Earth Smarts

An open framework for socioecological literacy

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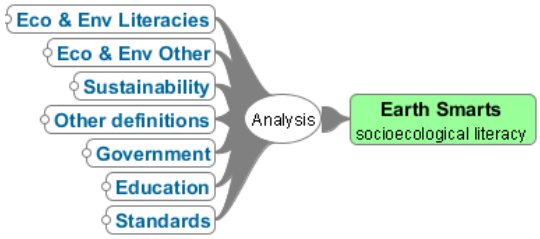
- This report describes the domains and components of socioecological literacy, or **earth smarts** (Nichols, 2011), a practical educational construct that describes the qualities we need to justly improve our quality of life in a changing world.
- Earth smarts is arranged as an hierarchical mind map (see next page) to improve its usability in education, but many of the components are interrelated in more complex ways. Some of the important connections are indicated by bracketed, italicized links to the appropriate headings.
- Although the expandable mind map may be the best way to visualize the construct, this report also includes references as well as notes for components that may not be self-explanatory.
- More information, including details on the construct analysis methodology (Krathwohl, 1993) that earth smarts emerged from, are available online at www.earthsmarts.info



Why is it Helpful?

Earth smarts provides a free tool to anyone designing curricula, preparing environmental literacy plans, conducting research, or simply hoping to improve the wellbeing and resilience of their community. It should be helpful to individuals, researchers, educators, and policy makers because it is:

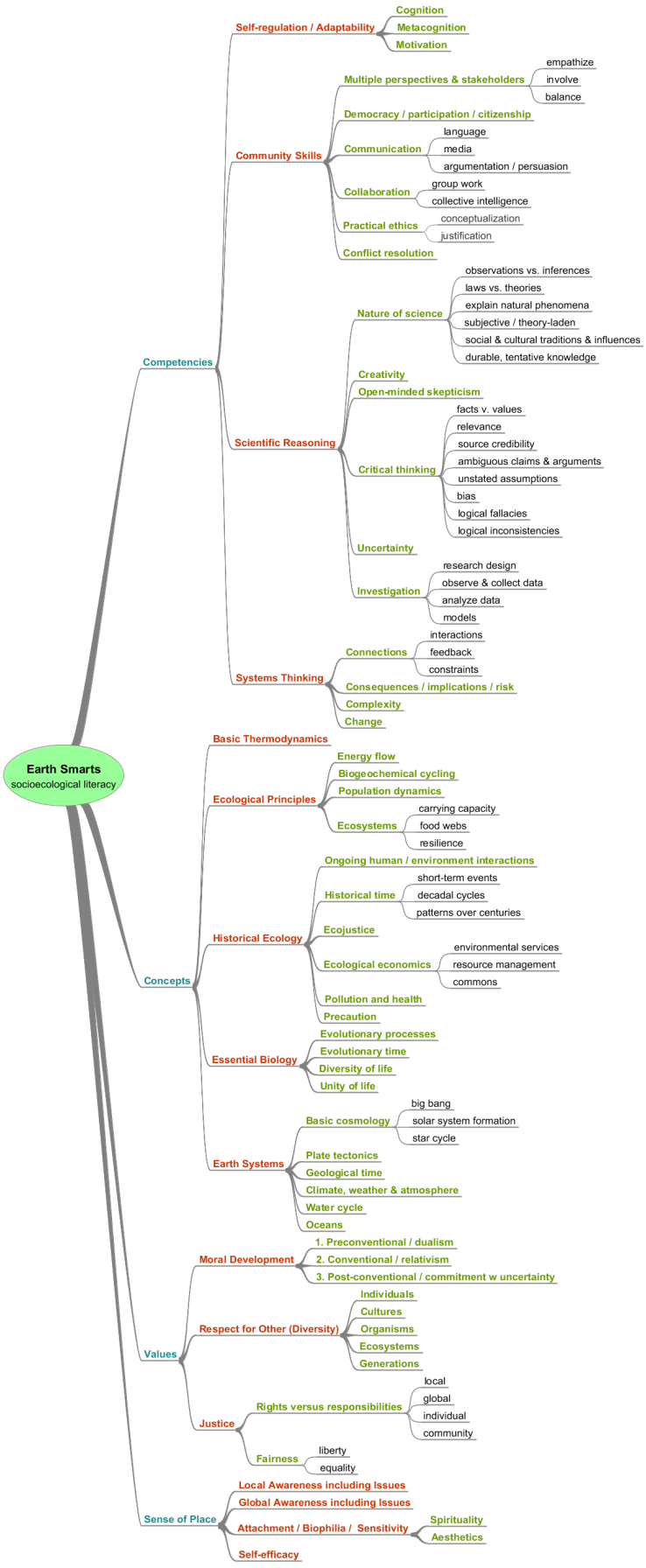
- **practical** – it is made up of components designed to be learned, practiced or developed;
- **nonpartisan** – it is based on respect, justice as fairness and a nearly universal human desire for quality of life;
- **theoretically grounded**, drawing on a range of disciplines;
- **flexible** enough to be useful across different cultures and ecosystems;
- flexible enough to encourage localization and creativity by teachers and parents;
- **focused** enough to be practical in modern, standards-based classrooms.

Earth Smarts for Everyone

The goal of earth smarts is to provide the capacity to adapt to environmental challenges, so in a just world, everyone should acquire earth smarts, picking up components through their schooling, family, community and experiences. Earth smarts is actively developed with free, open-source software to encourage contributions from the widest range of experts and stakeholders, including under-served groups. It is available under Creative Commons attribution (CC BY) licensing, so it is free for any individual, school, or community that wishes to use or adapt it to their needs.

The Components

Earth smarts incorporates new research from psychology, ecology, and education. It includes some key knowledge and thinking skills, but also includes affective and moral qualities that research suggests are essential to real learning beyond the classroom. To reduce the potential for political or cultural conflicts, earth smarts does not prescribe behavior – it describes qualities that will facilitate a wide range of creative solutions. Details of the components follow the mind map diagram.


Earth Smarts
socioecological literacy
Competencies
Self-regulation / Adaptability
Cognition
Metacognition
Motivation
Community Skills
Multiple perspectives & stakeholders
empathize
involve
balance
Democracy / participation / citizenship
Communication
language
media
argumentation / persuasion
Collaboration
group work
collective intelligence
Practical ethics
conceptualization
justification
Conflict resolution
Scientific Reasoning
Nature of science
observations vs. inferences
laws vs. theories
explain natural phenomena
subjective / theory-laden
social & cultural traditions & influences
durable, tentative knowledge
Creativity
Open-minded skepticism
Critical thinking
facts v. values
relevance
source credibility
ambiguous claims & arguments
unstated assumptions
bias
logical fallacies
logical inconsistencies
Uncertainty
Investigation
research design
observe & collect data
analyze data
models
Systems Thinking
Connections
interactions
feedback
constraints
Consequences / implications / risk
Complexity
Change
Concepts
Basic Thermodynamics
Ecological Principles
Energy flow
Biogeochemical cycling
Population dynamics
Ecosystems
carrying capacity
food webs
resilience
Historical Ecology
Ongoing human / environment interactions
Historical time
short-term events
decadal cycles
patterns over centuries
Ecojustice
Ecological economics
environmental services
resource management
commons
Pollution and health
Precaution
Essential Biology
Evolutionary processes
Evolutionary time
Diversity of life
Unity of life
Earth Systems
Basic cosmology
big bang
solar system formation
star cycle
Plate tectonics
Geological time
Climate, weather & atmosphere
Water cycle
Oceans
Values
Moral Development
1. Preconventional / dualism
2. Conventional / relativism
3. Post-conventional / commitment w uncertainty
Respect for Other (Diversity)
Individuals
Cultures
Organisms
Ecosystems
Generations
Justice
Rights versus responsibilities
local
global
individual
community
Fairness
liberty
equality
Sense of Place
Local Awareness including Issues
Global Awareness including Issues
Attachment / Biophilia / Sensitivity
Spirituality
Aesthetics
Self-efficacy

List of Components

1 Competencies

This domain captures cognitive **abilities** or **skills**, qualities that require encouragement and practice. Some may be associated with certain attitudes or habits of mind.

1.1 Self-regulation / Adaptability

Self-regulation in an educational context (Schraw, Crippen, & Hartley, 2006) may be thought of as effective life-long learning. It is associated with an internal locus of control and higher self-efficacy *[4.4]*, and is characterized by confident and effective learning. Whether we like it or not, the world is changing, and our brains need to be able to learn new things in order to adapt to new situations.

1.1.1 Cognition

Includes cognitive strategies, problem-solving and critical thinking *[1.3.4]*.

1.1.2 Metacognition

Understanding and improving your thinking and learning.

1.1.3 Motivation

Attitudes and beliefs that affect learning, especially self-efficacy [4.4] and epistemology.

1.2 Community Skills

Community skills include a range of sociopolitical skills and strategies to make our actions more effective in social and cultural contexts.

1.2.1 Multiple perspectives & stakeholders

Respect for cultural *[3.2.2]* and biological *[3.2.3, 3.2.4]* diversity are important values in earth smarts. To solve our differences justly, we need the ability to involve, empathize with and balance the perspectives of other stakeholders.

1.2.1.1 empathize

1.2.1.2 involve

1.2.1.3 balance

1.2.2 Democracy / participation / citizenship

Democracy comes in a variety of flavors – for earth smarts, the most important aspect is that people feel they have a voice in their own governance. Effective democracies require effort from their citizens, but help reduce stagnation, paralysis or fatalism when challenges arise. Participatory societies also encourage innovation, local solutions and effective responses to change.

1.2.3 Communication

A range of culturally appropriate communication skills are important to earth smarts, including language, media and argumentation/persuasion skills. Effective communication facilitates all the community skills *[1.2]* and numerous other components.

1.2.3.1 language

1.2.3.2 media

1.2.3.3 argumentation / persuasion

1.2.4 Collaboration

We cannot study global processes alone – technology like weather satellites or ocean monitoring networks require scientific and political cooperation between individuals, communities and nations. The ability to work effectively with others, and with the collective intelligence that modern communication technology enables, is valuable to both investigation *[1.3.6]* and all the community skills *[1.2]*.

1.2.4.1 group work

1.2.4.2 collective intelligence

1.2.5 Practical ethics

Learning and practicing practical ethics (e.g., Gert, 2004) provides a way to minimize conflict *[1.2.6]* and manage the messy ethical issues that arise when stakeholders with different values and perspectives *[1.2.1]* share essential resources. The process includes conceptualizing the issue and considering potential justifications.

1.2.5.1 conceptualization

1.2.5.2 justification

1.2.6 Conflict resolution

As history has shown, violence and war are often destructive, expensive, inefficient and unjust ways of resolving our differences. We need to learn and practice a wider range of techniques to deal with conflict.

1.3 Scientific Reasoning

Scientific reasoning consists of a set of cognitive skills that have helped us understand our world.

1.3.1 Nature of science

The nature of science (Lederman, 2007) consists of characteristics of the scientific enterprise. Understanding them and applying them effectively to real-world problems requires practice.

1.3.1.1 observations vs. inferences

1.3.1.2 laws vs. theories

1.3.1.3 explain natural phenomena

1.3.1.4 subjective / theory-laden

1.3.1.5 social & cultural traditions & influences

1.3.1.6 durable, tentative knowledge

1.3.2 Creativity

Education based on high stakes testing is often criticized for emphasizing rote learning and stifling creativity. However, creativity is an important skill when facing changing conditions and new situations.

1.3.3 Open-minded skepticism

Open-minded in this sense means being willing to consider new ideas, a key component of non-dogmatic scientific thinking. However, maintaining a healthy skepticism is always warranted, in science and in life, so we are not taken advantage of, or led too far down paths that distract or diminish us. This is closely related to the next skill set, critical thinking *[1.3.4]*.

1.3.4 Critical thinking

An essential skill set in a media-rich world, and one that interacts with numerous other components, including the nature of science *[1.3.1]*, open-minded skepticism *[1.3.3]* and investigation skills *[1.3.6]*. This conceptualization is based on Beyer (1995), and includes the ability to deal with the issues below.

1.3.4.1 facts v. values
1.3.4.2 relevance
1.3.4.3 source credibility
1.3.4.4 ambiguous claims & arguments
1.3.4.5 unstated assumptions
1.3.4.6 bias
1.3.4.7 logical fallacies
1.3.4.8 logical inconsistencies

1.3.5 Uncertainty

The world is complicated, and we need to better understand scientific uncertainty, so we can develop more effective methods of dealing with varying levels of it. This relates to managing risk *[1.4.2]* and complexity *[1.4.3]* in systems thinking *[1.4]*.

1.3.6 Investigation

Effective scientific reasoning involves investigation skills that help us better understand the world we inhabit and the challenges we face. These skills include the ability to design research, to observe and collect data, to analyze increasingly large sets of data, and to create useful models.

1.3.6.1 research design
1.3.6.2 observe & collect data
1.3.6.3 analyze data
1.3.6.4 models

1.4 Systems Thinking

Linear and static world views have come up short - we need to improve our ability to think in terms of complex systems, which more accurately reflect social and environmental realities.

1.4.1 Connections

We have focused too much on the parts of systems – we also need to carefully consider the way they connect and interact with each other, including feedback and constraints.

1.4.1.1 interactions
1.4.1.2 feedback
1.4.1.3 constraints

1.4.2 Consequences / implications / risk

Systems thinking can consider the implications of various inputs and changes *[1.4.4]*, including systemic risk. This kind of thinking relates to the sociopolitical concept of precaution *[2.3.6]*.

1.4.3 Complexity

Practice with systems thinking will enable us to better understand complexity – socioenvironmental systems *[2.2, 2.3.1]* are often very complicated, as are earth systems *[2.5]* like climate *[2.5.4]*.

1.4.4 Change

Earth systems science *[2.5]* has taught us that our world changes, often dramatically. As we face local and global changes, we need to recognize, accept and better understand the effects of change in complex systems *[1.4.3]*.

2 Concepts

This domain can also be considered **knowledge**, content or awareness, and is the domain that most formal education has focused on. It includes some big picture concepts from the natural and social sciences, including a better understanding of time on three scales – historical, biological and geological.

2.1 Basic Thermodynamics

Especially an understanding of entropy and open systems.

2.2 Ecological Principles

Includes some key principles from ecological science (e.g., Jordan, Singer, Vaughan, & Berkowitz, 2009) that help us understand how energy and nutrients move through local and global systems, and how populations, including our own, are connected to these ecosystem processes. This topic connects with earth systems *[2.5]* and systems thinking *[1.4]*.

2.2.1 Energy flow

A general understanding of the flow of energy through living and non-living systems, including the concept of fossil fuels.

2.2.2 Biogeochemical cycling

A basic understanding of the cycling of key elements like carbon, nitrogen and oxygen.

2.2.3 Population dynamics

An awareness of basic population dynamics helps us understand the interactions of predation, migration, invasive species and climate change. This is helpful for species that are directly important to us, as well as others we share the planet with.

2.2.4 Ecosystems

An overview of ecosystem science, including the concepts of carrying capacity, food webs and ecosystem resilience.

2.2.4.1 carrying capacity

2.2.4.2 food webs

2.2.4.3 resilience

2.3 Historical Ecology

An interdisciplinary topic that examines the two-way interactions between humans and their

environments (Crumley, 2007).

2.3.1 Ongoing human / environment interactions

There is no "divide" between humanity and nature – this component focuses on our interactive role in ecosystems, and how successful societies achieved and sustained a higher quality of life.

2.3.2 Historical time

A sense of the time scale of human existence, including our spread across the planet and increasing impacts. Includes consideration of short-term, decadal (the perspective of one human lifetime) and centuries-long events.

2.3.2.1 short-term events

2.3.2.2 decadal cycles

2.3.2.3 patterns over centuries

2.3.3 Ecojustice

Ecojustice (Bowers, 2001) mixes ecology with social justice, focusing on topics such as racism, colonialism, and fair access to resources for current and future communities. For the purposes of earth smarts, justice as fairness *[3.3.2]* is critical, and these issues should also be carefully considered from non-human *[3.2.3]* and ecosystem *[3.2.4]* perspectives *[1.2.1]*.

2.3.4 Ecological economics

Ecological economics (Røpke, 2005) is a transdisciplinary field that examines how we use and value resources, considering the issues with an ecological awareness. Our shared use of common resources (Bowers, 2006) is especially challenging.

2.3.4.1 environmental services

2.3.4.2 resource management

2.3.4.3 commons

2.3.5 Pollution and health

These are complex, wide-ranging topics closely related to ecojustice *[2.3.3]*, ecological economics *[2.3.4]*, and biogeochemical cycling *[2.2.2]*. They are critical to our quality of life, and can impact future generations *[3.2.5]* as well as other species *[3.2.3]* and ecosystems *[3.2.4]*.

2.3.6 Precaution

An awareness of various iterations of the precautionary approach (UNCED, 1992) and their implications for policy, especially economics *[2.3.4]* and ecojustice *[2.3.3]*.

2.4 Essential Biology

Key concepts from biology that provide a "big picture" understanding of life on Earth.

2.4.1 Evolutionary processes

A basic awareness of our increasingly sophisticated understanding of how life adapts to environmental changes.

2.4.2 Evolutionary time

A sense of the time scales involved in evolutionary change, including the implications of relatively short generations (e.g., microbes, mayflies) and long generations (e.g., people, deep-

sea fishes).

2.4.3 Diversity of life

An awareness and appreciation for the diversity of life on Earth *[3.2.3, 3.2.4]*, past and present.

2.4.4 Unity of life

An awareness of the connections that all species share, including the basic chemicals (notably carbon), molecules (notably DNA) and cells we are composed of.

2.5 Earth Systems

Key concepts about how the world works, including our place in the universe and the importance of the oceans and atmosphere.

2.5.1 Basic Cosmology

We can't fully grasp our place in the world without a basic understanding of the scientific origin of the universe, our solar system and the star cycle.

2.5.1.1 big bang

2.5.1.2 solar system formation

2.5.1.3 star cycle

2.5.2 Geological time

To understand biological and geological processes, we need to have a sense of the vast time scales they can involve.

2.5.3 Plate tectonics

A basic understanding of the rock cycle is important beyond the potentially catastrophic short term implications like earthquakes, tsunamis, and volcanos.

2.5.4 Climate, weather & atmosphere

Human societies have always been closely tied to weather and climate, and there have been some spectacular successes and failures triggered by climate changes. The more we understand them, the more successful and resilient our communities will be.

2.5.5 Water cycle

Water is so essential this should be a given, but many urban dwellers have a very poor understanding of their local water cycles.

2.5.6 Oceans

Whether we live near them or not, a basic understanding of oceans is important as they support biodiversity *[2.4.3]*, drive economies *[2.3.4]*, store carbon and other elements *[2.2.2]*, and have a huge effect on weather, climate *[2.5.4]*, and water cycles *[2.5.5]*.

3 Values

This domain includes **moral** components based on justice as fairness and respect.

3.1 Moral Development

This component represents a progression (Kohlberg, Levine, & Hewer, 1983). To achieve earth

smarts, we must move beyond seeing things as simply right or wrong. To do so involves competencies from systems thinking, including connections *[1.4.1]*, consequences *[1.4.2]* and complexity *[1.4.3]*.

3.1.1 First – preconventional / dualism

Decisions are based on consequences to the individual – punishment or reward.

3.1.2 Second – conventional / relativism

Decisions are based on the rules and norms of the society.

3.1.3 Third – post-conventional / commitment w uncertainty

Decisions are based on consideration of rules as well as the individual's abstract principles (e.g., justice, respect, liberty).

3.2 Respect for Other (Diversity)

Biological and cultural diversity is important for both intrinsic and extrinsic reasons, particularly as diversity tends to increase the resilience of systems (e.g., Elmqvist et al., 2003). This component asks that we respect a variety of "others", including nonhumans. In practice, this item is closely linked with the balance of rights, responsibilities *[3.3.1]* and justice as fairness *[3.3.2]*.

3.2.1 Individuals

Increasing our own quality of life must not unduly jeopardize the quality of life of other people.

3.2.2 Cultures

There are many ways to achieve wellbeing, and cultural practices may be socially or ecologically appropriate in one area *[2.3.1]* but not others. Within the context of respect and justice, this cultural diversity should be nurtured, with special respect for the sustainable aspects of traditional and indigenous cultures.

3.2.3 Organisms

We cannot ignore the wellbeing of other species – it is problematic, both scientifically and ethically, to draw stark moral lines between humans and nonhumans. While this is a deeply complicated topic, it seems reasonable to allow that the wellbeing of individuals of more intelligent species (e.g., dolphins and chimpanzees) deserves more careful consideration than that of individuals of less intelligent species (e.g., mosquitoes and turnips).

3.2.4 Ecosystems

This component represents a holistic consideration of ecosystems, not just species, that will help us avoid unduly diminishing them as we work to improve our own lives. The clash between individual rights, human or otherwise, and the rights of ecosystems can be philosophically complex, but it is going to become increasingly relevant as we are forced to consider which ecosystems are worth nurturing in a shrinking, changing world.

3.2.5 Generations

Our children are at the heart of most definitions of sustainability, although real consideration of the rights of future generations is complex (e.g., Heyward, 2008). Nonetheless, earth smarts requires some form of basic respect for the wellbeing of future generations – we need to

consider quality of life beyond the next economic or political cycle.

3.3 Justice

Justice is a key component of earth smarts – concerns about quality of life should not be restricted to a single person, class, society or species. Combined with respect for a range of "others" *[3.2]*, the consideration of justice necessitates a complex, ongoing negotiation of rights and responsibilities.

3.3.1 Rights versus responsibilities

Balancing individual rights and freedoms with responsibility to various communities (family, town, country, place...) is an ongoing, complicated process, and involves consideration of local, global, individual and community issues.

3.3.1.1 local

3.3.1.2 global

3.3.1.3 individual

3.3.1.4 community

3.3.2 Fairness

Justice as fairness (Rawls & Kelly, 2001) includes an ongoing negotiation between liberty (rights) and equality (fair opportunity and difference).

3.3.2.1 the liberty principle

3.3.2.2 the equality principle

4 Sense of Place

This domain captures some of the elements that influence how we think and feel about our environments, both local and global. It involves attitudes and emotions, often called **affective** elements, which are aptly named, as this domain's components affect many of the other components of earth smarts.

4.1 Local Awareness including Issues

How we feel about the places we live is partly based on what we know about them - we need to better understand our local communities and environments, particularly the factors that improve or diminish our quality of life. This is especially challenging in an increasingly mobile, urban world.

4.2 Global Awareness including Issues

Local knowledge isn't enough - we also need a sense of our place in the world, including how we affect and are affected by issues on a global scale, such as persistent pollutants *[2.3.5]*, energy *[2.2.1]* and climate change *[2.5.4]*.

4.3 Attachment / Biophilia / Sensitivity

Far too many of us have lost the emotional connection to the land that our ancestors had – we need to nurture our love for the places we live, and our remarkable world. This connection, which may have spiritual and/or aesthetic components, can express itself in a variety of culturally-influenced ways, and includes constructs such as biophilia or environmental sensitivity.

4.3.1 Spirituality

Many indigenous and traditional cultures had profound spiritual connections to the land. Such connections are challenging to maintain in the face of urbanization, globalization and environmental degradation, but we need to adapt and renew them.

4.3.2 Aesthetics

Encouraging people to experience natural places has a long tradition in environmental education. Whatever you call it, we are still moved by mountains, forests, ponds, seashores and other ecosystems, an aesthetic connection that may be especially important for children, and one that requires much more careful planning to achieve in urban centers.

4.4 Self-efficacy

Fatalism is a problem with some world-views and environmental messaging. Self-efficacy (Bandura, 2001) is believing that you have some control over your actions, and those actions have an effect on your environment (good or bad). In earth smarts, self-efficacy relates to systems thinking, especially interactions *[1.4.1]* and consequences *[1.4.2]*. Without it, we feel helpless.

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