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From School Lessons to Household Practice: Reverse Environmental Socialization and Waste Sorting in Guangdong, China

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Abstract

Environmental education is often evaluated by what children learn, yet its effects may extend beyond the classroom when children carry new norms and practices into family life. This paper examines reverse environmental socialization in Guangdong, China: the process through which children transmit environmental knowledge and practices upward to parents and grandparents. The study combines a single school glass recycling education pilot in Heyuan with 18 parent and grandparent interviews and a cross scale systems model. The school pilot involved approximately 50 primary school students, 47 valid student surveys, five student interviews, and interviews with roughly 11 teachers and school representatives. Students generally endorsed the environmental value of glass recycling and expressed willingness to participate, but operational confidence and accurate classification knowledge were substantially weaker. The household interviews examine the less understood transition from child communication to household practice. Across cases, adults' responses depended not on one variable but on configurations of child credibility, intergenerational authority, existing routines, and practical recycling conditions. Some adults accepted a child's suggestion but could not sustain it because infrastructure was weak; others resisted correction despite favorable environmental attitudes; still others adopted a practice after a child reframed advice as concrete assistance. These patterns support a cross scale account in which individual motivation, family relationships, and structural conditions can reinforce or counteract one another. The paper argues that reverse socialization is best understood as a dynamic process in which the outcome of one household interaction can change the conditions for the next.

Keywords: reverse environmental socialization, intergenerational learning, environmental education, household waste sorting, family authority, systems thinking, Guangdong, China

1. Introduction

Environmental education usually treats children as the primary recipients of learning: students are expected to gain knowledge, develop concern, and adopt more environmentally responsible behavior (Ballantyne, Connell, & Fien, 1998; Duvall & Zint, 2007; de Leeuw et al., 2015). Yet children do not live only in schools. They return

to households in which adults often control routines involving consumption, energy use, transportation, and waste. A child can carry a school taught idea into the home, raise it in conversation, correct an adult, demonstrate a practice, or repeatedly remind family members about it. In this sense, the child can become a recipient of socialization and also a source of it.

Waste sorting makes this upward pathway especially visible because it requires more than environmental concern. Households must know what belongs in which category, have access to usable infrastructure, decide who is responsible for sorting, and fit the practice into routines that may already be well established (Tonglet, Phillips, & Read, 2004; Zhang et al., 2015; Xu et al., 2017). In Guangzhou, the institutional context for such behavior became substantially stronger after the Guangzhou Municipal Domestic Waste Classification Management Regulations took effect in 2018 (Guangzhou Municipal People's Congress Standing Committee 2018). Environmental education has also increasingly entered Chinese schools through classroom instruction, campaigns, and broader ecological civilization education initiatives (Ministry of Education of the People's Republic of China et al. 2019).

These developments create an important sociological question. If children learn environmental norms at school, under what conditions do those norms travel into the household and become legitimate enough to challenge an established routine? Existing research shows that intergenerational environmental learning is possible. Children have influenced adult environmental knowledge, climate concern, water management, and other pro environmental practices in settings ranging from the Seychelles to the United States and China (Duvall & Zint 2007; Damerell, Howe, & Milner-Gulland 2013; Lawson et al., 2019; Zhang et al., 2025). However, evidence that influence is possible does not fully explain the mechanism through which it succeeds or fails.

The unresolved issue is not simply that several pathways are possible. Existing studies establish that child to adult environmental influence can occur, but they do not clearly identify which mechanisms become decisive when individual motivation, family relationships, and practical constraints point in different directions (Wu, 2020; Liu & Kaida, 2024; Spiteri, 2020; Zhang et al., 2025). A child may be knowledgeable but not be treated as a legitimate messenger. An adult may accept the environmental goal but reject being corrected by a child. A household may be receptive yet unable to sustain the behavior because collection is unreliable. The uncertainty, then, concerns how processes operating at different scales combine in a particular household and which combination is sufficient to move from communication to practice.

This paper develops that argument using a glass recycling education pilot conducted at Dongyuan County Huangcun Town Central Primary School in Heyuan, Guangdong, on June 12, 2026. The school pilot provides evidence about the first stage of the pathway: whether students possess the knowledge, confidence, and motivation necessary to become environmental messengers. The paper then uses household interviews to examine how the later mechanisms in the model operate across contrasting parent and grandparent cases.

This paper asks: Under what household conditions do children's environmental suggestions translate into changes in household practice, and how do processes at the individual, family, and broader structural scales combine to shape that transition? More specifically, the analysis follows child credibility and adult receptivity at the interpersonal level, intergenerational authority and household routines at the family level, and infrastructure and broader norms at the contextual level. The argument is that reverse socialization is conditional: the same environmental suggestion can produce different outcomes because it enters different configurations of relationships, routines, and material constraints.

The paper proceeds from this problem rather than assuming that one theory should explain the entire process. The next section reviews research at progressively broader scales, beginning with intergenerational learning and individual behavior, moving to family relationships and norms, and then to habit, infrastructure, and systems feedback. That progression provides the basis for the integrated conceptual model tested against the school and household data.

2. Literature Review

Reverse socialization challenges the conventional assumption that influence flows primarily from adults to children. Ballantyne, Connell, and Fien (1998) argued that students can act as catalysts of environmental communication beyond school

boundaries. Rather than treating the household as external to environmental education, their framework suggests that educational programs can deliberately create opportunities for children to initiate conversations with adults. Duvall and Zint's (2007) review of intergenerational environmental education studies similarly found that school programs can influence adults, particularly when programs involve parents and focus on locally relevant issues. The implication is that the design of school based education affects whether learning remains individual or becomes relational.

Subsequent empirical studies provide stronger evidence that child centered environmental education can affect adults. Damerell, Howe, and Milner-Gulland (2013) used a controlled trial in the Seychelles and found that adults whose children received wetland education displayed greater wetland knowledge and reported better household water management behavior. Lawson et al. (2019) experimentally evaluated a climate change curriculum in North Carolina and found increased climate concern among parents of children in the treatment group. These studies establish that child to parent influence can occur, but they also imply that it is not automatic: the strength of influence varies across family characteristics and prior beliefs.

Qualitative and community based research adds detail about how that influence is communicated. Spiteri (2020), in a multiple case study of young children and parents in Malta, found that children could carry Eco-Schools learning into the home, but parents differed in how much agency they granted children in environmental discussions. Milakovich et al. (2018) similarly documented child driven environmental health communication after a water focused summer program in the Apsáalooke (Crow) community: parents reported that children shared program content and initiated environmental health conversations at home. These studies are important for the present project because they move beyond the question of whether intergenerational influence occurs and direct attention toward the interaction through which adults receive, interpret, and respond to a child's message.

Recent research in China makes the reverse socialization question especially relevant, but it also reveals contrasts that require explanation. Wu (2020), using survey data from families in Jinan and follow up interviews, found that parent to adolescent environmental influence remained more frequent than adolescent to parent influence, even though more equal and open communication was associated with stronger reciprocal influence. Liu and Kaida (2024), by contrast, identified bidirectional parent child associations in environmental attitudes, psychological barriers, and pro environmental behaviors in China and Japan. Zhang et al. (2025) found another pathway in which children's green education was associated with parents' green travel behavior through environmental protection commitment. The contrast is not whether upward influence exists; it is why similar child originated environmental messages appear consequential in some family contexts but weak in others. That 'why' question shifts attention from the existence of transmission to the mechanisms that condition it.

One way to approach that question is to begin at the individual scale. The Theory of Planned Behavior (TPB) proposes that intentions are shaped by attitudes toward a behavior, subjective norms, and perceived behavioral control, with intentions and perceived control helping to explain behavior (Ajzen 1991). The framework has been directly applied to waste sorting in Guangzhou. Zhang et al. (2015), using household questionnaires, found that attitudes, subjective norms, perceived behavioral control, intentions, and situational factors significantly predicted waste separation behavior. This matters because it cautions against treating education as sufficient. Even a persuasive child cannot create convenient infrastructure, reduce time costs, or guarantee that the household believes sorting will be effective.

The application of TPB to recycling and waste separation is broad enough to show both the usefulness and the limits of an individual level account. Tonglet, Phillips, and Read (2004) used TPB to study household recycling in the United Kingdom and found that attitudes were important but were themselves tied to opportunities, facilities, knowledge, time, space, and inconvenience. Knussen et al. (2004) likewise found that perceived behavioral control and perceived lack of facilities mattered for recycling intentions. Later studies extended the model by adding moral norms, habit, and contextual constraints (Botetzagias, Dima, & Malesios, 2015; Knussen & Yule, 2008; Strydom, 2018). Chinese studies produce a similar pattern: Xu et al. (2017) showed that moral obligation, past experience,

and perceived policy effectiveness add explanatory value to TPB, while Wang and Lin (2023) found that attitudes, perceived norms, and self efficacy predicted waste sorting intentions among Chinese residents. These applications suggest that favorable attitudes alone are rarely sufficient to explain household recycling behavior.

TPB has also been applied directly to young people's environmental behavior. De Leeuw et al. (2015), studying high school students, found that attitudes, perceived norms, and perceived behavioral control predicted pro environmental intentions and later self reported behavior. Family behavior was also an important source of normative belief. This is especially relevant here because it connects environmental education to the same behavioral constructs used in household recycling research. Yet it still leaves open the relational problem at the center of reverse socialization: the child may possess the relevant beliefs and knowledge without having the household authority to translate them into shared practice.

The individual scale, however, is only part of the process. TPB does not fully specify what happens when the person who receives environmental education is not the person who controls the relevant household routine. Reverse socialization involves at least two actors: the child carrying the message and the adult evaluating it. An adult can hold a positive attitude toward recycling and still resist a child's correction because the interaction implicates status, credibility, habit, and the legitimacy of child to adult advice. To understand that step, the analysis has to move from individual decision making to the family relationship in which the decision is negotiated.

This relational problem is particularly relevant in a Chinese family context, where intergenerational authority remains important even as many family relationships become more reciprocal and negotiated. The purpose here is not to treat 'Chinese culture' as a fixed explanation or to assume that all households are hierarchical. Rather, authority is treated as a variable that differs across households and interactions. Some families may normalize children offering information and correcting adults, others may view such behavior as inappropriate or dismiss it as childish. Wu's (2020) findings support treating authority and communication style as mechanisms rather than as background culture.

Research on environmental socialization within families gives this relational mechanism a stronger empirical foundation. Grønhøj and Thøgersen (2009) found parent child similarities in environmental attitudes and behaviors across common household practices, and their later work showed that family norms can predict adolescents' pro environmental behavior alongside adolescents' own attitudes (Grønhøj & Thøgersen, 2012). In a matched parent adolescent study, autonomy supportive parenting and the strength of family environmental norms were associated with more internalized pro environmental motivation among young people (Grønhøj & Thøgersen, 2017). Matthies, Selge, and Klöckner (2012) similarly showed that parental communication and behavior shaped children's recycling and re use norms, while Ando et al. (2015) found direct and norm mediated intergenerational transmission of environmental behavior in Germany and Japan. Most of this literature examines downward parent to child influence, but it demonstrates that environmental behavior is embedded in family relationships rather than produced by isolated individuals.

For the Chinese context, the broader family literature also cautions against treating authority as a simple fixed cultural trait. Chao (1994) showed that common Western categories of authoritarian parenting can miss culturally specific meanings of parental guidance in Chinese families, while Yeh and Bedford's (2003) dual filial piety model distinguishes different forms of intergenerational obligation rather than treating filial relations as uniformly hierarchical. These studies do not directly predict recycling behavior, but they support the decision to treat intergenerational authority, legitimacy, and communication style as variables that can differ across households and interactions.

Moving from individual choice to family relations still does not capture the full problem, because household decisions are made inside material and social environments that can either enable or constrain action. A systems perspective provides the next scale of explanation. Existing routines reinforce expectations about what is normal; infrastructure affects whether a willing household can act; and the outcome of one interaction can influence whether similar interactions occur again. Systems thinking is useful here not because the household is assumed to behave like an ecological system, but because

it draws attention to interaction, feedback, path dependence, and the possibility that processes at different scales can push in different directions.

This broader scale move is deliberate. If individual attitudes, family authority, and external constraints all shape the same household decision, different theories are needed to capture processes operating at different scales. Research on habit helps bridge the family and systems levels: Knussen and Yule (2008) found that lack of recycling habit contributed to intentions even after accounting for TPB variables and situational constraints, illustrating why an established routine can persist independently of stated environmental attitudes. Panarchy and resilience research, at a more general theoretical level, conceptualizes social ecological systems as dynamic, cross scale arrangements in which feedback and prior states influence later trajectories (Gunderson & Holling, 2002; Allen et al., 2014). The present paper borrows that cross scale insight rather than applying an ecological adaptive cycle literally to households.

Taken together, the literature points to a gap that is best described as one of integration across scales. Reverse socialization research establishes that children can influence adults. TPB identifies individual motivational and control conditions. Family research shows that norms, communication, and authority shape how influence is received. Habit and systems research explain why prior routines and external conditions can stabilize or redirect behavior over time. The contribution of this paper is to put those processes on common footing and ask how they combine when a school originated environmental idea enters a household. Therefore, the focus is on explaining when individual motivation, family relationships, and structural conditions reinforce one another, when they conflict, and what those configurations mean for behavior change.

3. Integrated Theoretical Framework and Conceptual Model

Figure 1 organizes the argument as a sequence that crosses three analytical scales. At the child and individual scale, school environmental education can increase knowledge, confidence, and willingness to raise an environmental issue at home. Reverse socialization research predicts that stronger learning and engagement should make child to family communication more likely (Ballantyne, Connell, & Fien, 1998; Duvall & Zint, 2007). This produces the first proposition: students who leave an environmental activity with greater knowledge and confidence should be more likely to act as environmental messengers.

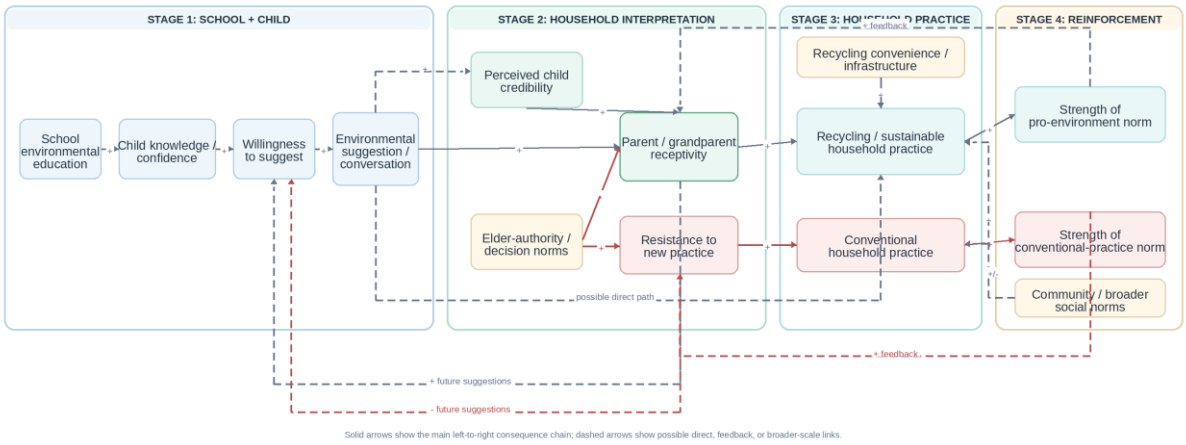


Figure 1. Systems model of reverse environmental socialization and household waste sorting practice

The model then moves to the interpersonal and family scale. A child's suggestion does not enter an empty decision space; it is interpreted by an adult. Perceived child credibility should increase receptivity, while authority norms can make the same suggestion feel inappropriate when it is experienced as correction rather than assistance. Family environmental norms and communication styles can further shape that reception (Wu, 2020; Grønhøj & Thøgersen, 2012, 2017). The second proposition is therefore relational: child communication is more likely to lead to a practice trial when the child is treated as a credible and legitimate messenger.

At the same family scale, existing routines create another source of friction. A household may endorse recycling but still be organized around a conventional disposal routine that is easier to reproduce. That possibility matters because habitual behavior can persist beyond stated attitudes (Knussen & Yule, 2008). The third proposition is that stronger conventional routines will increase resistance or reversion, even when environmental attitudes are favorable.

The next step moves outward to the practical and structural scale. TPB predicts that perceived behavioral control and situational conditions should affect whether receptivity becomes action (Ajzen 1991). In the present model, recycling infrastructure, collection reliability, available space, and broader community practice can either support or interrupt the transition from household willingness to sustained behavior. The fourth proposition is that positive attitudes and receptive family relationships will not be sufficient when the household perceives the practice as difficult, ineffective, or unsupported by the surrounding system.

These processes can also interact. High child credibility may increase receptivity but still fail to produce persistence if infrastructure is weak. Strong adult authority may suppress correction but coexist with adoption when a child demonstrates a concrete solution. A favorable attitude can coexist with reversion when the old routine remains easier to reproduce. The systems model is useful precisely because the outcome depends on configurations of mechanisms rather than one isolated predictor.

Two reinforcing pathways capture that configurational logic. In a pro environmental pathway, adult receptivity makes a practice trial more likely; successful repetition can make the practice easier and strengthen the sense that it is normal in the household. In a conventional practice pathway, established routines make resistance or reversion more likely, and continued conventional behavior further stabilizes the old norm. These are not assumed to be permanent states. They describe how repeated behavior can make one pathway easier to reproduce than another.

The model also includes feedback from adult response to later child communication. If a suggestion is taken seriously, the child may become more willing to raise related issues again. If the child is repeatedly dismissed, willingness to intervene may fall. This produces the fifth proposition: adult response to one environmental suggestion can alter the probability of future child to adult environmental communication.

The current work focuses most directly on the uncertain middle of Figure 1: the transition from child communication to adult interpretation and household practice. The Heyuan pilot provides evidence about the child side of the pathway, including knowledge, confidence, willingness, and institutional constraints. The household interviews examine child-to-adult communication, perceived credibility, receptivity and resistance, intergenerational authority, routines, infrastructure, reported practice trials, negotiation, and reversion. Retrospective accounts also provide suggestive evidence about feedback into later child communication.

Long-term changes in household norms, the durability of feedback across extended periods, and community-level or institutional effects lie beyond the evidence available here. Those parts of the model remain targets for longitudinal research rather than claims of the present study.

4. Research Design and Methods

The study has two complementary components. The first is a completed single school environmental education pilot at Dongyuan County Huangcun Town Central Primary School in Heyuan, Guangdong while the second is a household interview component.

4.1 School Pilot and Post-Intervention Student Survey

The school pilot was conducted on June 12, 2026 and was designed primarily to assess the first stage of the proposed reverse socialization pathway: whether students possessed or could acquire the knowledge, confidence, and motivation necessary to carry an environmental message beyond the classroom. Approximately 50 primary school students participated. Forty seven valid student surveys were collected: 43 from Grade 5 and four from Grade 2. Five students were interviewed after the activity, including three Grade 5 students and two Grade 2 students. Approximately 11 teachers and school representatives, including homeroom teachers, science teachers, and administrators, participated in interviews or group discussion about the school's waste sorting conditions and the feasibility of a longer term glass recycling mechanism.

The intervention combined multiple educational formats. Students received a PPT based lesson, The Wonderful Rebirth Journey of Glass Bottles, covering glass production, recycling, environmental value, and the idea that different forms of glass require different handling. The activity also included classroom questioning, a classification game, a short student survey, student interviews, teacher and administrator interviews, and an introduction to a proposed Glass Circularity Fund that could direct some future recycling value toward visible school environmental activities.

The student survey measured baseline awareness and operational knowledge. Questions asked whether students understood glass recycling, knew that bottles could be made into new glass products, could distinguish ordinary recyclable glass from items such as mirrors, bulbs, and window glass, and felt confident using a glass recycling bin. Additional items measured agreement that recycling helps the environment, willingness to join school recycling activities, and whether a school environmental fund would increase participation willingness.

A complete matched post survey was not collected because of onsite time and implementation constraints. Therefore, the analysis does not estimate a causal pre/post treatment effect. Instead, immediate post activity evidence comes from five open responses to the question 'What is the most important thing you learned today?' and from the five student interviews. Teacher and administrator interviews provide evidence about implementation conditions, including infrastructure, safety, waste handling, suitable grade levels, and institutional support.

4.2 Household Interview-Based Case Studies

For the household component, the paper uses a purposive sample of 18 parent and grandparent interview cases: 12 parents and six grandparents distributed across Guangzhou and Heyuan. Ten respondents lived in Guangzhou, including seven parents and three grandparents, while eight lived in Heyuan, including five parents and three grandparents. The cases were selected to create theoretically meaningful variation in baseline recycling practice, strength of conventional household routines, perceived child credibility, openness to child to adult advice, grandparent involvement, and recycling convenience. This design follows a maximum variation logic rather than a statistical representativeness logic. These cases permit cross-case comparison of plausible mechanisms across varied household situations, rather than statistical generalization; thematic saturation was not formally assessed.

Household interviews were conducted between September 5 and September 7, 2026, after the school pilot. The ten Guangzhou respondents were recruited separately through community and personal referral networks to introduce additional variation in recycling infrastructure, household routines, and intergenerational relationships. Interviews lasted between 20 and 40 minutes, with an average length of approximately 29 minutes. All interviews were conducted by Zoom or Feishu call, primarily in Mandarin Chinese. Sixteen interviews were audio recorded with verbal consent and transcribed. Detailed contemporaneous notes were taken for two respondents who preferred not to be recorded, and all direct quotations reported below come from recorded interviews. Respondents gave verbal consent for anonymized use of their interview material. Each respondent was assigned an identifier combining location and generation: GZ and HY indicate Guangzhou and Heyuan, P indicates parent, and GP indicates grandparent.

The household interview guide begins with concrete events rather than abstract labels. Respondents are asked to describe a recent example of a child suggesting an environmentally helpful practice, how the adult responded, whether the household tried the practice, whether the practice persisted, and whether the child raised the issue again. Additional questions probe perceived child knowledge, household decision authority, normal waste routines, neighborhood recycling conditions, and practical barriers. The analysis codes responses into acceptance, negotiation, resistance, indifference, symbolic agreement, and reversion, while also examining the mechanisms that connect communication to those outcomes.

Typical, deviant and diverse cases of student-family interactions are constructed based on interview results to ensure both representativeness and diversity of the sample. Cross-case comparison was conducted to investigate the common and divergent mechanisms of behavioral change.

4.3 Coding and Pattern Matching

The analysis used qualitative pattern matching rather than treating every interview as a separate anecdote. I first read each transcript for the sequence of events: what the child suggested, how the adult interpreted the suggestion, what the household did next, and whether the practice persisted. An initial three part distinction among acceptance, negotiation, and resistance became too coarse as repeated readings revealed verbal agreement without action, minimal engagement, and cases in which a trial faded over time. The final outcome codes were acceptance, negotiation, resistance, indifference, symbolic agreement, and reversion. In a second round, I coded the mechanisms that appeared to shape those outcomes—child credibility, adult receptivity, intergenerational authority, established routines, recycling infrastructure, community norms, and feedback into later child communication. Mechanism codes were nonexclusive because the same passage could contain several processes at once.

Cases that ran against an initial expectation were retained and compared with more typical cases. For example, a grandparent who emphasized adult authority but still adopted a child's suggestion weakens a simple 'hierarchy blocks influence' claim; a parent who trusted the child but abandoned sorting when collection seemed unreliable separates credibility from perceived behavioral control. Comparisons were then made across Guangzhou and Heyuan and between parent and grandparent respondents. This cross case logic is what allows the analysis to ask whether a mechanism appears and what happens when several mechanisms operate at the same time.

5. Results: The Heyuan School Pilot

The pilot produced three patterns that are especially relevant to the broader model. First, students expressed relatively positive environmental attitudes while showing weaker operational confidence. Second, immediate post activity responses showed that some students could articulate several core recycling concepts presented during the activity. Third, the school context itself imposed practical constraints, reminding us that knowledge and willingness operate inside institutional systems rather than independently of them.

Baseline awareness was uneven. Twenty seven of 47 students (57.4 percent) reported that they were either very clear about or knew at least something about glass recycling, while 35 of 47 (74.5 percent) knew that glass bottles could be recycled into new glass products. Yet only 11 of 47 students (23.4 percent) fully identified the ordinary recyclable glass items in the classification question. Thirty two students (68.1 percent) were partially correct but included items such as mirrors, light bulbs, or window glass. The accompanying pilot assessment also counted 34 of 47 students (72.3 percent) who selected at least one unsuitable item; this broader count includes some responses outside the partially correct category. The pattern suggests that the abstract idea of recycling was more familiar than the practical boundary rules needed to perform sorting accurately.

The same gap appears in the rating items. Agreement that glass recycling helps the environment averaged 3.93 out of 5, willingness to join school glass recycling activities averaged 3.84, and agreement that the proposed fund would increase willingness averaged 3.93. In contrast, average confidence in knowing how to use a glass recycling bin was only 2.46. Students therefore appeared more ready to endorse recycling as a value than to carry it out confidently as a routine. This distinction matters for reverse socialization because a child who is enthusiastic but operationally uncertain may be less credible when correcting an adult or explaining a new household practice.

The five immediate post activity open responses provide evidence of students' post activity understanding, but not a causal estimate of how much the lesson changed knowledge. Students mentioned that glass can be recycled and reused, that not all glass belongs in the same recycling stream, and that recycling can protect the environment. Several specifically distinguished perfume or beverage bottles from mirrors, bulbs, and windows. These responses show that at least some students could articulate specific, communicable propositions after the activity rather than only a generalized pro environmental sentiment.

The individual answers add more detail than the aggregate survey alone. Table 1 presents English translations of excerpts from all five recorded Question 8 responses. Their emphasis varied: some students remembered how glass is made, others drew a boundary between recyclable bottles and mirrors or windows, and one focused on the environmental value of recycling. The responses show what students could articulate

immediately afterward, not a measured change from baseline.

Table 1. Five post activity Question 8 responses (English translations of selected excerpts; ellipses reflect the interview manuscript)

Response	English translation	Analytical code
S-Q8-01	*I learned how glass is made ... and that glass can be recycled and reused.*	Glass production and reuse
S-Q8-02	*Not all glass can be recycled. Examples of recyclable glass include perfume bottles and glass bottles, while mirrors and window glass cannot be recycled in the same way.*	Boundary between bottles and other glass
S-Q8-03	*It helped me understand the process of making glass and some of its historical value ... and that not all glass can be recycled.*	Production, history, and sorting limits
S-Q8-04	*The most important thing I learned is that recycling glass can protect the environment.*	Environmental value
S-Q8-05	*Some glass can be recycled and reused ... perfume bottles and glass bottles can be recycled, while mirrors, light bulbs, and window glass are less suitable for recycling.*	Reuse, sorting, and exceptions

Student interviews also suggest that interactive formats increased engagement. Students identified classroom questions, games, lectures, and competitions as helpful, with games receiving particular emphasis. When asked whether they would use a school glass recycling bin, students generally said yes and linked the behavior to being more environmentally friendly. Students also suggested that teachers, parents, and schools should help build recycling habits through demonstration, practice, and facilities. This is important theoretically because the students themselves did not describe behavior as an individual choice alone, they located habit formation within a network of adults and institutions.

Teacher and school representative interviews revealed an institutional implementation gap. The school did not have a specific waste classification or separate recycling system, and glass waste was generally mixed with other waste before being sent to a unified station. Teachers identified safety as the first concern, followed by management and connection with recycling companies. They also emphasized the need for clear labels, teaching materials, funding, volunteers, partnerships, and safety training. Thus, even if students became motivated environmental messengers, the school itself lacked the infrastructure necessary to make glass sorting an ordinary routine.

Therefore, the pilot provides evidence of post activity awareness and engagement, but not a measured treatment effect or completed household behavior change. It also exposed two bottlenecks that matter for the conceptual model: operational knowledge and institutional feasibility. Students could value recycling without being confident about how to sort correctly, and the school itself lacked a separate glass recycling system. The distinction among valuing a practice, knowing how to perform it, and having a system that makes it feasible becomes important again in the household interviews.

Table 2. Selected baseline indicators from the Heyuan school pilot (N = 47 valid student surveys)

Indicator	Result	Interpretation
At least some prior awareness of glass recycling	27/47 (57.4%)	Basic awareness existed, but was incomplete.
Knew bottles can become new glass products	35/47 (74.5%)	Circular use concept was relatively familiar.
Fully correct classification of	11/47 (23.4%)	Accurate sorting knowledge was

ordinary recyclable glass		limited.
Partially correct but confused classification	32/47 (68.1%)	Many students over included mirrors, bulbs, or window glass.
Confidence in using a glass recycling bin	2.46/5	Operational confidence lagged behind attitudes.
Agreement that glass recycling helps the environment	3.93/5	Environmental attitudes were generally positive.
Willingness to join school glass recycling activities	3.84/5	Participation willingness was relatively high.
Agreement that the fund would increase willingness	3.93/5	Visible collective benefits may strengthen motivation.

6. Household Interview Findings

The household interviews examine the middle of the process that the school data cannot resolve on their own: what happens after an environmental idea enters family conversation. The sample was deliberately varied across household routines, authority relationships, child credibility, and practical recycling conditions. Rather than producing a simple division between 'successful' and 'unsuccessful' reverse socialization, the interviews revealed a continuum of acceptance, negotiation, symbolic agreement, resistance, partial adoption, and reversion.

6.1 From School Learning to Household Conversation

Across the 18 household cases, children's environmental suggestions were common but their effects varied substantially. Fourteen respondents could recall at least one recent occasion when a child or grandchild suggested an environmentally beneficial practice. These suggestions included separating recyclable bottles, changing how household waste was sorted, using fewer disposable plastic bags, turning off unused lights, reducing water waste, and reusing household materials. However, the presence of a suggestion did not by itself predict behavioral change.

In most cases, school originated environmental ideas entered family life through ordinary conversation rather than a formal lesson. Some children explicitly referred to teachers or classroom activities. Others corrected adults while observing everyday behavior. One Heyuan parent (HY-P02) described a household conversation about glass recycling:

"After he came home, he told us that not all glass is recycled in the same way. Things like drink bottles can be recycled, but mirrors and light bulbs cannot. He also kept telling us not to throw bottles directly together with the kitchen waste. Before that, we honestly did not pay much attention to it." (HY-P02)

Another Heyuan parent (HY-P03) remembered a less technically specific message:

"She came home saying that her teacher had explained that waste should not all be mixed together because it is bad for the environment. She herself did not necessarily remember every category clearly, but she would keep reminding us that this should not be thrown away casually and that should be separated." (HY-P03)

These examples show that school originated communication can be both technical and normative. Some children transmit procedural information about how to sort. Others carry home a broader moral expectation that waste should be handled more responsibly. Environmental influence often appeared as a series of small interventions embedded in everyday routines rather than as a single deliberate conversation.

6.2 Perceived Child Credibility

A recurring distinction across the cases was between hearing a child's suggestion and believing that the child knew what they were talking about. Adults frequently evaluated the credibility of the child before deciding whether to take the recommendation seriously. School affiliation often mattered because it gave the child's claim an identifiable source.

One Guangzhou mother (GZ-P03) explained:

"Sometimes she tells me something and I do not know where she heard it, so I may not believe it immediately. But if she says they just learned it at school, or that the teacher asked them to tell their parents, then I feel there is probably some basis for it and I listen more carefully." (GZ-P03)

Credibility was also domain specific. Several adults viewed children as relatively knowledgeable about environmental topics or technology while still regarding them as inexperienced in household management. This sometimes produced partial receptivity: the adult accepted that the information might be correct but questioned whether the proposed practice was realistic. One Heyuan grandparent (HY-GP02) explained:

"I know what he is saying is probably right. They definitely learn more of this at school now than we did before. But this is how our family has always handled the rubbish, and suddenly asking everyone to change is not that easy. It is not that we refuse to listen to him, the habit is already there." (HY-GP02)

This distinction separates epistemic credibility from behavioral authority. The adult can acknowledge that the child possesses valid information while still maintaining that knowledge alone does not determine how the household behaves.

6.3 Intergenerational Authority and the Social Meaning of Correction

Prior research suggests that family norms and parenting structure can shape how environmental guidance is received, while research on Chinese family relations cautions against reducing intergenerational authority to a single authoritarian dimension (Grønhøj & Thøgersen, 2012, 2017; Chao, 1994; Yeh & Bedford, 2003). The way a suggestion was delivered also mattered because child to adult correction carries a social meaning beyond environmental content. Respondents differed in how comfortable they were with children correcting adults. Several parents characterized reminders as acceptable when they were occasional or conversational, but reacted more negatively when they felt the child was policing adult behavior.

One Guangzhou mother (GZ-P04) explained:

"I do not mind if he reminds me once or twice, but if I have just thrown something away and he immediately says, 'Mom, you did that wrong,' sometimes my first reaction is still to feel a little annoyed. Later I may think about it and realize he was not wrong, but in the moment it feels different." (GZ-P04)

Authority concerns were more explicit in several grandparent cases. One Heyuan grandparent (HY-GP01) explained:

"Of course it is good for children to learn these things, and I listen when he comes home and tells us about them. But sometimes the way he says it makes it sound like he is the one managing us. I tell him that he can remind us, but he should not keep telling adults how to do things." (HY-GP01)

These cases show that agreement with the environmental content does not necessarily produce receptivity to the interaction itself. In other households, however, child to adult advice was treated as normal, particularly in areas where children were seen as learning newer information. Intergenerational authority therefore operates as a variable rather than a fixed cultural condition.

6.4 Existing Household Routines and Competing Norms

Research on recycling has similarly found that past behavior and habit can explain variation beyond environmental attitudes alone (Knussen et al., 2004; Knussen & Yule 2008). A recurring source of resistance was not explicit disagreement with recycling but the existence of an established household routine. Many adults described their preexisting waste practices as something they rarely thought about before a child raised the issue. One Guangzhou parent (GZ-P06) explained:

"Before, we did not separate things that carefully. Kitchen waste went into one bag, and most other things went into another. We might put cardboard aside because someone comes to collect it. But with glass bottles, if we saw one, we would usually just throw it away with the rest rather than specifically thinking about which category it belonged to." (GZ-P06)

Several households occupied a mixed position in which adults endorsed environmental goals while retaining a waste routine organized around convenience and familiarity. Where households already practiced some recycling, children's suggestions generally reinforced existing behavior. Where little sorting existed beforehand, the same child suggestion required a much larger disruption of routine. This contrast supports the idea of competing household attractors: existing practice can make either environmental adoption or conventional persistence easier to reproduce.

6.5 Negotiation Rather than Simple Acceptance or Rejection

Adult responses rarely fit a binary distinction between acceptance and rejection. Several cases involved negotiation. Families agreed to separate

only certain high visibility recyclables, created a single additional collection point rather than a complete sorting system, or allowed the child to manage one part of the practice without requiring every family member to follow the full recommendation.

One Guangzhou parent (GZ-P05) described a compromise:

"At first he said every type should be separated, but I told him we do not have enough space at home for that many bins. Later we decided to at least put cardboard and bottles separately, while handling the rest as before. That was easier to maintain." (GZ-P05)

Negotiation is important because it complicates what counts as successful reverse socialization. The child's original recommendation may not be adopted exactly, yet the interaction can still alter household behavior. Negotiation may therefore be a central pathway between receptivity and durable practice.

6.6 Infrastructure as a Constraint on Household Change

Even where adults were receptive, practical conditions frequently constrained behavior. Respondents raised concerns about bin availability, confusing labels, irregular collection, and uncertainty about whether separated waste remained separated after collection. A Guangzhou parent (GZ-P07) explained:

"When he said we should separate the bottles, I thought that was fine, it is not that much trouble. But with the bins downstairs, sometimes the labels are clear and sometimes they are hard to understand. More importantly, even after you separate everything, you do not know whether it all gets mixed together later anyway. Then you start wondering whether all the effort you put into sorting actually does anything." (GZ-P07)

A Heyuan grandparent (HY-GP03) described a similar problem:

"Everyone understands the idea, of course it is better if things can be recycled. The question is where you put them after separating them and whether anyone actually comes to collect them. If they are eventually transported together with the other waste anyway, then it is difficult to keep sorting them separately at home." (HY-GP03)

These cases support the perceived behavioral control component of TPB. Positive attitudes and interpersonal receptivity did not guarantee behavior when adults doubted that the surrounding waste management system made sorting meaningful. Infrastructure also interacted with household norms: where recycling was easy, a child's request required little disruption, where it required additional storage, transport, or uncertainty, the suggestion competed more strongly with convenience. This pattern is consistent with prior recycling research in which facilities, convenience, perceived control, and policy effectiveness help explain why favorable attitudes do not always become behavior (Tonglet, Phillips, & Read, 2004; Strydom, 2018; Xu et al., 2017; Wang & Lin 2023).

6.7 Adult Response and Feedback into Future Child Communication

A recurring pattern involved feedback from adult response to later child behavior. Adults who responded positively often described children continuing to introduce other environmental suggestions. One Heyuan mother (HY-P01) recalled:

"After we actually started putting some bottles aside separately, she became even more into it. If she saw me taking a plastic bag, she would ask whether we could bring our own bag next time. Sometimes she gets a little repetitive, but you can tell that she really remembers these things." (HY-P01)

The opposite process also appeared. One Guangzhou grandparent (GZ-GP01) described an interaction in which repeated reminders became irritating:

"At first he talked about it quite a lot. Whenever he saw me throwing something away, he would say something. Then one time I was probably a bit annoyed and said, 'Okay, okay, I know. You do not need to keep saying it.' After that, he really did seem to bring it up less. I did not pay much attention to it at the time, but thinking back, it may have had something to do with that." (GZ-GP01)

The respondent's uncertainty is analytically useful. The account does not prove that adult rejection caused the child to stop raising the issue, but it is consistent with the proposed feedback mechanism. Adult response can shape the immediate behavior under discussion and whether future upward socialization occurs.

6.8 Persistence, Reversion, and the Formation of New Norms

Not all adopted practices persisted. Several cases involved a period of careful sorting followed by partial reversion. One Guangzhou parent (GZ-P02) described:

"For the first few weeks we really did separate things

more carefully because the child checked every day. Later everyone became busy, and he stopped mentioning it every day, so gradually we stopped sorting quite so carefully. We still put cardboard and bottles aside now, but not as carefully as at the beginning." (GZ-P02)

By contrast, other cases described a practice becoming easier after repetition. One Heyuan parent (HY-P04) explained:

"At first she had to remind us, but later she did not need to say anything. After finishing a bottle, I would put it aside myself. Once you have done it for a while, it does not actually feel that troublesome. At the beginning, though, someone has to keep reminding you." (HY-P04)

These contrasting reported trajectories support the distinction between initial adoption and durable norm change. Respondents' accounts suggest that a new practice can remain dependent on active child reminders, partially survive after those reminders weaken, or become sufficiently routinized that the child no longer needs to intervene.

6.9 Cross-Scale Synthesis: Interactions Among Mechanisms

Cross-case comparison shows why the mechanisms are more informative when read across scales than when treated as rival explanations. Some cases fit the individual-level logic of TPB: adults expressed favorable environmental attitudes and were comfortable receiving advice from children, but practical barriers prevented adoption. In those households, perceived behavioral control was the most immediate constraint.

Other cases make the family scale more visible. Adults could support recycling, have reasonably convenient infrastructure, and acknowledge that the child's information was correct, yet still react negatively because the child was perceived as correcting or directing an adult. These cases do not invalidate TPB but they show that favorable individual level conditions can be interrupted by a relational process that TPB does not foreground.

A third pattern sits between family and system. Some adults neither rejected the child nor faced major infrastructural barriers, but the existing routine was sufficiently automatic that the new practice faded after an initial trial. Here, attitudes and receptivity were not enough to overcome path dependence: the old practice remained easier to reproduce.

One deviant case complicated the expectation that stronger intergenerational authority necessarily reduces upward influence. GZ-GP02 described household decision making as adult led and said that children should not repeatedly correct adults. Nevertheless, she adopted her grandson's suggestion to separate beverage bottles after he showed her the sorting procedure and placed a small container beside the kitchen bin. She explained, "If he only tells me that I am doing it wrong, I may not like it. But when he shows me how to separate it and helps put the bottles aside, then I think this is something I can learn." (GZ-GP02) This case suggests that strong adult authority can coexist with child influence when a suggestion is concrete and framed as assistance rather than correction.

A second deviant case weakened a simple credibility centered explanation. GZ-P07 viewed her child as knowledgeable and initially accepted the suggestion to separate bottles, but reported abandoning the practice after roughly three weeks because she believed the residential collection process recombined separated waste. Her case indicates that credibility can produce receptivity without producing persistence when perceived behavioral control remains low. Rather than contradicting the broader model, the case helps distinguish the relational mechanism from the infrastructural constraint.

Finally, households in which child suggestions produced more durable changes tended to combine several favorable conditions rather than a single determining factor. The child was viewed as knowledgeable, communication was relatively open, the proposed practice was concrete, and infrastructure made adoption reasonably convenient. Once the behavior was attempted successfully, repetition further reduced resistance.

Taken together, these cases show why the systems model adds something beyond a longer list of predictors. Credibility, authority, habit, and infrastructure can operate at the same time and can push in different directions. High child credibility may increase receptivity yet still be overridden by weak infrastructure. Strong adult authority can inhibit correction yet coexist with adoption when the suggestion is concrete and framed as assistance. Favorable attitudes can coexist with reversion when an established routine remains easier to reproduce. The

important empirical pattern is therefore configurational: outcomes depend on how processes at different scales line up in a particular household. Because one response can also change later communication and practice, the process includes feedback as well as interaction.

6.10 Summary of Household Findings

Taken together, the household cases suggest that children's environmental influence operates through a sequence of socially mediated steps. School learning can generate information that enters the household, but adults evaluate both the message and the messenger. A suggestion is more likely to produce behavioral experimentation when the child is perceived as credible, when child to adult advice is considered legitimate, when the proposed behavior does not strongly conflict with established household routines, and when the material environment makes the practice feasible.

The cases also show why outcomes should not be reduced to a binary distinction between change and no change. Households can accept, negotiate, temporarily adopt, partially maintain, resist, or revert from new practices. These different responses reveal distinct mechanisms.

Most importantly, the household analysis supports a dynamic rather than one directional model of reverse socialization. Respondents' accounts suggest that adult response can shape whether the child continues to communicate. Household practice then shapes household norms, which in turn affect receptivity to later suggestions. Reverse socialization therefore becomes a recursive process: school originated environmental knowledge enters a family, is filtered through existing social relationships and routines, and can either weaken or reinforce the conditions for future environmental influence.

7. Discussion

Household adoption is better understood by considering processes operating at different scales. The school data show that motivation and operational knowledge are not identical. The household interviews then show that even a knowledgeable child and a receptive adult do not guarantee sustained practice. Family authority, existing routines, and infrastructure can reinforce or interrupt the pathway at different points.

The first important implication concerns TPB. The school pilot itself contains a value practice gap: students generally endorsed glass recycling but reported much weaker confidence in knowing how to use a recycling system. The household cases reproduce a similar structure among adults. Positive attitudes are often present even where behavior does not change. This supports TPB's emphasis on perceived control and situational conditions, but the interviews also show that perceived control is not the whole story.

The second implication is relational. Adults sometimes agreed that the child was factually correct while still resisting the interaction because the child was perceived as correcting or directing an older family member. This separates environmental attitude from receptivity to the messenger. The mechanism is especially visible in cases where infrastructure is adequate and the adult endorses recycling, yet behavior still does not change. Such cases are difficult to explain through attitudes alone and provide stronger support for the household authority and credibility model.

The third implication concerns norms and routines. Several cases show that a household can support an environmental goal in principle while remaining organized around a conventional disposal routine. Because routines reduce the need for repeated decision making, they can persist without being consciously defended. This is why a new environmental suggestion may be accepted rhetorically yet fail behaviorally. The systems framing captures this by treating both pro environmental and conventional practices as potentially self reinforcing.

The fourth implication concerns feedback. Respondents' accounts suggest that adult response may affect the future supply of child originated environmental communication. Acceptance can encourage the child to raise related topics again, while rejection can reduce later suggestions. At the same time, successful practice can strengthen a pro environmental household norm, and repeated failure can reinforce the old routine. Reverse socialization is therefore recursive: the effect of one interaction changes the conditions under which the next interaction occurs.

These mechanisms also help reconcile apparently inconsistent findings in the broader literature. Studies that identify strong child to parent influence may be observing households where messenger credibility, communication openness, and practical feasibility align. Studies finding

weaker or asymmetric influence may include more households in which these conditions do not align. The relevant question is hence which configurations of household and institutional conditions make it more likely.

Therefore, the cross scale synthesis in Section 6.9 is not a contest in which one theory replaces the others. TPB captures individual motivation and control conditions; the relational account captures messenger legitimacy and authority; research on habit explains why routines can persist despite favorable attitudes; and the systems model explains why these processes can combine, counteract one another, and feed back over time. The contribution of the larger model is to explain why apparently contradictory household cases can emerge from different configurations of otherwise familiar mechanisms.

The Guangdong case is analytically useful because environmental education, waste sorting policy, infrastructure, and family practices coexist but do not operate uniformly. Variation within the province makes it possible to study the same broad environmental norm under different household starting states. The contribution should therefore remain mechanism based rather than population wide. The claim is that child influence appears to depend on identifiable combinations of credibility, authority, norms, and practical opportunity.

8. Limitations

The study has several limitations. First, the Heyuan pilot was conducted in a single school and cannot be treated as representative of Guangdong primary schools. Second, the intervention did not produce a complete matched post survey, preventing a strict pre/post estimate of knowledge change. Immediate open responses and interviews demonstrate post activity comprehension but not the magnitude of learning attributable to the activity.

Third, glass recycling is a specific and sometimes unusually difficult waste sorting behavior because of safety, classification, storage, and collection issues. Mechanisms observed for glass may not transfer perfectly to food waste, paper, plastics, energy conservation, or green travel. A broader household instrument should therefore include examples of sustainable practices beyond glass while retaining waste sorting as the focal behavior.

Fourth, the household findings rely on retrospective adult accounts rather than continuous observation of family behavior. The interviews can show how adults interpreted children's suggestions, how they remember responding, and whether they report that a practice continued, but they cannot independently establish the duration of a habit or isolate the cause of change. Recall and social desirability may affect respondents' accounts, and most interactions are represented from the adult rather than the child perspective. Claims about persistence, reversion, and feedback should therefore be read as reported sequences consistent with the proposed mechanisms rather than direct observation of causal processes over time.

9. Conclusion

Environmental education does not end when a lesson ends. Children can carry environmental ideas into households, but the path from learning to household practice is neither automatic nor linear. The Heyuan pilot shows that even before family influence is considered, environmental values can exceed operational knowledge: students may believe recycling is important while remaining uncertain about how to perform it correctly. This gap highlights why environmental behavior depends on both motivation and practical capacity.

The broader argument is that reverse socialization is not governed at one scale. A child's knowledge and willingness matter, but so do the adult's interpretation of the messenger, the authority structure of the family, the inertia of existing routines, and the practical environment in which the behavior must occur. These processes can reinforce one another or pull in opposite directions. Adult responses then feed back into later communication, making the pathway dynamic rather than one directional.

The central research question is hence not simply whether children can make adults recycle. Existing studies already show that child to parent environmental influence is possible. The more useful question is what combination of conditions allows that influence to become legitimate, actionable, and durable. By placing individual choice, family relationships, habitual practice, and structural constraints on the same conceptual map, this paper offers a cross scale explanation of household adoption.

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