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ANALYSIS OF STUDENT ERRORS IN SPLTV LITERACY QUESTIONS USING THE NEWMAN PROCEDURE

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ABSTRACT

This study analyzed Grade X students' errors in solving mathematical literacy problems involving systems of linear equations in three variables (SPLTV, the Indonesian abbreviation) using Newman's procedure and identified factors associated with those errors. A descriptive qualitative design involved 57 students from three schools in Banda Aceh and Aceh Besar: SMAN 15 Banda Aceh (n = 20), SMAN 1 Kuta Baro (n = 17), and SMK SMTI Banda Aceh (n = 20). Data were collected through three written literacy tasks, interviews, and documentation; interview participants represented upper, middle, and lower within-school performance strata. Written responses were coded into reading, comprehension, transformation, process-skill, and encoding errors, while interviews clarified the reasoning behind observed errors. Across 171 student-item responses, transformation errors were most frequent (44; 25.7%), followed by encoding (42; 24.6%), comprehension and process-skill errors (36 each; 21.1%), and reading errors (15; 8.8%). Interview evidence indicated difficulties in converting contextual information into equations, applying elimination or substitution accurately, maintaining calculation precision, and expressing a contextual final conclusion. The findings suggest that instruction on three-variable linear systems should explicitly scaffold mathematical modeling, procedural verification, and interpretation of final answers rather than focusing only on algebraic computation.

Keywords: Newman procedure; student errors; mathematical literacy; linear systems; mathematical modeling.

INTRODUCTION

Mathematical literacy requires students to interpret contextual information, represent relationships mathematically, execute procedures, and communicate results in relation to the original situation. Word problems therefore demand more than computation: students must construct a coherent situation model and translate it into mathematical representations (Boonen et al., 2016; Jupri et al., 2014; Jupri & Drijvers, 2016; Wijaya et al., 2014). In algebra, this translation is especially demanding because variables, equations, and operations must be coordinated with verbal information. Systems of linear equations in three variables (SPLTV) intensify this demand by requiring students to define three unknowns, formulate several equations, and preserve the meaning of the context throughout the solution process.

Newman's error framework provides a diagnostic sequence for locating breakdowns in mathematical problem solving: reading, comprehension, transformation, process skills, and encoding (Clements, 1980; Karnasih, 2015; Singh et al., 2010). Studies in different mathematical domains repeatedly show that errors frequently occur after students have read the text, particularly when they must transform information, perform procedures, or state a final answer (Abdullah et al., 2015; Agustiani, 2021; Ahyan et al., 2019; Fatimah & Nasution, 2024; Prasetyaningrum et al., 2022; Rohmah & Sutiarso, 2018; Salim & Mahmudah, 2021; Suratih & Pujiastuti, 2020; Zulyanty & Mardia, 2022). Recent work on SPLTV also reports modeling and procedural difficulties across student ability levels (Lubis et al., 2025; Oktaviani et al., 2026).

Most closely related studies have examined a single school or a small group of selected students. The present study extends that diagnostic perspective across three different secondary-school settings. It addresses two questions: (1) What Newman error types occur when Grade X students solve SPLTV literacy tasks across the three schools? and (2) What factors are associated with the observed errors? The intended contribution is descriptive rather than causal: the cross-school data are used to identify recurring instructional needs and variation in observed error patterns.

RESEARCH METHODS

The study used a descriptive qualitative design. Participants were 57 Grade X students: 20 from SMAN 15 Banda Aceh, 17 from SMAN 1 Kuta Baro, and 20 from SMK SMTI Banda Aceh. Data collection was completed in two meetings through three contextual mathematical-literacy tasks on SPLTV, follow-up interviews, and documentation. All written responses were examined using the five Newman categories: reading error (failure to read or identify required information), comprehension error (failure to understand what is known or asked), transformation error (failure to convert the context into an appropriate mathematical model or operation), process-skill error (incorrect execution of the selected procedure), and encoding error (failure to express the final answer appropriately in context).

For qualitative follow-up, three students from each school were purposively selected to represent upper, middle, and lower within-school performance strata, giving nine interviewees. Because score distributions differed markedly among schools, these strata were interpreted within each school rather than as equivalent cross-school ability groups. Interview evidence was compared with written work to clarify why an error occurred. Analysis followed data reduction, data display, categorization by Newman stage, and conclusion drawing. For a compact cross-school summary, the task-level counts were aggregated. Because 57 students completed three tasks, each Newman stage had 171 student-item opportunities; the percentages in Table 1 therefore describe error incidence per stage, not the percentage of unique students.

RESULTS AND DISCUSSION

Errors occurred at every Newman stage, but their distribution differed. Table 1 consolidates the error counts reported for the three tasks at each school.

Table 1. Aggregated Newman Errors Across Three SPLTV Literacy Tasks

School	Reading	Comprehension	Transformation	Process skills	Encoding
SMAN 15 Banda Aceh	5	17	20	16	16
SMAN 1 Kuta Baro	8	18	19	20	18
SMK SMTI Banda Aceh	2	1	5	0	8
Total	**15**	**36**	**44**	**36**	**42**
Incidence (%)	8.8	21.1	25.7	21.1	24.6

Note. Percentages use 171 student-item opportunities for each Newman stage (57 students x 3 tasks).

Transformation was the most frequent error category (44/171; 25.7%). Students often identified information from the story but failed to define variables consistently or translate relationships into a correct three-equation system. This pattern is consistent with research describing mathematization as a major obstacle in algebraic word problems (Jupri et al., 2014; Jupri & Drijvers, 2016) and with SPLTV-specific findings that emphasize contextual modeling difficulties (Lubis et al., 2025). In practical terms, correct algebra cannot compensate for an incorrect model: once a relationship is represented inaccurately, subsequent elimination or substitution operates on the wrong system.

Encoding was the second most frequent category (42/171; 24.6%). Interview evidence showed that some students, including relatively strong performers, considered the final numerical values sufficient and omitted a sentence that interpreted those values in the problem context. Similar final-answer errors have been documented in Newman-based studies of word problems (Abdullah et al., 2015; Prasetyaningrum et al., 2022; Suratih & Pujiastuti, 2020). This finding matters for mathematical literacy because a solution is not complete when students cannot reconnect symbolic results to the contextual question.

Comprehension and process-skill errors each occurred 36 times (21.1%). Lower-performing interviewees tended to become stuck while identifying what was known, what was asked, or how to begin, whereas middle-performing interviewees were more likely to construct part of the model but make elimination, substitution, sign, or arithmetic errors. Such sequential dependence is central to Newman's framework: an early comprehension or transformation failure can prevent a valid later procedure, while a student who understands the model may still fail at procedural execution (Agustiani, 2021; Salim & Mahmudah, 2021; Singh et al., 2010; Zulyanty & Mardia, 2022). Reading errors were least frequent (15/171; 8.8%), indicating that the principal difficulty was not simply decoding the text but reorganizing its meaning mathematically.

The school profiles should be interpreted descriptively. SMAN 1 Kuta Baro recorded more observed errors in comprehension and process skills, SMAN 15 Banda Aceh showed substantial transformation and process errors, and SMK SMTI Banda Aceh recorded fewer errors overall but still showed encoding and transformation errors. Because sample sizes, score distributions, and instructional contexts were not experimentally controlled, these patterns do not establish a school effect. They instead show that the same five-stage diagnostic lens can reveal different concentrations of difficulty across classes. Accordingly, the study does not infer cross-school ability differences from the within-school performance strata.

The instructional implication is to make the full solution chain visible. Teachers can require students to state variables and units, map each sentence to an equation, justify the selected elimination or substitution step, verify the obtained values by substitution, and write one final contextual sentence. Diagnostic results can then guide targeted worksheets or learning media that emphasize realistic problem solving and mathematical reasoning (Khani et al., 2026; Zairi & Bagas F, 2026). The goal is not merely to reduce arithmetic mistakes, but to strengthen transitions among comprehension, modeling, procedure, and interpretation.

CONCLUSIONS

Grade X students demonstrated errors at all five Newman stages when solving SPLTV literacy tasks. Transformation errors were most frequent, followed by encoding errors, while comprehension and process-skill errors remained substantial and reading errors were least frequent. Written responses and interviews linked these errors to incomplete conceptual understanding, difficulty translating contextual relationships into equations, inaccurate elimination or substitution, limited checking, and failure to state a contextual conclusion. The cross-school patterns are descriptive and should not be interpreted causally. For instruction, SPLTV learning should explicitly scaffold modeling, procedural verification, and final-answer interpretation. The study is limited by three tasks, unequal school sample sizes, two data-collection meetings, and purposive interview selection. Future research should use independently validated parallel tasks, clearer common performance criteria, and designs that can test whether observed school-level differences persist.

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