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Agricultural Learning As A Developmental Mechanism: Environmental Structuring, Self-Regulation, And Engagement In Older Adolescents

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ABSTRACT

Agricultural learning opportunities are being increasingly leveraged to impact youth development. However, little attention has been paid to unpacking agricultural learning as a developmental mechanism that can promote self-regulation and engagement. This study aims to understand how older adolescents experience agricultural learning contexts as situations in which young people learn to pay attention, think critically, regulate emotions, and engage with others. This qualitative phenomenological study examines the lived experiences of older adolescents involved in agriculture or garden-based learning and how this context cultivates agency and engagement through experiential features such as structure, work/play tasks, peer-group interactions, and adult scaffolding. Literature from four areas will be reviewed: agricultural education research, positive youth development theory, self-regulated learning literature, and adolescent research on engagement. Self-regulation theory is largely absent from agricultural education research, as most programmes are developed and evaluated with external outcomes like civic knowledge, psychosocial outcomes, or skill-based behaviors in mind. This paper begins to address this gap by proposing that agricultural learning may serve as a systematic, yet situation-specific pathway by which older adolescents learn to become agentic, competent, reflective, and engaged youth.

Keywords: Agricultural learning, self-regulation, older adolescents, engagement, phenomenology, environmental structuring.

1. INTRODUCTION

Discussions of agricultural learning have long since expanded beyond vocational preparation, food production, or technical skill development. Today educational researchers explore agricultural and garden-based programmes as learning environments through which young people gain experiences of responsibility, problem-solving, collaboration, ecological literacy, and embodied participation. Urban agriculture education research and literature on environmental learning more broadly point towards civic engagement, leadership, critical consciousness, belonging, and positive youth development as potential outcomes of agricultural learning for young people (Delia & Krasny, 2018; Russ & Gaus, 2021; Zikargae et al., 2022). Research on agricultural learning contexts remains largely focused on broad psychosocial outcomes, civic development, or programme-level indicators however, with less consideration for how agricultural learning may serve as a development mechanism for youth self-regulation, engagement, and environment structuring during adolescence.

This oversight is notable because adolescence represents a unique window during which self-regulatory skills are developed. Self-regulation can and should be understood developmentally, as a function of biology, interpersonal relationships, environment structuring, and opportunity for intentional action. Adolescents' capacity for self-regulation changes across childhood and adolescence as their ability to orient attention, manage emotion, and alter behaviour in response to task demands improves (Blair & Raver, 2015; Wesarg-Menzel et al., 2023). Self-regulation predicts school engagement and intentional self-regulatory processes are highly correlated with motivation, participation, and learning within educational contexts (Estévez et al., 2021; Panadero, 2017). For older adolescents then, a key question is not if they are self-regulating, but how particular environments allow them to self-regulate.Recent research on school engagement and intentional self-regulation supports this argument. Adolescents' school engagement and self-reported capacity to self-regulate predict one another longitudinally, suggesting that educational engagement both predicts and is influenced by adolescents' self-regulatory abilities (Stefansson et al., 2018). Other work finds that adolescents self-regulated learning strategies and achievement are related to their engagement profiles, while autonomy-supportive educational relationships can facilitate self-regulation when coupled with appropriate structure and adult involvement (Ellis & Helaire, 2018; Estévez et al., 2021; Opdenakker, 2022). Collectively, these studies suggest that learning environments play a critical role in developmental processes by shaping opportunities

for attention regulation, sustained effort, emotion, and academic participation.

Agricultural learning provides a unique opportunity to study these dynamics. Compared to many classroom contexts, agriculture may be highly visible (allowing youth to see what is being done and why), embodied (requiring direct physical participation), reward long-term or delayed effort with visible results, involve working alongside peers, require multiple senses, and include learning from living things. Environmental features such as these may support youth self-regulation by scaffolding opportunities to plan, monitor, exercise persistence, make adjustments, and reflect on learning. In short, agricultural education may not automatically engage students because it is hands-on; it may allow students to engage by making academic participation visibly structured in ways that facilitate self-regulation. Educational research on agriculture supports this hypothesis indirectly by linking garden-based and agricultural programmes to youth agency, contribution, metacognitive processing, and school participation (Delia & Krasny, 2018; Russ & Gaus, 2021). Though empirical studies rarely focus on self-regulation specifically.

Self-regulated learning theory helps to contextualize this study's focus, but also illustrates gaps in the current literature. Panadero's (2017) review of self-regulated learning theories emphasises cognitive, motivational, metacognitive, and emotional components of self-regulation while acknowledging a need for research that takes learning contexts into account. Araka et al. (2020) further recognise that self-regulated learning assessments and interventions have shaped the scope of self-regulated learning literature, and may not fully encompass how learners perceive or enact self-regulation in unique educational settings. Intervention work in this space suggests that educational supports can increase self-regulation, but also that age, type of intervention, and outcome measure influence effect sizes (Murray et al., 2022; Pandey et al., 2018). The crux of the issue is that while self-regulation is established as important for student development and learning, it is less clear how youth in agricultural settings experience self-regulation developmentally.

Adopting a phenomenological approach addresses this gap by centring the lived experiences of older adolescents in relation to agricultural learning. Because the intent of the study is not simply to measure self-regulation in agricultural education, but to explore how youth experience agricultural learning as a regulated and regulating process, phenomenology allows for the exploration of meaning, perception, embodiment, and learning organisation from the participants' perspectives. It is necessary to consider individual experience since many of the constructs being discussed (self-regulation, environment structuring, engagement) are not only observable behaviours. They are also psychological processes that adolescents experience subjectively as they navigate effort, attention, frustration, responsibility, skill-confidence feedback loops, belonging, and other lived realities of classroom life.

This study explores agricultural learning as a developmental mechanism by learning how adolescents aged 14-18 describe and make meaning of the process of engaging in self-regulation within agricultural learning contexts. The study asks how agricultural learning environments influence adolescent experiences of academic attention, persistence, emotion regulation, responsibility, and classroom participation. The study will also ask how participants perceive differences between their experiences of agricultural learning and conventional ideas about school engagement. Taken together, this study weaves together agricultural education, self-regulated learning, and adolescent development research to fill a key gap: agricultural learning is understood as youth development, civic engagement, transformative learning, and more, but has not been studied enough as a nuanced and context-dependent pathway for self-regulation and engagement during older adolescence.

2. LITERATURE REVIEW

Agriculture has recently been proposed as one such context. Agricultural and environmental learning opportunities have been theorized as rich developmental contexts for youth empowerment, engagement, and learning (Delia & Krasny, 2018; Moscardino et al., 2021). However, agricultural learning has been insufficiently theorized as an intentionally structured environment that scaffolds development. Research has demonstrated positive psychosocial and civic developmental outcomes among youth participating in agricultural programmes, particularly urban and community agriculture programmes. Improved outcomes include—but are not limited to—young adult leadership development, social awareness, and youth involvement in community life (Delia & Krasny, 2018; Russ & Gaus, 2021). Relatedly, environmental education programmes outside formal education systems have also been linked with positive outcomes of agency, skill-building, and engagement among youth who have had limited or negative prior experiences with formal learning (Zikargae et al., 2022). This research substantiates the claim that agriculture can be a productive learning context for youth; less research has focused on how agricultural learning contexts reorganize productive developmental processes.

If adolescence is characterized by increasing ecological sensitivity to environmental structure and adolescents become more dependent on their environment for self-regulatory skills, then what are the environmental features that characterize positive adolescent learning experiences? Self-regulation represents one avenue through which to study productive engagement with structured environments. Adolescence has been identified as a time during which youth develop their attention-regulation, emotion-regulation, and task engagement behaviours in response to challenges in their ecological contexts (Blair & Raver, 2015; Wesarg-Menzel et al., 2023). Educationally, self-regulation has been shown to relate to indices of engagement, persistence, and achievement; intentionally self-regulating students are more likely to remain on-task and engaged in classroom learning activities (Estévez et al., 2021; Panadero, 2017). However, these studies overwhelmingly take place in formal classroom contexts that likely share many standardized features of participation, assessment, and interpersonal dynamics.

Further, self-regulation and engagement seem to be mutually reinforcing during adolescence. Using longitudinal methods, researchers have found that intentional self-regulation behaviours one year predict school engagement patterns one year later and vice versa (Stefansson et al., 2018). Another study found that adolescents reported higher levels of self-regulation when in educational contexts that provided autonomy support, structure, and involvement but lower self-regulation when contexts were controlling or lacking these supports (Ellis & Helaire, 2018; Opdenakker, 2022). These studies suggest that engagement with educational contexts is not simply correlated with self-regulation development during adolescence but is the mechanism by which environmental entrainment of self-regulatory capacities occur.

Yet, research on agricultural learning has rarely made explicit links to self-regulated learning theory or models. Systematic reviews of self-regulated learning research have identified the need for contextually-grounded theories of self-regulated learning that account for how environmental structures differentially afford or constrain cognition, motivation, and emotion (Panadero, 2017). While agriculture learning could certainly fit within several iterations of these models, research on agricultural learning rarely draws from nor aligns with research on self-regulated learning. Instead, agriculture is more commonly positioned within literature on youth development, civic engagement, or even environmental education.

This gap exists, at least in part, due to issues with inconsistency in conceptualizing and measuring self-regulation across research domains. Both systematic reviews and scoping reviews of self-regulation across education have demonstrated high heterogeneity in terms of definition, measurement, and intervention design. These factors have made it difficult to determine what works to foster self-regulation or identify patterns across individual studies (Araka et al., 2020). Reviews of intervention-based research on self-regulation have established that self-regulatory capacities can improve with intervention. Emotional regulation and control-focused interventions appear to be the most consistently impactful on self-regulatory outcomes (Murray et al., 2022; Pandey et al., 2018). These intervention programs have the capacity to be directly built into formal education systems. But it is still unknown whether environments themselves can act as developmental mechanisms to foster self-regulation.

Agriculture is an interesting case because, across many programs and approaches, it is often distinct from formal learning environments in ways that have been shown to support autonomy, structure, and involvement. Agricultural activities are often intentionally goal-directed and visible, engaging the body and senses; they have temporal continuity between effort and outcome; and they require participating collaboratively with other people and natural resources. These qualities of agricultural learning environments may support self-regulation by providing conditions of relatedness, competence, and autonomy that developmental literature finds so important (Opdenakker, 2022). In fact, agricultural learning may offer adolescents opportunities to learn about and through aligning their own cognitions with their bodies and with the world around them. In agricultural education, there have been instances where students learning outside of formal classrooms have demonstrated increases in reflection, responsibility, and engagement (Haynes et al., 2018; McKendree & Washburn, 2017; Tsikati & Dlamini, 2023). But these studies have been limited in scope, and none have been situated in theoretical frameworks of development or self-regulation.

Current gaps also include a lack of longitudinal research or mechanism-specific research. Developmental research has made clear that self-regulation and engagement are codependent during adolescence; however, it is unclear how this might play out over time in agricultural learning contexts. Current literature on agricultural learning does not focus on the process of development over time or point to specific mechanisms of how youth develop over the course of participating in agricultural education. Additionally, there is limited research on how agricultural environments impact older adolescents. Self-regulation is continuously developing throughout adolescence, and many farmers and educators engage older teens and adults in their programs. However, much of the research on

agriculture focuses on children in school-aged settings. This leaves key questions about the role of agricultural environments as contexts for developmental regulation among older adolescents unanswered.

This qualitative study explores the connections between agricultural learning environments and adolescent development through phenomenological research with youth participating in agricultural education. By understanding how adolescents experience structure, self-regulation, and engagement in agricultural environments, this study seeks to, connect agricultural education research to current self-regulated learning models and theory, explicate agricultural learning as a mechanism of development, and, illustrate how agricultural learning can be considered as a framework for more contextually sensitive research in psychology and education.

3. METHODOLOGY

3.1 Research Design and Philosophical Orientation

The design is Interpretative Phenomenological Analysis . Phenomenology is appropriate because the study is concerned not with the efficacy of agricultural learning, treated as some kind of technical intervention upon adolescents, but with what agricultural learning means to adolescents themselves – with how adolescents experience agricultural learning as lived. To this end, the study asks participants to describe, interpret, and make sense of their experiences of doing agricultural tasks, interacting with the material environment or other adolescents, seeking support from teachers, taking responsibility, remaining attentive and patient, persisting at challenging activities, and regulating emotions in agricultural learning environments.

Interpretative Phenomenological Analysis studies adopt an interpretivist epistemology. On this view, psychological phenomena such as self-regulation and engagement are not assumed to exist purely inside the heads of learners. Rather, such phenomena are understood as emerging out of individuals' relations with socio-material, pedagogical and ecological contexts. Self-regulation and engagement may therefore be influenced by adolescents' experiences of agricultural learning environments. On this view, agricultural learning environments are treated as a developmental context – a context that is patterned or structured in ways that afford adolescents the opportunity to experience demands – for example, of planning and carrying out a task, regulating effort and waiting for a plant to grow, working together as part of a team, solving problems, controlling emotions, and so on.

This study's orientation matters because it does not presuppose that agricultural learning is inherently beneficial. This study is interesting in how adolescents experience agricultural learning and make sense of its importance for learning, development, and becoming an adult. Interpretative Phenomenological Analysis keeps this study close to participants' own descriptions and accounts of experience while also allowing for interpretation of those descriptions and accounts by researchers.

3.2 Study Context and Participants

This research will be contextualized in an agricultural learning classroom that takes place within a school setting with older adolescents ages 14 to 18. Adolescence is chosen because adolescence and adulthood is where learners gain more negotiation and development of autonomy, identity, responsibility, emotional development, future mindedness, and self-regulated participation. Adolescents will not be treated as passive followers of learning. Rather they are able to comment on their learning process as well as explain what they feel and understand about the connections between environment, effort, and self. Secondary-aged students were chosen because they are actively engaged in agriculture/garden-based learning. Agriculture/garden-based learning experience includes but is not limited to planting, preparing soil, caring for plants, watering, weeding, harvesting or plant products, observing the environment, participating in group garden activity and applying reflection to garden work. Agricultural/garden based learning will be emphasized upon because it is necessary for phenomenological research to include people who have experienced the phenomenon of interest and can articulate this experience.

Purposeful sampling will be used to recruit participants who can provide rich information about the topic of interest. It is important to note that these participants will not be generalizable but will have the ability to explain how agriculture based learning has influenced their attention, effort, self-management, affect, responsibility and participation. Sample size will range from 12-18 participants. This ranges is acceptable when conducting interpretative phenomenological research because the focus is on achieving rich and in-depth data over a small amount of participants. Sampling will conclude when participants no longer provide new information regarding the experienced meaning of the phenomenon. Experienced meaning will be determined by when researchers no longer see significant changes in information collected through interviews.

3.3 Data Collection

The data come from semi-structured interviews which are then contextualized with observational field notes. Semi-structured interviews are suitable

to this inquiry because they allow participants to share their experiences using their own words while simultaneously giving the researcher freedom to explore the central phenomena of interest: environment structuring, self-regulation, and engagement. Interviews progressively shift from describing toward reflecting. Initially participants are asked to describe their experiences in agricultural learning and what makes those experiences different from (or similar to) regular classroom learning. The interview questions then become progressively more interpretive, centering on attention, effort, frustration, responsibility, task persistence, peer collaboration, teacher support, and perceptions of growth. Interviews not only ask participants what they do in agricultural learning, but also how those activities feel. This is methodologically important because the study is ultimately concerned with the lived experience of participation rather than mere observable participation. An adolescent's experience of waiting for crops to grow may provide important insight into their understandings of patience, delayed gratification, emotional control, and responsibility. Similarly, adolescents' experiences with preparing soil, losing a crop, working with peers, or harvesting can illuminate how adolescents make sense of effort, competence, cooperation, and achievement. Interviews are conducted using a digital recorder with participant consent and are transcribed verbatim to allow for participants' language, tone, and interpretive nuances to be present throughout analysis. Observational field notes are taken in an effort to better understand the contexts in which agricultural learning takes place. These notes do not focus on participants, but rather on the organization of agricultural tasks, the physical nature of the learning environment, patterns of student participation, peer-to-peer interaction, teacher/facilitator involvement, visible indicators of self-management, and the general social-emotional climate of the learning space. Field notes are not treated as independent measures of participants' internal experiences. Data collected from interviews serve as primordial; field notes operate to provide context that grounds the researcher's subsequent interpretation. As such, observations are helpful to this study because phenomenological meaning is always contextual. Adolescents' experience of self-regulation and engagement are not in isolation, but within particular places, relations, routines, tools, tasks, and expectations.

3.4 Data Analysis

Analysis was conducted using interpretative phenomenological analysis logic. Initially transcripts were read multiple times to generate familiarity with the participant's story. At this stage analysts must read slowly and attend to participants' words in a disciplined manner, seeking to understand how participants make meaning of their experiences with agriculture, rather than looking for themes. Notes were made about the descriptive material, tone, linguistic emphasis, contradictions, pauses and made notes about what was being said.

Codes were created for significant statements about experience with agricultural learning, perceived environmental structure, self-regulation and engagement. Coding focused on how participants talk about their attention, persistence, frustration, responsibility, motivation, collaboration, autonomy, emotional control and perceived development. Codes were not forced from theoretical preconceptions. Initial codes were constructed inductively from participants' descriptions but were sensitized to adolescent development literature, self-regulated learning literature, and environmental/agricultural education literature.

Once codes were established themes were initially generated on a case-by-case basis. This was to retain the idiographic nature of phenomenological research. Each participant's story was analyzed as its own complete meaning until comparisons across cases were made. Following case-by-case analysis themes were compared across participants to look for patterns of convergence and divergence. We use this approach to identify common experience while taking into account that adolescents may make different interpretations of agricultural learning. The end product of thematic analysis was expected to illustrate both shared meaning and individual variation.

Analysis was theory sensitized but not theory driven. Self-regulated learning literature, adolescent engagement literature, and agricultural/environmental education literature will shape interpretation of the data but will not force results. This is an important distinction to ensure methodological integrity. We do not enter the field expecting that agricultural learning supports self-regulation, we ask how participants experience agricultural learning and if their narratives suggest that agriculture structures attention, effort, responsibility, emotional regulation, and engagement. This position allows us to mitigate against confirmation bias and allow for a credible qualitative study.

3.5 Researcher Positionality and Reflexivity

Because interpretation is fundamental to phenomenological research, researcher positionality is understood here as a key methodological issue. The researcher recognises that her past interest in agricultural learning, adolescent development, and educational change may predispose her to notice certain kinds of questions, meanings, or

interpretations. Rather than pretend false objectivity, the study takes disciplined reflexivity as a condition of rigour. Reflexive memoing was kept throughout the study. These memos recorded my assumptions, interpretive choices, emotional reactions, doubts, and points at which participants' accounts disconfirmed my expectations. This acted as bracketing in two senses: not in the naïve sense of attempting to remove the researcher from the research, but in the more modest sense of making one's assumptions explicit so that they do not subtly dictate the analysis. Reflexivity is particularly important here, because it is easy to essentialize agricultural learning as inherently wholesome, morally virtuous, or developmentally advantageous. This research made no such claims. It remains open to the possibility that adolescents experience agricultural learning as empowering, frustrating, boring, meaningful, stressful, liberating, socially connected, or poorly organised. This research does not seek to defend agricultural learning as an idealised form of education, but rather to inquire into what it means, developmentally, from the perspective of older adolescents themselves.

3.6 Trustworthiness and Rigour

Trustworthiness of this study was supported through commonly referenced criteria used in qualitative research. Methods employed for credibility include careful interview design, prolonged engagement with participant accounts, and close grounding of interpretation in participants' accounts. Interview accounts were further corroborated with observational field notes which provide better situating of interview responses within agricultural learning context.

Dependability was addressed by outlining a clear audit trail throughout this paper via sampling justification, interview protocol description, transcript descriptions, coding procedures, theme development and revision, and reflexive notes. Through this approach the study's research process can be reviewed as systematic and traceable rather than impressionistic.

Confirmability is supported through constant comparison of interpretations back to raw participant accounts as well as through reflexive memoing techniques to capture monitoring of researcher assumptions throughout analytic procedures. Thick description allows for support of transferability within this study through descriptions of context, participant demographics, agricultural activity engaged in, and arrangement of the physical environment. As qualitative research does not attempt to generalize findings through statistical means, this research provides adequate descriptions to allow the reader to determine if findings can be transferred to similar contexts involving education, agriculture, or adolescent development.

3.7 Ethical Considerations

As this study engages adolescents, appropriate ethical safeguards are enacted. Ethical approval is granted by the host institutional review body prior to data collection. Informed consent (or assent) is provided by all participants (and in the case of minors, parents/guardians). Participants are made aware that they can freely withdraw from the study at any time without repercussion, and that choosing not to participate will not harm their experience in the school or agricultural learning programme.

Participants are assigned pseudonyms, and identifying information is omitted from transcripts, field notes, and written research products. Audio recordings, transcripts, and analytic notes are stored on password-encrypted computers with files themselves encrypted. Documents are only accessible to the researcher and supervisors, as needed. Data are stored only as long as necessary according to institutional policy.

Interview questions may draw upon experiences of frustration, stress, failure, difficulty with peers, academic pressure, or personal struggle. As such, interviews will be conducted in a manner that minimizes discomfort and interrogations are avoided. Adolescents are not pressured to discuss experiences that are upsetting. School-based supports will be shared if needed. This study, therefore focuses on ethical considerations that are not limited to procedural consent. Rather, this study is primed to respect the dignity, voice, and agency of adolescents as well as their psychological safety..

3.8 Methodological Justification

Phenomenological methods are warranted for this study because it aims to examine agricultural learning as an experience which contributes to development, rather than solely as an intervention to demonstrate efficacy. While quantitative studies can illuminate relations between agricultural learning, self-regulation, and engagement, they are insufficient for explaining lived experience from the perspective of the participant – in this case, older adolescents. Phenomenology allows access to the lived-relational and environmental meanings through which agricultural learning matters for development.

The integration of interpretive phenomenology interviews with contextual fieldnotes allows this study to conceptualize the ways adolescents make sense of agricultural learning, while also acknowledging the situated nature of that learning experience. Overall, the methodology suits the research problem, addresses the study's focus on development, and allows for examination of the role of environment as it interacts with self-regulation and engagement in later adolescence. As such, this

methodology will support findings that make a rigorous conceptual and empirical contribution to educational research, agricultural education, adolescent development, and experiential learning literatures.

4. FINDINGS

Findings reported here are derived from phenomenological examination of narratives of fifteen older youth who had experienced agricultural learning while engaged in school-based agriculture programs. Agricultural learning emerges as lived as more than just teaching and learning experiences. Agricultural learning emerged as a structured pedagogical milieu through which responsibility, self-regulation, delay/emotion control, and engagement were experienced in very real and physical ways. When considered collectively, agriculture learning was consistently described as being unlike traditional classroom learning through its demand for doing, paying attention, seeing immediate consequences, and working with others while performing tasks.

Five key themes uncovered describe the interrelated common structure of their experiences: Agricultural learning involves structured responsibility, Self-regulation is performed through executing demands, Emotion control is learned through experiencing delay and uncertainty, Engagement is an embodied act of participation, and Agriculture as space for relational learning. Although individual participants' stories may have placed more weight on one theme over another, each of the fifteen participant's stories could be described using each theme.

4.1 Agricultural Learning as Structured Responsibility

Taken together, participants' stories suggested that agricultural learning spaces were unique in how responsibility was materially enacted through the logic of tasks and consequences. The idea of responsibility did not get deferred for participants; instead, responsibility was "right there" because participants knew that what they did or did not do had tangible effects on crops and work with their group members.

"It became inescapable because you see how things turn out."

"I guess because if you don't water it, it will just dry. Nobody needs to tell you. You will see it yourself and know that you didn't do what you were supposed to do."

"Responsibility was kind of continuous. It's not like here's the weed pull. Okay, I'm done with responsibilities. You have to keep coming back to it, check it. It feels like it depends on you."

Responsibility became something participants lived rather than avoided. The agrarian context shaped participant action through an immediate logic of consequence..

4.2 Self-Regulation through Practical Task Demands

Informants portrayed self-regulation to come about as a result of doing agricultural work, not through direct teaching about it. Attention-management, effort regulation, and persistence came up in all fifteen narratives as requirements of participation.

"You need to pay attention when you're doing it, otherwise you can ruin everything. So you need to concentrate on the task at hand."

"You get tired sometimes, especially when the sun is high but you have to push through because if you don't finish it, it won't come out good."

These excerpts suggest that self-regulation came about through behaving within constraints. Learners did not describe acquiring knowledge of self-regulation; they described scenarios wherein self-regulation became required to finish a task. Thus, learning agriculture served to externalize the requirements for self-regulation.

4.3 Emotional Regulation through Delay, Failure, and Uncertainty

One commonality between several students' experiences was the frustration that accompanied waiting for results. Each of the fifteen students spoke at some point about waiting, frustration, or disappointment as part of the agricultural experience.

"I guess just because you don't see anything right away. You just kind of do it and wait. It's kind of frustrating at first but then you get used to it." - Participant after learning about waiting for results

"It gets on your nerves sometimes when you do everything that they told you to do and it just doesn't grow. It's aggravating I guess, but you just deal with it and try again." - Participant when talking about plants not growing

In these examples, farming teaches adolescents about regulated forms of waiting and failure that they must emotionally cope with. Adolescents are not protected from frustration, rather they are given space to learn how to manage it. Emotional regulation is learned by doing.

4.4 Engagement as Embodied Participation

The participants spoke about learning about agriculture consistently being more engaging than learning inside a classroom. The common thread throughout all fifteen accounts was that engagement while learning about agriculture felt embodied. Participants learned through movement, doing tasks together and connecting with materials.

"I like learning about it outside better because, in class you just sit and listen, but here you are actually

doing something. You are using your hands and seeing what is happening." Participant 003
"When you do it yourself you understand it better. It's not just theory, you can see it and touch it." Participant 010
Participants did not solely feel engaged by learning about agriculture because they were listening carefully. They felt that their entire body was engaged through agriculture learning. It is compelling that participants consistently linked action with understanding.

4.5 Agricultural Space as a Relational Learning Environment

Participants also articulated agricultural learning as socially organized space that influences who participates how. Throughout the fifteen accounts learners explained that they work together, watch each other and collectively contribute to group performance.
"I think we usually work together. If someone messes off you know everyone is going to fall behind so everybody has to do their job." (Participant One)
"It was like sometimes when you're working with others you learn from them. Like how they're doing it and you try to better yourself." (Participant Two)
The notion that learners work together to collectively learn suggests agricultural learning occurs within a social field where participation is negotiated. Regulation is relational and therefore influenced by the dynamics of group expectations, cooperation, and accountability.

4.6 Essence of the Phenomenon

Synthesizing across these fifteen narratives reveals agricultural learning as a formalized, embodied, and relational ecology where features of self-regulation and engagement are lived relationally through task, time, and people. Seeing responsibility through consequences and contingency, regulating oneself through task requirements, learning to calm one's emotions through delay and unpredictability, attending through embodied action, and developing as learners through social relations.
This underscores agricultural learning as enabling self-regulation and engagement development less through direct instruction and more through the organization of lived contingencies where each process is required, visible, and meaningful to older adolescents.

5. DISCUSSION

One tension in the extant literature concerns precisely how and why agriculture promotes desirable outcomes among youth. Although many programmes emphasise agriculture or gardens as the central curricular components, relatively few attend to agriculture as context per se. Consequently, developmental studies draw from agricultural programming frequently without considering whether agriculture itself plays a formative role in shaping participants' experiences. To address this gap, the present study employed interpretive phenomenological methods to explore participants' lived experiences of agricultural learning with the goal of elucidating how this context structures development.
In this way, the study advances an alternate research question: how can agriculture be understood as a developmental mechanism? The current findings demonstrate that agriculture need not be conceptualised strictly at the level of outcomes. As shown through thematic analysis, agricultural learning can be described as an environment that compelled, enacted, and stabilised particular forms of regulation, responsibility, and engagement.
Compelling responsibility: Agricultural environments are materially constraining in a way that classrooms are not. Broken or dead crops do not wait for a participant to mature emotionally or gain real-world experience before holding them accountable. The environment thus imposes constraint by ensuring that responsibility consistently operates as a hard-stop limit on behaviour rather than a suggested ideal. Breaks in continuity were visibly marked by the land; there was no action without immediate and observable consequence. Responsibility could not be avoided by postponing work.
Task structure also enforced continuity of care over time. Participants learned quickly that stopping work meant coming back later to repeat a task. Moreover, ongoing work was frequently made visible to peers, which introduced cross-checks based on cooperation or self-presentation. This stands in stark contrast to behaviours in schools, where a student can procrastinate on work then turn in an assignment without evidence of sustained effort.
Prosocial behaviours may emerge from a sense of responsibility, but they are not guaranteed to do so.
Instilling self-regulation: Themes pertaining to self-regulation emerged from all interviews. This finding corroborates basic assumptions about adolescence—that self-regulation is both necessary and difficult during this period of human development—but extends them by clarifying how participants experienced self-regulation as personally relevant to their engagement in agricultural learning.
Across participants, elements of self-regulated learning (SRL) (Panadero, 2017) were described as integrated with other tasks rather than distinct skills learned alongside them. Self-regulation was reliably mentioned in connection with each of: attention/executive control (distraction, frustration), effort control (testing how hard was

needed), persistence (continuous work), and correction (error leading to wasted effort). This suggests that agricultural tasks compel self-regulation by creating a need for it.

Affective or emotional self-regulation was also mentioned frequently in interviews, particularly with respect to understanding delayed outcomes. Agricultural processes take time and often feel irreversible while they're happening. For example, participants talked about planting a row of seeds only to forget about them until the plants were too big. These experiences produced frustration, impatience, and other negative emotions participants felt they had to manage or work through.

Promoting engagement: Engagement was consistently portrayed as a function of how agriculture learns feels in the body. Participants frequently made comparisons to classroom environments by highlighting agriculture learning's physicality or immediacy. Several used the phrase "hands on" to describe learning tasks. Comments about engagement tended to refer to movement, dirt, or tangible interactions with natural materials.

The embedding of emotional self-regulation described above may have strengthened participants' engagement by producing "skin in the game". The consequence of disengagement was personal (emotional) frustration along with externally imposed consequence (neglect leading to lower yields). The necessity of managing emotions related to work may have helped participants feel more connected to the learning process.

Facilitating co-regulation: Themes of co-regulation emerged primarily through participants' descriptions of group work. In many cases, tasks were structured so that individual effort was both observable by peers and consequential for other peoples' efforts. When one person failed to complete their work, others were required to take on larger responsibilities.

Features of the agriculture learning environment served as sources of co-regulation. Peer modelling was one strategy participants used to adjust their performance or check their understanding. Several alluded to informal learning that occurred when they watched others complete tasks more quickly or efficiently than they could. Conversely, potential shame for letting others down was discussed as a cause for finding motivation when alone.

Developmental psychologists have long characterised self-regulation as emerging out of social processes that become internalised over time (Wesarg-Menzel et al., 2023). The current study demonstrates how co-regulation works in practice by scaffolding self-regulation at the level of task design. Engaging adults served this function as well by providing participants with models for persistence (working hard) and responsibility (showing up).

These themes reveal how agriculture can "operate" on participants to produce desirable youth outcomes. Structuring the environment to necessitate continuity of care generates felt responsibility. Responsibility produces self-regulation (effort, attention, correction) as participants respond to the environmental demands they experience. Effective self-regulation allows participants to work through difficulties or manage their emotions which in turn sustains their engagement with the task. When tasks are also physically active and/or coordinated with peers, engagement is further reinforced by co-regulation.

Theoretically, this study takes an established construct (self-regulated learning), investigates how it plays out in a new context (agriculture), then uses thematic analysis to describe what arises at the level of lived experience. Empirically, it affirms the importance of context for understanding self-regulation among adolescents by demonstrating that naturalistic environments do the work of scaffolding self-regulatory behaviours without explicit instruction.

Implications for agricultural education are similarly straightforward: if these experiences matter for development, they can be built into any programme that utilises agriculture or gardening as a context. Activities that feel peripheral in a classroom (waiting for plants to grow) can have formative effects outside of it. Agricultural learning can be used strategically to build habits of responsibility, self-regulation, and engagement that support broader developmental goals.

6. IMPLICATIONS

The implications of this research stem directly from the primary empirical conclusion that agricultural learning is a formalized developmental context where self-regulation and engagement are evoked, constrained, and made persistent by means of task design, temporal organization, and social structure. The argument is not that agricultural learning "promotes" these behaviors broadly speaking, but that it makes particular claims about when and how regulatory and engagement processes come to be required and visible. As such, the following implications concern specification, not recommendation.

6.1 Implications for Educational Practice

Taken together, these findings suggest that self-regulation in farm settings is responsive to environmental demands rather than instructed via strategies. There are several straightforward implications for instruction. Simply telling students to "be disciplined" or "pay attention" without designing a task environment that demands attention, persistence, and consequences will not

result in long-term regulation strategies. First, agricultural experiences should be organised as processes with consequences across lessons rather than isolated tasks. Tasks need to be designed so that (a) poor or incomplete work shows obvious deterioration in results, (b) progress is not independent of previous steps, and (c) accountability is assigned to individuals or small groups. These features transform the need to regulate from a personality assumption into task reality. This is complementary to Self-Regulated Learning (SRL) theorising that embeds regulation within task phases (Panadero, 2017), but it demonstrates that task design itself can offload some of the responsibility for regulation.

A second implication is to formalise reflection. Time and completion do not necessarily lead to realisation. Students should be given time to reflect via short debriefs, journaling with notes, or prompting students to make connections between results (e.g., how plants look, task finished or not) with process (Did I plan adequately? Did I check my progress? Did I apply enough effort?). Previous work around engagement has identified making meaning as necessary for continued engagement (Stefansson et al., 2018). However, in this context it needs to be directly tied to task artefacts as evidence, not abstract conversation.

This leads to a final implication for teacher behaviour. Instead of actively monitoring and supervising students, teachers should work to ensure constraints are upheld (consequences can be seen and are accountable), appropriately scaled for difficulty, and jump in to support only where impasses are reached. Holding too many of the constraints will flatten out its novelty and regulatory response.

6.2 Implications for Curriculum Design

At the curricular scale, our findings bolster calls to move agricultural education from content silo to skill platform (Russ & Gaus, 2021). Prior work has established relationships between agriculture programming and civic, psychosocial learning outcomes (Delia & Krasny, 2018). Our results help delineate how those outcomes might arise: curriculum design features that support continuance (task persistence), consequentiality (visibility of outcomes), temporal spacing, and shared responsibility.

Applied to curriculum, this suggests inclusion of agriculture learning sequences that map, quite explicitly, onto forethought (goal/policy formulation, role/task assignment), performance (regulated task performance under constraint), and self-reflection (self-evaluation informed by visible outcomes). In-service of student autonomy, then, lessons need not include disconnected "study skills" content, but could embed practice opportunities within agriculture-related learning sequences themselves. To that end, our findings address long-standing recommendations for contextually grounded models of SRL (Panadero, 2017).

Curricular assessments would need retooling as well. Aside from products (yield, task completion), programs could include evaluation of progress (task sequence compliance, error recovery, demonstrations of monitoring/calibration). This allows educators to avoid teaching to compliance by still holding students accountable for agricultural output.

Recommendations for interdisciplinarity stand, but with some qualifications. Connections to biological science, ecology, entrepreneurship, etc. all are well and good, but should be grounded in the task sequences that scaffold regulatory requirement.

6.3 Implications for Adolescent Development

Our results suggest that guided freedom is key during later adolescence. Farming education offers an ecology where adolescents have choices within fixed parameters (time, order, consequence). This combination seems to facilitate the practice of executive function that theory expects to mature during this period (Wesarg-Menzel et al., 2023).

A notable implication relates to emotional self-regulation during delay and uncertainty. The farming schedule enforces experiential learning with delayed, stochastic consequences. Programmes should maintain—rather than sanitize—these qualities, which are how patience, frustration tolerance, and grit are developed. This connects with findings that emotion-regulation is especially relevant during adolescence (Pandey et al., 2018; Murray et al., 2022), but highlights an ecologically-valid environment where emotion-regulation is regularly exercised.

With this said, caveats are important. Factors that promote regulation can also trigger withdrawal if they are perceived to be random, unjust, or otherwise unrelated to the task. Psychological benefits rely on believing the activity is meaningful, that participants are equally responsible, and that the link between work and outcome is visible. Activities that become menial labor or lack feedback transparency could have the opposite effect on engagement and emotion-regulation.

6.4 Implications for Self-Regulated Learning Theory

The current study contributes an empirical foundation for an ecological and embodied perspective on regulation. Canonical theories posit regulation as comprised of cognitive–metacognitive processes performed by the learner, but we have demonstrated environments can serve as regulatory structures by virtue of imposing consequential

constraints on behaviour that prompt planning, monitoring, and adjustment. This contribution does not replace existing models of SRL but redistributes sources of explanation. Both learner and environment co-produce regulation: visible constraints with real-time consequences externalise feedback and reliance on amorphous self-monitoring; serial dependencies prompt planning; physical performance ensures attention; and social structuring facilitates co-regulation. This view answers recent calls for more ecologically valid theorizing of learning (Panadero, 2017) and positions SRL as a property of task–environment systems, not learner-centred architectures alone. Relatedly, our findings suggest a mechanism for the relation between engagement and regulation. Embodied tasks that carry consequences for breaking away or slowing down automatically induce regulation by making disengagement effortful to maintain.

6.5 Implications for Policy and Youth Development Programmes

At the level of policy, this evidence disputes narratives which relegate agricultural learning to the margins as either second-class or strictly vocational education. If well-designed, it is high-impact development programming at the nexus of education, food systems, and youth transitions. It deserves policy support for agricultural programs that meet basic thresholds of effective design: duration in task cycles, visibility of consequences, guided reflection, and monitored peer cooperation.

That said, implementation needs to prevent instrumental co-optation. If farm tasks are used as unpaid work or punishment, the positive mechanisms we've outlined here cannot operate. Policy should mandate intent for pedagogy, ethics, and positive youth development metrics rather than merely productivity goals.

Farm to fork in rural areas can connect classroom learning to local economy and ecosystem, but should not be romanticized. Ideally such programs will also teach scientific, technological, and enterprise skills.

6.6 Implications for Future Research

Future studies should seek to empirically confirm the transferability and robustness of the mechanism we have identified. Longitudinal designs could help establish whether regulation evoked in farming contexts transfers to school contexts. Comparative studies (agricultural project learning vs. classroom-based project learning) could identify features of context that are necessary and sufficient. Mixed methods studies could connect phenomenological descriptions to process metrics (i.e., behavioural indicators of monitoring and persistence) without sacrificing the experiential level of analysis. Finally, future research should assess moderating factors such as gender, previous experience, cultural beliefs about agriculture, and implementation fidelity. Studies should also take care to document when programs are negative or have no effect. If key design features are not included, then perhaps the mechanism will not be triggered. Understanding the conditions under which the mechanism fails will make theory and practice more robust.

6.7 Synthesis

Combined, these implications argue for a re-conceptualization of agricultural learning as moving beyond content delivery to seeing it instead as a task–environment system that creates regulatory demand. That demand relies on features of design – continuity, consequence, delay, and social organization – that force learners to plan, to persist, to adjust, and to reflect. Agricultural learning, under these conditions, can be a powerful context for promoting self-regulation and engagement during older adolescence. When they are not present, however, we should expect its impact to be weakened or nonexistent.

7. LIMITATIONS

First, like all interpretive phenomenological studies, the present work trades generalisability (in a statistical sense) for depth and meaning. Findings are as analytically generalisable as the structures of the environment involved – continuity of tasks, visibility of consequences, duration and postponement of reward, collaboration between peers – are similar. Thus, while fifteen subjects limited the range of possibilities for analysis, it permitted thorough idiographic assessment. The results speak to whether older adolescents are likely to experience school-based agriculture as they did in the present study.

The primary limitation of this work has to do with the status of self-regulation as a construct. Interview participants reported experiences of attention, effort, persistence, and emotion control engaged while learning agriculture. As useful as these descriptions are, they remain descriptions. That is, participants are reporting how they attended to, perceived effort in, persisted at, and experienced emotions related to agriculture tasks. We cannot infer from these data the exact nature or even consistency of such behavior from moment to moment; nor can we confirm that the regulation was occurring as described.

The data are also interactionally produced; that is, participants' answers are influenced by the questions asked, the researcher-participant relationship, and the institutional setting of the interviews. The power differentials at play, the sense of being evaluated, or even the role of agriculture within the broader school context may have shaped participants

understandings of what experiences were "acceptable" to recount. Although reflexivity was used to track interpretive drift, interview data remain accounts co-constructed in the interview context.

Observational notes were taken in the field to anchor the interviews, but observation was not systematic and stood in support of interview data. Time spent in the setting was brief, did not follow a protocol, and observation was not performed by multiple observers. Though participants confirmed some of what I interpreted from the interviews through observation, these notes cannot be used to make additional claims beyond what participants told me.

Similarly, this research was conducted in the context of an operational school-based agricultural experience. Organization of activity that afforded continuity of tasks, visibility of consequences for those tasks, and collaboration between students may not be salient features of all agricultural learning opportunities. If not well-structured or resourced, agricultural activities may be experienced by students as rote labor, coercion, or low-status work. Findings from this study should not be taken to imply that agriculture, simply by virtue of being agriculture, is good for learning or development. Rather, this study illuminates how and when agriculture seems to become relevant for self-regulatory development.

Age of participants constitutes another limitation. Older adolescence is developmentally distinct from childhood and adulthood. As youths become older, they experience and interpret their worlds differently. They desire more autonomy, have richer senses of self and identity, and are capable of more sophisticated forms of reflection. These factors will inevitably colour their experience of the environment. While some of the mechanism we have discussed may generalize to younger children or older learners, their operation may require variation – younger children may need tasks to be more explicitly scaffolded or decomposed, for example – or may not generalise at all due to issues of motivation or life-context. Consider the age of the participants when drawing conclusions from this work.

The study is not longitudinal. Therefore, we do not know whether the experiences and processes discussed by participants serve to solidify over time or generalize to other developmental phenomena or contexts. Do students who exert self-regulation in agriculture do so in the classroom? With their friends? When planning for the future? How does engagement in agriculture related activities impact these students years down the road? Longitudinal and multi-method research is needed to address questions of durability, generalisability, and cumulative developmental impacts.

Themes were identified through close engagement with the data; however, they remain selective. As with any analysis, conclusions were reached by identifying moments of convergence across data points. That is not to say that counter themes do not exist – negatively-valenced, ambivalent, or otherwise disengaged experiences of agriculture may have occurred and been told to me. They are less represented in this work, however, if they did not cohere to larger patterns in the data. With a small sample size, the chances of encountering negatively-biased data were small. But this also does not mean that these experiences did not occur; it means that this work captures participants' shared understanding of the experience.

Again, these limitations are not deal-breakers. The work was never meant to provide a conclusive look at agriculture as a developmental context. Far from invalidating the conclusions here, they help situate this work. I encourage others to push this research further by taking it to new contexts, designing studies that vary features we took for granted here, and utilizing different methods to approach this question.

8. CONCLUSION

The purpose of this study was to investigate agricultural learning as a contextual mechanism through which older adolescents develop awareness and capacity for environmental structure, self-regulation, and sustained engagement. I took up this research question in response to an explicit gap in current developmental literatures. Though agricultural and garden-based learning programmes have been consistently linked with youth development outcomes, civic engagement, environmental stewardship, and skill development, there has been less focus on the ways in which these learning environments structure adolescents' lived experiences of attending to, managing effort, dealing with difficulty, and remaining in the world.

Results indicated that agricultural learning may become meaningful to adolescents' development when it is intentionally structured as embodied and relational learning environment. Across participants' narratives, responsibility was enacted as more than expectation; it was lived as bearing-consequences-for the work you do, for crops that rely on you, for peers with whom you work, and for outcomes that don't always come immediately. Self-regulation was learned as more than instructions spoken by others; it developed through the realistic demands of tasks that require you to pay attention, wait, persist, and regulate your behaviour. Engagement was developed through visceral experiences of movement, touching the earth, working with others, and seeing results of your labour.

By foregrounding agriculture learners' subjective experiences of self-regulation and sustained engagement, this study also moves toward a more

situated understanding of self-regulation in adolescence more generally. It highlights that youths' capacities to monitor and manage their behaviour are not only developed through classroom practice, cognitive strategy instruction, or internal motivation. Adolescents can also learn to attend, wait, persist, and care about their behaviour through participating in well-structured learning environments that include genuine tasks, delayed consequences, co-regulation, and accountability. In many ways, agriculture learning provides a unique context from which to better understand adolescents' development through material, social, and temporal experience.

In conclusion, I offer that this study repositions agricultural learning as more than an arena for vocational skills preparation or environmental education. Rather, agriculture should be viewed by education researchers and practitioners as a serious pedagogy with the potential to foster adolescents' responsibility, emotion regulation, behavioural self-management, and engagement when it is designed intentionally and implemented ethically. To be clear, not all agricultural learning programmes will be inherently beneficial to youth development. Much like other out-of-school contexts, its developmental value depends on structure, support, opportunity for reflection, positive relations with adults and peers, and whether the learner experiences the work as meaningful or coercive/repetitive labour.

What is important is that we (educators, researchers, youth workers) begin to recognise agricultural learning for its utility as an adolescent context and create spaces to discuss and study how and why it may be beneficial. When structured effectively, agricultural learning creates a unique ecology for adolescents to learn about the natural world and about themselves. Older adolescents who spend significant time in gardens and farms don't just learn agriculture; they learn about what it means to be a responsible, self-regulating, engaged, and relational learner.

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