The Urgency of the OIDDE Instructional Model for Teaching Inheritance of Traits: Implications for Junior High School Students' Learning Interest and Critical Thinking Skills

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Abstract
Inheritance of traits (heredity) is a conceptually demanding topic for Grade 9 junior high school students. It requires learners to coordinate abstract entities (genes/alleles), symbolic representations (Punnett squares, pedigrees), and probabilistic reasoning—conditions that often produce misconceptions and low confidence. At the same time, junior high science curricula increasingly emphasize higher-order outcomes such as critical thinking and sustained learning interest, not only factual recall. The OIDDE learning model (Orientation–Identify–Discussion–Decision–Engage in behavior) was developed as a staged inquiry model to guide learners through dilemma-based reasoning and responsible action. Evidence from higher education and secondary contexts indicates that OIDDE can foster higher-order thinking (including critical thinking), ethical decision making, and learning engagement when implemented with appropriate scaffolding (Hudha *et al*., 2016; Husamah *et al*., 2018; Hudha *et al*., 2024). This article provides a framework synthesis (≤2024) to argue for the urgency of applying OIDDE to the inheritance topic in junior high school. We integrate three research strands: (1) the structure and documented impacts of OIDDE; (2) evidence on conceptual difficulties and misconceptions in genetics learning; and (3) motivation research on learning interest and autonomy-supportive instruction. Results include an explanatory framework linking OIDDE stages to motivational mechanisms and cognitive mechanisms, and we translate the framework into a lesson flow and assessment checkpoints for Grade 9 heredity. We also provide an evidence map, a stage-by-stage activity template, and rubrics for critical thinking and interest measurement.

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1. Introduction

Genetics and inheritance are increasingly visible in everyday life. Students encounter genetic ideas through media discussions about inherited diseases, forensic DNA, selective breeding, and genetically modified organisms. However, classroom learning about inheritance often remains procedural (e.g., filling Punnett squares) without conceptual understanding or critical reasoning about evidence and uncertainty. This is a missed opportunity, because heredity is an ideal context to cultivate critical thinking: learners must interpret representations, analyze patterns, evaluate competing explanations, infer probabilities, and communicate reasoning clearly.

In Indonesian junior high science (SMP), inheritance of traits is typically introduced through Mendelian principles, genotype–phenotype relations, and probability. These components demand abstract thinking and mathematical reasoning, and students frequently confuse key terms (gene vs chromosome; genotype vs phenotype; dominant vs recessive) and misinterpret probability

as certainty. Studies of genetics education internationally show that misconceptions persist even after instruction, suggesting that conceptual change requires carefully structured learning experiences, not only explanations (Ojo, 2024).

Learning outcomes in this topic are also shaped by motivation. When students feel the topic is confusing or irrelevant, their interest decreases, effort drops, and misconceptions become entrenched. Learning interest is not merely a pleasant byproduct; it is a mechanism that influences attention, persistence, and willingness to engage in cognitive challenge.

The OIDDE learning model offers a structured way to integrate motivational supports and reasoning demands. OIDDE is an acronym for Orientation, Identify, Discussion, Decision, and Engage in behavior. The model was developed through a review and modification of social learning and behavioral systems syntax and the tri prakoro model (Hudha *et al*., 2016) [4]. Subsequent studies show that OIDDE can enhance higher-order thinking and learning engagement (Husamah *et al*., 2018; Hudha *et al*., 2024) [6, 5].

Therefore, this paper argues that OIDDE is urgent for teaching inheritance in Grade 9 SMP because it provides a practical, assessable pedagogy that can increase learning interest and strengthen critical thinking. The article is positioned as a framework synthesis (≤2024) that translates research into an actionable lesson design, assessment plan, and evidence templates for schools.

2. Literature Review

2.1. The OIDDE instructional model: origin, syntax, and documented outcomes

Hudha *et al*. (2016) [4] describe OIDDE as a staged model—Orientation, Identify, Discussion, Decision, and Engage in behavior—developed through analysis and modification of social learning and behavioral systems syntax and the tri prakoro model. OIDDE was proposed as a valid, practical, and effective instructional alternative, originally to address dilemma-based learning in ethics-related contexts. Subsequent research indicates that OIDDE can stimulate higher-order thinking. Husamah, Fatmawati, and Setyawan (2018) [6] report improvements in self-regulated, critical, and creative thinking among biology teacher candidates using OIDDE in cycles. More recently, Hudha, Oktapiani, and Rahardjanto (2024) [5] found that OIDDE improved critical thinking, learning outcomes, ethical attitudes, and learning engagement among Indonesian high school students. A 2024 literature study (Temi *et al*., 2024) [9] also synthesizes multiple studies reporting positive impacts of OIDDE on critical thinking and related outcomes.

2.2. Why inheritance of traits is difficult in junior high school

Inheritance topics require students to coordinate abstract entities, multiple representations, and probabilistic reasoning. Genetics content is widely reported as difficult and misconception-prone, and negative perceptions can reduce persistence. Ojo (2024) [7] reports that many secondary students hold misconceptions about genetics concepts and that confusing terminologies and perceived difficulty contribute to negative perceptions. In Indonesia, heredity misconceptions have also been documented with diagnostic approaches. Fajri *et al*. (2022) [3] report that two-tier diagnostic testing can reveal misconceptions across heredity indicators. These findings support the need for structured learning models that (a) diagnose misconceptions early, (b) provide reasoning-based discussion opportunities, and (c) require justification under uncertainty.

2.3. Learning interest and motivation in adolescence

Interest is a motivational state characterized by attention, positive affect, and perceived value, and it influences persistence in challenging tasks. Self-determination theory emphasizes that autonomy support, competence feedback, and relatedness contribute to engagement and more self-determined motivation (Deci & Ryan, 2000). For heredity learning, situational interest can be triggered through meaningful cases (family traits), hands-on representations, and collaborative problem solving—then sustained by competence scaffolds (clear vocabulary, stepwise tasks) and autonomy (student choice in case analysis).

2.4. Critical thinking constructs and alignment with OIDDE

Critical thinking is commonly framed as purposeful, self-regulatory judgment involving interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990) [2]. These skills map onto OIDDE's structure: Orientation and Identify support interpretation and problem framing; Discussion supports analysis and evaluation through argumentation; Decision emphasizes inference and justification; Engage in behavior supports explanation to audiences and reflection. Therefore, applying OIDDE to heredity can operationalize critical thinking as observable student performance rather than as an abstract goal.

3. Method

This article uses a framework synthesis approach. We synthesize theoretical and empirical literature published up to 2024 to develop an evidence-informed argument and a practical instructional design for Grade 9 inheritance instruction using OIDDE.

Sources were selected to represent three evidence clusters: (1) OIDDE model development, syntax, and empirical impacts (Hudha *et al*., 2016; Husamah *et al*., 2018; Hudha *et al*., 2024; Temi *et al*., 2024) [4, 5, 6, 9]; (2) genetics/heredity learning difficulties and misconceptions (Ojo, 2024; Fajri *et al*., 2022) [7, 3]; and (3) motivation and learning interest frameworks (Deci & Ryan, 2000) and critical thinking constructs (Facione, 1990) [2]. We excluded sources published after 2024 to support backdated publication.

Analytically, we mapped each OIDDE stage to expected motivational triggers (interest, autonomy, competence, relatedness) and critical thinking indicators. We also mapped common heredity misconceptions to conceptual change tasks in the Discussion and Decision stages, and we specified assessment checkpoints to generate credible evidence.

4. Results and Discussion

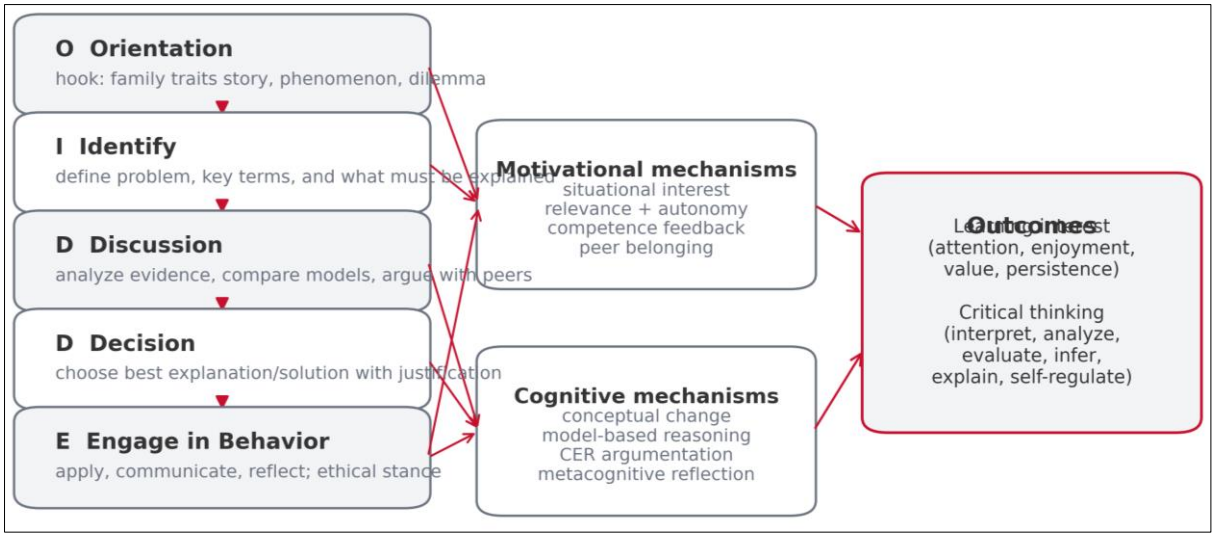

Fig 1: OIDDE pathways to learning interest and critical thinking in Grade 9 inheritance instruction

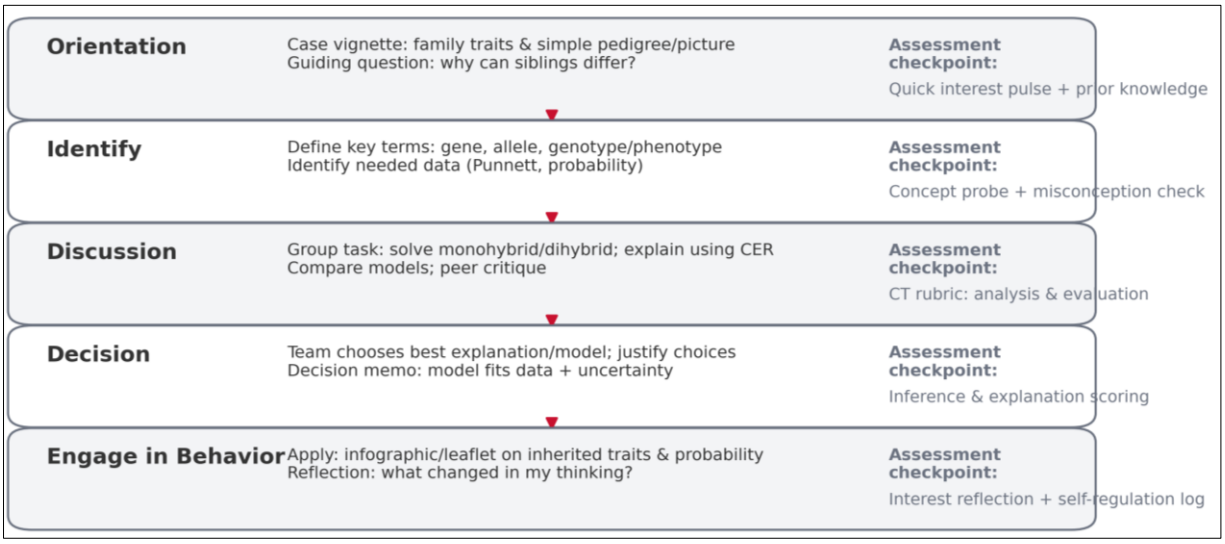

Fig 2: OIDDE lesson flow for inheritance of traits (Grade 9) with assessment checkpoints

The synthesis yields four major results. First, we propose a conceptual framework (Figure 1) explaining how OIDDE supports both learning interest and critical thinking during heredity instruction. Second, we translate the framework into a detailed lesson flow for Grade 9 inheritance topics (Figure 2) with assessment checkpoints. Third, we provide a stage-alignment table (Table 1) linking OIDDE to interest triggers, critical thinking indicators, and heredity tasks. Fourth, we propose practical instruments and rubrics (Tables 2–3) for measuring progress and refining instruction.

4.1. Result 1: OIDDE creates a dual pathway motivation and reasoning.

Figure 1 highlights that OIDDE is both a cognitive model and a motivational design. Orientation triggers situational interest through relevance and novelty. Identify reduces ambiguity by clarifying terms and goals, supporting competence. Discussion enables social interaction and argumentation, supporting relatedness and deeper analysis. Decision requires justification using evidence, strengthening inference and evaluation. Engage in behavior connects learning to real-world communication and reflection, strengthening value and self-regulation. This dual pathway is particularly important for heredity, a topic often perceived as difficult and terminology-heavy (Ojo, 2024) [7].

4.2. Result 2: A heredity-focused OIDDE lesson flow is feasible and assessable.

Figure 2 provides a practical example lesson sequence for Grade 9 heredity. The key design feature is frequent checkpointing—short assessments that diagnose misconceptions early (e.g., gene vs chromosome), performance tasks requiring claim–evidence–reasoning explanations, and reflection prompts that support self-regulation. This is consistent with the view that heredity misconceptions are widespread and require explicit diagnosis and response (Fajri *et al.*, 2022) [3].

4.3. Result 3: Stage-by-stage design principles.

Orientation should use an age-appropriate case vignette that feels personally relevant but ethically safe. Identify should build shared vocabulary and clarify what data are needed (Punnett squares, probabilities, pedigrees). Discussion should require students to solve tasks using multiple representations

and to critique alternative explanations. Decision should produce a group memo that justifies the chosen model and explicitly states uncertainty. Engage in behavior should apply learning to communication products (infographic/leaflet) and reflection logs.

4.4. Result 4: Measuring learning interest and critical thinking.

Teachers can combine an interest survey (attention, enjoyment, value, persistence intentions) with performance rubrics aligned to critical thinking indicators. OIDDE naturally produces artifacts—problem statements, discussion notes, decision memos, and reflective journals—that can serve as evidence. This aligns with prior findings that OIDDE can enhance engagement and higher-order thinking (Husamah *et al*., 2018; Hudha *et al*., 2024) [6, 5].

Implications for equity and feasibility. OIDDE can widen gaps if tasks assume access to resources or if group work allows some students to disengage. To prevent this, teachers should provide low-cost representations, rotate roles, scaffold language for argumentation, and grade evidence of reasoning rather than product aesthetics. Inheritance learning should also avoid sensitive personal medical disclosure; use hypothetical or anonymized cases.

Table 1: OIDDE stage alignment for Grade 9 inheritance of traits: interest triggers, critical thinking indicators, and sample tasks.

OIDDE stage	Motivational trigger (interest)	Critical thinking focus	Inheritance content focus	Example task/product
Orientation	Novelty + relevance (family trait story); curiosity	Interpretation; problem framing	Trait variation; basic heredity phenomena	Case response; "what do we need to explain?" list
Identify	Competence support (clear goals; vocabulary)	Interpretation; analysis	Gene/allele; genotype/phenotype; probability	Concept map; misconception probe; investigation plan
Discussion	Relatedness + autonomy	Analysis; evaluation; argumentation	Monohybrid/dihybrid; pedigree; probability	CER explanation; peer critique; multi-representation solution
Decision	Agency + value	Inference; explanation; evaluation	Model selection; uncertainty	Decision memo; decision matrix
Engage in behavior	Meaning/purpose; public audience; reflection	Self-regulation; explanation	Application + ethics of communication	Infographic/leaflet; reflection log

Table 2: Suggested instruments for measuring learning interest and critical thinking in an OIDDE heredity unit.

Construct	Instrument type	What it measures	When	Evidence example
Learning interest	Short Likert survey + open response	attention, enjoyment, value, persistence intention	Orientation & Engage	Interest change score; student quotes
Misconceptions	Two-tier diagnostic / concept cartoon	common heredity misconceptions	Identify & after Discussion	Misconception profile; reteach plan
Critical thinking (test)	Scenario-based essay test	interpret, analyze, evaluate, infer, explain	Pre & post unit	Rubric-scored essays
Critical thinking (performance)	Artifact rubric	evidence use, reasoning quality, counterarguments	Discussion & Decision	CER rubric; decision memo rubric
Metacognition	Reflection journal	self-regulation and revision	Engage	Revision notes; reflection excerpts

Table 3: Critical thinking rubric (adapted from Facione, 1990) [2] for Grade 9 heredity tasks.

CT indicator	Emerging	Developing	Proficient	Advanced
Interpretation	Misreads terms/representations	Understands basics; misses context	Interprets Punnett/pedigree correctly	Interprets nuanced patterns; states assumptions
Analysis	Lists facts without linking	Links some variables; partial	Analyzes mechanisms and relations	Builds model; considers alternatives
Evaluation	Accepts answers without checking	Checks some steps; weak criteria	Evaluates evidence and limitations	Compares alternatives; judges robustness
Inference	Conclusion not supported	Partly supported; ignores uncertainty	Warranted conclusion; notes uncertainty	Infers implications; proposes next test
Explanation	Vague; lacks evidence	Some evidence; weak logic	Coherent claim–evidence–reasoning	Clear to audiences; anticipates rebuttal
Self-regulation	No reflection/revision	Minimal reflection	Revises using feedback/evidence	Iteratively improves; monitors bias

5. Conclusion

This framework synthesis argues that applying OIDDE to the Grade 9 inheritance of traits topic is urgent because heredity is both conceptually difficult and highly relevant to students' lives. OIDDE provides a staged inquiry structure that can increase learning interest and strengthen critical thinking through diagnosis, discussion, justified decisions, and reflective behavior engagement.

The paper contributes a practical toolkit: conceptual figures, lesson flow with checkpoints, alignment tables, and rubrics for interest and critical thinking. Future research should empirically test the proposed design in SMP contexts, compare it with other inquiry models, and examine long-term retention and transfer to socioscientific decision making.

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