise awareness and support best practices with regard to the surrounding gold mining activity.

#### **Data Analysis**

##### **Thematic analysis**

This study is conducted using a qualitative approach analyzing interviews and focus group discussions and observations with students, educators, community members and local leaders narratively as well thematically. The focus will be on how education shapes the community's awareness and online experiences of socio-environmental impacts of gold mining in Dangassa's rural community. The analysis aims to uncover crucial themes pertaining to the impact of education in terms of raising awareness, building attitudes, and encouraging

youth engagement to reduce the adverse effects from gold mining. This will reveal how educational strategies may help the community to develop resilience and allow us to discuss any interventions we can promote for sustainable development and conservation of nature within the impacts of gold mining.

#### **Coding and identifying patterns**

Qualitative data analysis coding pattern relevant study methodology We will systematically use all of these three levels of coding, open coding, axial coding, and selective coding where we identify major themes regarding how education can offer education for the mitigation of socio-environmental effects of gold mining. The analysis aims to identify community perceptions, barriers and strategies by identifying repetitive patterns and developing overarching themes emphasizing the role of education in influencing how the rural community of Dangassa responds to challenges posed by gold mining.

#### **Ethical Considerations**

This study was approved by the Malian Ministry of National Education and other relevant local authorities. All participants were informed of their rights to voluntarily participate and withdraw from the study at any time, without consequence, as well as measures instituted to keep their privacy protected (Consent), confidentiality and sensitivity to culture. All participants were identified by an anonymized ID code and all data were stored securely to prevent unauthorized access.

## **RESULTS AND DISCUSSION**

### **Results**

#### **Idealization and Vilification of Youth and Community Leaders**

##### **Impact of mining on health**

"Last year, the health problems we had in Dangassa were something that was not new; but now with mercury pollution, we have learnt that this is what destroys our families. We are angry that we have accepted sickness as inevitable" (Secondary school students). It indicates that awareness can alter perceptions and inspire action against environmental damage.

"Even with the things that leaders do to say that some of these health issues are okay and that they've fixed them, there's still a lot of stuff going on but our learned youth are starting to change this by ensuring all children get an education beyond elementary/middle school; if we're not educated, then there is no future for anyone" (Community Leaders). This testimony describes education reframed as community defense infrastructure, rather than individual economic mobility.

##### **Impact of mining on education**

Where those who had been to school perceived education as abstract, the residents of rural Mali saw benefits through mining income immediate and tangible with a limited infrastructure. The mine gives money today where education "Is something that you are promised but is still

years away, we dropped out of school in grade 9 after our father lost their land to the mining company, I want to do be an engineer but my family needs and wants me to work at the mine now” (Youth participants).

“The mining company has built a school, but who decides what is taught there, we know the water is bad, but knowing does not give us clean water and young people learn about rights in school but cannot use this right against the company” (Village chiefs, Elders, local NGO representants). Leaders regularly acknowledged the ambivalence of mining company-sponsored educational initiatives (school construction, scholarships) and implied that education’s mitigative potential was contingent on context and politically situated.

### Effects of mining on social life

“School taught us that mercury is poison, but it didn’t teach us how to eat when our fathers are sick from mining, we (know we) should not touch the chemicals, but when the choice is between knowledge and 2,000 CFA francs for today, money wins” (Students who dropped out after lower secondary school). This story illustrates how education can often feel disconnected, leaving those most at risk with difficult tradeoffs about whether to know the risks they face or focus on survival in even the shortest timeframes.

This quote highlights the truth that traditional knowledge and modern education together should be balanced, if either of it forgotten it does not lead to practical skills or real understanding. “Education might assist if it recalled what we already knew. Those who have certificates despise the old ways, but cannot construct a house that doesn’t fall in the season of rain. We are losing two educations, the new one doesn’t fit, and the old is forgotten” (community leaders).

### Educational Initiatives and Their Effectiveness

#### Awareness programs

This example of the teacher’s improvised methodology (open coding: ad-hoc environmental sampling) reflects an emergent strategy when formal systems of education are lacking. “Three years ago, when we detected mining moving into farms the school added environmental lessons. Distant and disjointed at first, students connected via an infected stream that affected the neighborhood. But unfulfilled promises and lack of resources threaten the sustainability of the program” (Teachers, Secondary school)

Focus Group Discussion that show “the speaker was trained in beekeeping and has twelve hives, but there is a rainy season cycle when they return to mining facing rumors and threats from bosses” (Youth Participants Males and Females). The speakers train in bee farming and keep twelve hives, but return to mining in rainy seasons while facing rumors and threats from the bosses

#### School-based interventions

Good environmental education works, as Teachers demonstrates in positive ways what kids choose.

“Environmental lessons added to students choosing education over mining once they experienced water pollution before, fueled by their interests in finding cleaner solutions” (Secondary school teachers). Teachers bring this program to students, very often the youth look for quick cash a grind jobs which is not sustainable in any way, confirming education cannot be taken lightly as we shape up a better world.

“Our fathers wanted us to go work in the mine when we were 14, but we decided to take tractor and irrigation training,” said Ibrahim. Now we cooperate and get paid regularly, so no more dust. The following quote captures this sentiment, “Three friends left the mines after seeing this” (Community youths) Young people are turning to safer, stable jobs instead of dangerous mines, thanks to improved working environments and education. This community attitude toward mining and alternative career paths may change.

#### Adult education

“With support from a local NGO, we initiated the evening literacy classes three years ago... for approximately 25 adult miners, specifically with relevance to understanding contracts and environmental hazards” (Community Literacy Facilitators). They focus more on making money in the short term rather than learning for the longer term. They’ve attempted adjusting schedules, but the instability of mining livelihoods makes adult education consistently elusive.

The brief training was in French and technical, so it confused young Bambara speakers with limited education, though they nodded politely. “The two-day mining safety training was confusing for young Bambara speakers with limited education, as it was in French with technical language, and they nodded politely despite needing basic environmental knowledge” (Former Mine Worker)

#### Barriers to Education

#### Economic constraints

Gold mining activities, youth participants elaborated time and again, offer immediate economic opportunities that compete directly with educational investment. “When the mining company arrived, our fathers told us that we could earn 5,000 CFA francs a day working at the processing site or that we could go to school and be an expense for them in terms of books and uniforms. “It was not an easy decision for our family” (Youth former students).

“The school is still standing, but it’s not ours anymore. The teachers ask us to pay for ‘parent-teacher associations’ that we can’t afford. The students who remain are those whose families hold mining contracts or run businesses” (Community Elder, Focus Group participants). This verse makes an oblique reference to social disparity, as only the wealthier families are able to send their kids to school, while others exclude themselves due to costs and economic inequality.

#### Cultural factors

Youth participants reported feeling pressured socially

to leave school for work in mines. Some Youths males' participants reiterated, stating: "When my friends come from the mines with new clothes and money, my parents ask me why I am wasting time at school when I can be taking care of the household". (Youth Participants). Workers from Dangassa' local NGO expressed this tension: "When we teach about mercury contamination and water pollution, some elders say that by speaking negatively about the mines, we are angering the spirits. They think the disease is caused by breaking taboos, not by toxins" (NGO Representative). Cultural beliefs and attitudes towards conservation are thus important factors in preserving the planet. Better awareness and cooperation can be achieved by merging scientific education with cultural sensitivity.

#### **Lack of resources**

"Forces the families who attend school there to stop going because they can't survive and have to work at the mine" (Youth student Participants) This highpoint how families are forced by the economic and environmental impacts of mining to choose short-term survival at the expense of long-term education.

Through open coding, we find damage to infrastructure, teacher attrition, outdated materials and pedagogical constraints. Teachers wrote that "due to mining damage and lack of funds, there has only school serving three villages. There are shortages of qualified teachers, outdated textbooks and insufficient materials and room for the safety education related to mining dangers" (Primary School Teachers).

#### **Opportunities for Enhancing Education**

##### **Community participation**

Focus group data with youth participants revealed high demand for vocational-environmental hybrid learning: "If they taught us how to mine safer—how to use less mercury, how to reclaim the land after—we wouldn't have to choose between learning and working. We could do both." (Youth Participants, Males).

Thematic analysis of interviews with local leaders and environmental experts uncovered untapped opportunities for knowledge exchange between communities: "Dangassa is not the first village to experience this. Gold mining has affected Sokolo for two decades. Instead, we learn alone, reliving their mistakes. Education should connect us" (Community Leaders, Dangassa).

##### **Government support**

Participants noted a chasm between national revenue promises from mining and infrastructure conditioning in the community. "The government talks about 'mining royalties for development' in Bamako, but here in Dangassa no science laboratory has been built for our school." Since the state's curriculum does not relate to their environmental reality, youth excel at gold extraction being one of their only practical forms of education" (Local School Administrators).

"When the government acts alone, nothing happens. But when they have (NGOs) help do evening classes for youth who work in mines, then we learn about land rehabilitation and saving money." This is knowledge that knows our life here" (Youth Participants). The story underscores the need for government-NGO collaboration to provide youth with real world, practical education.

#### **NGO involvement**

The NGO has formed an additional program known as "Mining-Aware Schools" initiative through the head teachers of three local schools to incorporate environmental and health education into the existing curriculum. "The youth want to learn, but the challenge is how to reach those who have already dropped out of school to work in mining. We need evening literacy programs paired with practical skills and trades training that speaks to their everyday lives in the mines" (Local Malian NGO Coordinator implementing programming in Dangassa).

NGOs work project to project with little continuous funding available for long-term changes in education. "We have experienced that education programs imposed from outsiders, when there is no community ownership, fail after two years. The challenge is to build education inside established systems—mosques, youth associations, women's savings groups—not on parallel ones" (Representatives from some international NGOs on the ground).

#### **Discussion**

##### **Interpretation of Findings**

##### **How education shapes the resilience and mitigation of young people**

Dangassa's findings suggest that education operates as a double-edged sword in fostering youth resilience heightening environmental health awareness, even as it reveals the limitations of formal schooling in situations where economic vulnerability is desperate. The testimonies indicate that when environmental education is experiential and native-venue-based—students see polluted water sources, for example, they're able to effect behavioral changes in safer livelihoods and community advocacy. But the continued struggle between short-term economic survival and long-term educational investment illustrates that resilience cannot be developed in traditional classroom schooling alone, but needs structural economic support and culturally relevant pedagogies linking knowledge rooted in communities to modern environmental science.

This is in line with a wider body of evidence that community-focused environmental education and vocational training have sufficient promise to reduce health risks when integrated into artisanal mining contexts, but that their effectiveness ultimately depends upon addressing the underlying socio-economic constraints facing youth leading them to hazardous work (Rajae, M., *et al.*, 2015). Moreover, the gap between national mining

governance and local educational infrastructure indicates that sustainable mitigation strategies need to integrate both formal schooling as well as vocational training, intercommunity knowledge exchange, and partnering up with NGOs/government to make education a collective community defense (Mambrey, V. *et al.*, 2020).

### The significance of community contextualization and approaches

These findings highlight the importance of community engagement and cultural context in determining the effectiveness of educational interventions to address gold mining impacts on youth in rural Mali (Odey, A. P., & Ugar, A. A., 2023). Dangassa's qualitative conclusions indicate that educational interventions that lack community ownership—adopted as equitable “apprenticeships” (interventions not imposed by a stark, external agenda such as curricula developed from outside their community or technical training in French for Bambara-speaking miners) tend to disappear within two years of failing to get traction in a place built up around incorporating elements into the already existing social structure (mosques, youth associations and women's savings groups) report remarkably more sustainable results (Cissé, S., 2018).

This aligns with wider evidence from Malian mining contexts indicating that participatory approaches, which respect local knowledge systems and engage stakeholders in the curriculum design process enjoyed far more significant educational outcomes and environmental awareness (Tomaselli, K. G., & Dyll, L., 2024). The disconnection between elders blaming sickness on spiritual taboos instead of mercury contamination points to the need for culturally relevant pedagogies that join indigenous epistemologies with modern environmental science, making education real defense infrastructure of communities rather than enacting alienated teaching techniques.

### Implications for Policy and Practice

#### Incorporating education into mitigation strategies

The Dangassa findings show that education is an untapped mitigation opportunity to address gold mining impacts on children and youth, and that it needs to be integrated into policies more structurally in order to facilitate the interface between schooling and real-world economies (Juachon, E. S., 2024). When curricula did not align with actual livelihoods, youth consistently indicated a preference for immediate mining income over other long-term considerations of well-being; this indicates that effective interventions are vocational-environmental hybrids situated in ongoing community relationships (Veiga, M. M., *et al.*, 2014).

Like cooperatives and religious institutions rather than establishing unsustainable parallel systems. It is necessarily a partnership with government, to help deliver appropriate training in the language of the community, contextualizing education away from top-down delivery towards an ongoing focus on enhancing local livelihoods

through practice and alternative income streams not at odds with mining (Hilson, G., & Maconachie, R., 2019). Supporting educational infrastructure and programs in the region

Research out of Dangassa demonstrates that successful educational infrastructure will not simply be about the traditional schooling paradigm, but an integrated, livelihood-centric approach to education that considers the current economic landscape. Youth have knowledge of mining dangers but no other options, a disconnection between what is taught in formal education and what applies in practice. This resonates with Adonteng-Kissi and Adonteng-Kissi (2018), who argue that alternative livelihoods programs need to become “livelihood-centered interventions,” which create sustainable engagement rather than imposing externally-derived models that fail two years later.

Similarly, Tomcic *et al.* (2023) show that an integrated approach of a field-based environmental education and a low technology (graphics-based, in community languages) safety training resulted in significant improvement of knowledge retention and behavioral changes with respect to mercury safety. For Dangassa, the policy implications have to do with embedding education within existing structures in the community (mosques, youth associations, women's groups) through vocational-environmental hybrid training which allows for “doing both” learn and work safely instead of pitting survival against education. Limitations of the Study

The main limitation of this study is its exclusively qualitative nature, which may hinder the broad applicability of the findings to a wider population. Furthermore, the qualitative nature also means that results are based on subjective perceptions and experiences; this could potentially introduce bias and reduce efforts taken to weed out such bias as it would be difficult to quantify how much education does in curbing the adverse effects of gold mining. Moreover, the findings from Dangassa may not be generalized to other areas with varying socio-economic and environmental settings.

### Recommendations

#### Integrate Vocational-Environmental Hybrid Education

Design applied curricula that marry environmental literacy and livelihood skills (e.g., improved mining practices, beekeeping, irrigation farming). This allows youth to “do both”, continue learning while working, rather than having to choose between survival and education.

#### Embed Education in Existing Community Structures

Instead of externally imposed programs, we need culturally-grounded initiatives, delivered through mosques and outreach, youth associations and women's savings groups. This not only helps in maintaining sustainability by respecting the local knowledge systems but also it is the bridging point between traditional and modern environmental science.

### Develop Government-NGO Partnerships for Local-Language Training

Partner to provide relevant education in Bambara (never mind French) on practical skills such as understanding contracts, working safely with mercury or rehabilitating land. Top-down approaches do not work — learning must connect with the daily realities within a mine.

### Choose Local Educational Infrastructure for Mining Royalties

National mining revenues should show tangible local benefits - science laboratories, qualified teachers and updated materials - so youth view education not as an abstract, disconnected system but as a viable alternative to mining.

### Create Inter-Community Knowledge Exchange Networks

Encourage learning across mining-impacted villages (i.e. linking up Dangassa with the 20-years' experience of Sokolo and vice versa) so that successful mitigation efforts can be shared, errors avoided, opportunities for regional resilience explored — rather than cabinet-level decisions being left to individual communities to implement in isolation from one another.

### CONCLUSION

This study finds that while artisanal gold mining in Dangassa, Mali, comes with strong risks and threats to youth through health hazards, educational disruption, and economic precarity — when education is strategic by design and culturally grounded it can serve as powerful mitigative force. The results suggest that traditional formal schooling tends to remain uncompetitive compared with instant mining income from the adaptable and more creative vocational-environmental hybrid education embedded into community structures (mosques, cooperatives, youth associations), rendering it critical for resilience and other safer sources of livelihoods. In the end, these educational interventions will need to go beyond instruction abstracted away from the structural relations of poverty, traditional and modern knowledges, practical skills training merged with environmental literacy — ultimately repurposing education from an individual goal into a collective community protection mechanism against the destructive logics of extraction.

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