

Learning Profiles of Slow Learner Students on Periodic Properties of Elements Using E-LAPD

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Kata Kunci:

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Slow learner students require adaptive chemistry learning support to understand abstract concepts. This research aims to explore the learning profiles and learning outcomes of slow learner students using Electronic Student Activity Sheets (E-LAPD) with individualized learning strategies on the topic of periodic properties of elements. Participants consisted of three slow learner students at Senior High School 10 Surabaya. This research employed a mixed-method approach using an embedded design. Qualitative data were analyzed using NVivo 11 software, while quantitative data were analyzed using N-gain scores to measure learning outcomes. The findings indicated a dominant visual learning tendency, although one student also demonstrated an auditory preference. The results also showed improved learning outcomes with a high average N-gain score. These findings highlight that E-LAPD can support inclusive chemistry learning by accommodating diverse learning needs and facilitating adaptive and inclusive learning for slow learner students.

Abstrak

Siswa *slow learner* memerlukan dukungan pembelajaran kimia yang adaptif untuk memahami konsep-konsep abstrak. Penelitian ini bertujuan untuk mengeksplorasi profil belajar dan hasil belajar siswa *slow learner* menggunakan Lembar Aktivitas Peserta Didik Elektronik (E-LAPD) dengan strategi pembelajaran individual pada materi sifat periodik unsur. Partisipan penelitian terdiri atas tiga siswa *slow learner* di SMA Negeri 10 Surabaya. Penelitian ini menggunakan pendekatan *mixed methods* dengan desain *embedded*. Data kualitatif dianalisis menggunakan perangkat lunak NVivo 11, sedangkan data kuantitatif dianalisis menggunakan skor N-gain untuk mengukur hasil belajar. Temuan menunjukkan adanya kecenderungan gaya belajar visual yang dominan, meskipun satu siswa juga menunjukkan preferensi auditori. Hasil penelitian juga menunjukkan peningkatan hasil belajar dengan rata-rata skor N-gain yang tinggi. Temuan ini menunjukkan bahwa E-LAPD dapat mendukung pembelajaran kimia inklusif dengan mengakomodasi kebutuhan belajar yang beragam serta memfasilitasi pembelajaran yang adaptif dan inklusif bagi siswa *slow learner*.

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A. Introduction

Education is an essential foundation for every human being to develop their potential, including in shaping character, thinking skills, and social attitudes. In Indonesia, Law No. 20 of 2003 explains that every citizen or individual has the right to access education. In line with this principle, Inclusive education aims to provide equal educational opportunities for all students, including students with disabilities and diverse learning needs (Khasanah & Salim, 2018). Therefore, inclusive education plays an important role in ensuring that every student, including slow learner students, has equal opportunities to participate and succeed in the learning process (Hasibuan et al., 2020). Inclusive education also creates learning environment that support students in developing their potential and participating meaningfully in classroom activities (Singh, 2024). Inclusive education refers to an educational system that enables students with diverse characteristics and abilities to learn together within the same educational environment (Arrianti et al., 2021).

One group of students who require particular attention in inclusive classrooms is slow learner students. Slow learners are generally characterized by slower learning progress and the need for more time and support in understanding academic material compared to their peers (Cheon, 2024). Previous studies describe slow learner students as learners who often experience difficulties in conceptual understanding, concentration, and academic performance in regular classroom settings, and who may demonstrate below-average cognitive functioning compared to their peers (Nurfadhillah et al., 2021; Rovik, 2017). Therefore, slow learner students require adaptive instructional strategies and individualized learning support during the learning process. One approach that can support inclusive learning is the implementation of individualized learning strategies through learning accommodations that adjust instructional methods and media according to students' diverse learning needs (Sukinah et al., 2024). Individualized learning strategies also play an important role in increasing students' motivation, participation, self-confidence, and task completion during learning activities (Anggraeni, 2022; Haryati et al., 2022).

Learning media play an important role in supporting inclusive learning environments by providing adaptive and accessible learning experiences that can increase participation and facilitate students' understanding of abstract concepts (Chumairo et al., 2022). One form of digital learning media widely used in classroom instruction is the Electronic Student Activity Sheet (*Lembar Aktivitas Peserta Didik Elektronik/E-LAPD*), which has been reported to increase students' engagement, interest, and learning outcomes (Sitinjak et al., 2024). For slow learner students, interactive and accessible digital learning media are particularly important because they can provide repeated instruction, visual support, and structured learning experiences that accommodate diverse learning needs. This is especially relevant in chemistry learning, which involves abstract concepts and complex scientific representations (Priliyanti et al., 2021). One chemistry topic that is often considered difficult by students is the periodic properties of elements, including atomic radius, ionization energy, electron affinity, and electronegativity (Sari et al., 2020). These challenges indicate the importance of adaptive and individualized learning media that can support students' conceptual understanding and participation in inclusive chemistry learning environments.

Efforts to develop an adaptive and inclusive learning approaches for slow learner students, are increasingly important in response to demands of 21st-century education. In modern educational contexts, learning focuses not only on knowledge acquisition but also on the integration of technology to support meaningful and accessible learning experiences (Irawati et al., 2022). Previous studies have shown that technology-based electronic worksheets, such as Liveworksheet, can improve students' motivation, engagement, and learning outcomes (Rahmayani & Atmazaki, 2025). Interactive digital media also help students visualize concepts more clearly and provide accessible learning resources

through multimedia features (Nsabayezu et al., 2022; Teoh & Neo, 2007). However, most previous studies have focused on general students in conventional classroom settings and have primarily measured overall learning achievement. Research specifically investigating slow learner students in inclusive chemistry classrooms remains limited, particularly regarding how E-LAPD supports individualized learning needs, learning profiles, and learning outcomes in abstract chemistry topics such as periodic properties of elements.

Therefore, this research aims to explore the learning profiles and learning outcomes of slow learner students using E-LAPD integrated with individualized learning strategies on the topic of periodic properties of elements. The novelty of this research lies in the integration of E-LAPD, individualized learning strategies, and inclusive chemistry learning to support slow learner students' participation and conceptual understanding of abstract chemistry concepts. Preliminary observations and interviews conducted at Senior High School 10 Surabaya involving chemistry teachers and special assistant teachers revealed that the implementation of inclusive education for slow learner students still requires further improvement. Existing learning media and student worksheets were still designed for regular classroom instruction and had not fully accommodated students' diverse learning needs. In addition, learning implementation was still conducted using classical instructional approaches without sufficient individualized support.

Based on these challenges, the researchers developed E-LAPD as an adaptive digital learning medium for the topic of periodic properties of elements. Two E-LAPDs were used for periodic properties of elements, with the first sub-material in the first E-LAPD being atomic radius and ionisation energy. Meanwhile, the second E-LAPD includes the sub-material of electron affinity and electronegativity. This research focuses on exploring slow learner students' learning styles, interactions with digital learning media, and participation during the learning process, as well as examining their learning outcomes after using E-LAPD integrated with individualized learning strategies. The E-LAPD was designed with interactive features such as drag-and-drop activities, matching exercises, guided instructions, visual representations, audio support, and interactive practice questions to support students' conceptual understanding and engagement in inclusive chemistry learning.

B. Research Methods

1. Research Design

This research employed a mixed-method approach using an embedded design, in which one type of data was embedded within another as the primary source of analysis. In this study, qualitative data obtained from interviews, observations, and field notes served as the primary data to explore students' learning profiles, participation, and interactions with E-LAPD during the learning process. Meanwhile, quantitative data obtained from pretests, posttests, and questionnaires functioned as supporting data to describe students' learning outcomes after using E-LAPD integrated with individualized learning strategies. This embedded design was selected because it provides a more comprehensive understanding of the research problem and supports the evaluation of educational interventions (Halcomb, 2019; Poth et al., 2024).

2. Research Setting and Participants

This research was conducted on August 8, 2025, at Senior High School 10 Surabaya. The study was initiated based on preliminary observations conducted at the school, which revealed that the implementation of inclusive learning for slow learner students had not been optimally supported by adaptive instructional media and individualized learning strategies. Existing student worksheets were still designed for regular classroom instruction and had not fully accommodated students' diverse

learning needs. These findings indicated the need for adaptive digital learning media to support slow learner students' participation and conceptual understanding in inclusive chemistry learning.

This study involved three Grade XI students at Senior High School 10 Surabaya who had previously received chemistry instruction on the topic of periodic properties of elements. The participants were identified by the school as slow learner students or students requiring additional learning support in classroom learning. They were selected using purposive sampling based on several criteria: (1) experiencing difficulties in understanding abstract concepts, (2) having challenges in maintaining concentration and attention during learning activities, and (3) requiring additional instructional adjustments or learning accommodations. Information related to students' learning development was triangulated through school counsellors, academic assessment records, and chemistry teachers. In this study, the term slow learner was used to refer to students who were identified by the school as requiring additional support due to persistent difficulties in classroom learning, concentration, adaptive behaviour, and conceptual understanding. This identification was based on school-based assessment records and teacher recommendations rather than a single clinical or psychometric criterion. Therefore, the participants were understood as students with learning support needs within the context of inclusive classroom practice. The characteristics of the research participants are presented in Table 1.

Table 1
Research participants

Name of Student	Age	IQ	Gender
DADH	17	108	Male
AHA	18	104	Male
E	18	87	Female

3. Research Instruments

Research instruments prepared in this study included E-LAPD worksheets, observation sheets, interview guidelines, and pretest-posttest instruments. The E-LAPD was developed using Canva and Liveworksheet software to create interactive learning activities through features such as matching, drag-and-drop exercises, multiple-choice selection, and short-answer responses. Liveworksheet is an online platform that enables conventional worksheets to be transformed into interactive digital worksheets that are accessible, interactive, and capable of providing immediate feedback to students (Hernanto et al., 2023).

Observation sheets were used to document students' participation and interactions with E-LAPD during the learning process, while interview guidelines were used to explore students' learning experiences and responses toward the use of E-LAPD. In addition, pretest and posttest instruments were administered to measure students' initial and final learning outcomes on the topic of periodic properties of elements. The tests consisted of six multiple-choice questions designed to assess cognitive levels of understanding (C2), application (C3), and analysis (C4), in accordance with the need for more structured and accessible learning evaluation for slow learner students. C2-level questions focused on identifying periodic trends, C3-level questions required students to apply periodic concepts to predict element properties, and C4-level questions required students to analyze relationships between atomic structure and periodic properties. The test items and research instruments were reviewed by the chemistry teacher and special assistant teacher to ensure their relevance to the topic of periodic properties of elements and their suitability for students requiring additional learning support. This review focused on the clarity of instructions, appropriateness of language, cognitive level, and accessibility of the learning tasks.

4. Data Collection Procedure

Data collection began with the administration of a pretest to measure students' initial understanding of the topic of periodic properties of elements. After completing the pretest, students participated in learning activities using E-LAPD integrated with individualized learning strategies. E-LAPD 1 focused on the subtopics of atomic radius and ionization energy, while E-LAPD 2 covered electron affinity and electronegativity. These learning activities aimed to examine students' conceptual understanding, participation, and learning style tendencies during the learning process.

During the implementation of E-LAPD, researchers used observation sheets to document students' participation, learning behaviors, and interactions with the digital learning media. The observations focused on students' engagement in various learning activities, such as observing images and tables, listening to explanations, watching instructional videos, and completing interactive tasks. In addition, interview guidelines were used to explore students' perceptions of E-LAPD, including aspects related to ease of use, visual design, clarity of content, and learning experiences during the implementation process. Interviews were conducted after students completed E-LAPD 1 and E-LAPD 2 to identify students' learning style tendencies and responses toward the use of E-LAPD in learning periodic properties of elements.

After completing all learning activities, a posttest was administered to evaluate students' learning outcomes. Similar to the pretest, the posttest consisted of questions related to periodic properties of elements. The posttest results were then compared with the pretest scores to identify changes and improvements in students' learning outcomes following the implementation of E-LAPD integrated with individualized learning strategies.

5. Data Analysis

Qualitative data obtained from interview recordings were used to explore students' learning profiles, particularly their learning style tendencies during the implementation of E-LAPD. The interview recordings were transcribed and analyzed using NVivo 11 software through the matrix coding query feature. This feature enabled researchers to organize, compare, and interpret coding results across categories and themes derived from the interview data. Through this analysis process, patterns related to visual, auditory, and kinesthetic learning tendencies among slow learner students were identified.

Meanwhile, quantitative data obtained from pretest and posttest scores were analyzed using the N-gain score to determine improvements in students' learning outcomes on the topic of periodic properties of elements. The quantitative analysis was also used to support the qualitative findings regarding the relationship between students' learning style tendencies and their learning outcomes after using E-LAPD integrated with individualized learning strategies. The formula used to calculate the N-gain score is presented below:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}}$$

Table 2
Criteria of N-gain score (Hake, 1998)

N-gain Score	Criteria of N-gain Score
$G \geq 0.7$	High
$0.3 \leq G < 0.7$	Moderate
$G < 0.3$	Low

C. Results and Discussion

Analysis of Slow Learner Students' Learning Profiles

The findings revealed that each slow learner student demonstrated different learning style tendencies and interactions with E-LAPD during the learning process on periodic properties of elements. The characteristics of the research participants are presented in Table 3.

Table 3
Characteristics of research participants

No.	Initial of participants	Learning Characteristics
1.	DADH	DADH is a student who experiences difficulties in language processing that affect participation in academic and social activities. Although DADH demonstrates average cognitive ability, the student experiences challenges in maintaining emotional regulation, concentration, and responsiveness during classroom learning activities. DADH also demonstrates characteristics associated with attention and hyperactivity difficulties, requiring structured learning environments, clear classroom rules, and consistent instructional guidance.
2.	AHA	AHA demonstrated adequate social interaction and adaptability during classroom learning but required additional encouragement and instructional support to optimize learning participation and conceptual understanding.
3.	E	Student E demonstrated adequate comprehension and concentration during learning activities but tended to show low self-confidence and mood-dependent participation, requiring additional adjustment time and supportive learning environments.

The characteristics of the participants provided important information for understanding students' learning needs and adapting instructional strategies during the implementation of E-LAPD. Therefore, E-LAPD was designed with interactive features intended to support individualized learning and accommodate diverse learning characteristics among slow learner students. The findings analyzed using the matrix coding query feature in NVivo 11 revealed several dominant learning style tendencies demonstrated by students during the implementation of E-LAPD on the topic of periodic properties of elements.

Table 4
Summary of students' learning style

Student	Dominant Learning Style Tendency	Interaction with E-LAPD
DADH	Visual	Demonstrated stronger engagement when interacting with pictures, diagrams, drag-and-drop activities, matching exercises, and other interactive visual features provided in the E-LAPD.
AHA	Visual	Showed active participation when learning materials were presented through visual representations such as periodic tables, diagrams, and image-based explanations.
E	Visual-Auditory	Demonstrated better concentration when learning materials combined visual displays with verbal explanations and reading activities during the learning process.

Observational findings indicated that DADH and AHA demonstrated stronger engagement when interacting with visual representations such as pictures, diagrams, periodic table illustrations, and interactive features provided in the E-LAPD. Both students were able to explain concepts related to atomic radius and ionization energy through visual recall and interactions with the digital learning media. In addition, interactive learning activities such as drag-and-drop exercises, matching tasks, and table completion activities appeared to increase students' participation and engagement during the learning process. These findings suggest that visual and interactive learning activities may support conceptual understanding among slow learner students, particularly in learning abstract chemistry concepts.

These findings are consistent with previous studies reporting that visual and interactive digital media can support students with learning difficulties through more concrete representations and reduced cognitive load (Teoh & Neo, 2007). Previous research has also shown that adaptive and multimodal learning environments integrating visual and interactive elements can facilitate conceptual understanding, participation, and learning motivation in inclusive classrooms (Adi et al., 2023; Insa Melle, 2019; Rahmayani & Atmazaki, 2025). Therefore, the implementation of E-LAPD appears to support visual learning tendencies by providing more accessible and engaging learning experiences for slow learner students. Interactive visual learning activities have also been shown to increase student participation and motivation in inclusive learning environments (Insa Melle, 2019). Therefore, the implementation of E-LAPD appears to support visual learning tendencies among slow learner students by providing structured and engaging learning experiences.

Meanwhile, student E demonstrated a tendency toward multimodal learning interactions, particularly visual and auditory learning preferences. Observations showed that student E often read learning materials aloud while observing visual representations presented in the E-LAPD. Student E also demonstrated better concentration when learning materials were presented using clear and colorful visual displays combined with verbal explanations. These findings indicate that the integration of visual and auditory learning activities may support students' concentration and conceptual understanding during chemistry learning activities.

Previous studies have reported that multimodal learning approaches integrating visual and auditory elements can help students remember and understand concepts more effectively through the combination of visual representations and verbal reinforcement (Ramos Castro, 2022). Visual learning activities involving animations, tables, and images have also been shown to support students' focus and participation during learning activities (King et al., 2023). Overall, these findings highlight the importance of adaptive digital learning media and individualized learning strategies in supporting diverse learning needs among slow learner students in inclusive chemistry learning environments.

Interaction of Slow Learner Students with E-LAPD

The findings indicated that the three slow learner students demonstrated positive interactions with E-LAPD during the learning process on the topic of periodic properties of elements. Based on interview and observational data, students perceived E-LAPD as an accessible and engaging learning medium that supported their understanding of abstract chemistry concepts. Frequently mentioned responses such as "easy," "clear," "interesting," and "picture" reflected students' positive experiences when interacting with the digital learning media.

These findings suggest that accessibility in inclusive digital learning is not limited to the availability of technology but also involves how learning content is presented according to students' learning needs and characteristics. The integration of images, interactive exercises, audio, and guided

instructions in E-LAPD appeared to support students' participation, concentration, and conceptual understanding during chemistry learning activities. Previous studies have also reported that adaptive digital learning environments can improve participation, motivation, and conceptual understanding among students with learning difficulties by providing clearer representations and more structured learning experiences (Rahmayani & Atmazaki, 2025).

In this study, E-LAPD supported students' learning experiences through the integration of images, interactive exercises, audio, and guided instructions. Although all participants demonstrated positive interactions with the digital learning media, each student emphasized different aspects of the learning experience. DADH showed stronger engagement with visual representations and interactive activities, highlighting the importance of visual support in understanding abstract chemistry concepts. This finding is consistent with previous studies reporting that visual media such as images and videos can facilitate conceptual understanding in chemistry learning (Erlina et al., 2023).

Meanwhile, AHA emphasized the importance of clear instructions and structured features during the learning process, suggesting that guided navigation helped maintain participation and focus during learning activities. Student E described the E-LAPD as engaging and visually appealing, indicating that attractive visual displays contributed to learning motivation and sustained attention. These findings suggest that slow learner students demonstrate diverse interaction patterns with digital learning media depending on their learning preferences and support needs (Nurmalisa et al., 2023).

Learning Outcomes of Slow Learner Students

The analysis of students' learning outcomes was conducted based on the pretest and posttest scores on the topic of periodic properties of elements. The pretest and posttest each consisted of six multiple-choice questions designed to assess conceptual understanding at the cognitive levels of understanding (C2), application (C3), and analysis (C4). The results showed that all three slow learner students demonstrated improvement in learning outcomes after participating in learning activities using E-LAPD integrated with individualized learning strategies.

The N-gain analysis indicated high improvement in students' learning outcomes. DADH and AHA obtained N-gain scores of 1.00, while student E obtained an N-gain score of 0.80, with an average N-gain score of 0.93. According to Hake's classification (1998), these results fall within the high improvement category. These findings indicate that the implementation of E-LAPD supported students' conceptual understanding of periodic properties of elements during inclusive chemistry learning activities (Rahmatsyah & Dwiningsih, 2021). The result of the N-gain score is shown in Table 5. However, these results should be interpreted cautiously because the study involved only three participants, used a one-group pretest-posttest design, and employed a limited number of test items. Therefore, the N-gain results do not indicate a broad causal effect but provide supportive evidence of learning improvement within this small-scale exploratory context.

Table 5
N-gain score result

Name of Students	Pretest Score	postest Score	N-gain Score
DADH	33	100	1.00
AHA	83	100	1.00
E	16	83	0.80
Average			0.93

Qualitative findings from observations and interviews also supported the quantitative results. DADH demonstrated better understanding of atomic radius and ionization energy concepts after interacting with visual illustrations, interactive exercises, and individualized guidance during the learning process. Similarly, AHA showed improvement in understanding electron affinity and electronegativity concepts, particularly after receiving structured instructions and guided learning activities through E-LAPD. Meanwhile, student E demonstrated improved conceptual understanding despite still experiencing difficulties in interpreting ionization energy trends and numerical relationships. Observations indicated that multimodal learning activities integrating visual displays and verbal explanations helped student E maintain concentration and participate more actively during learning activities. This is in accordance with the research statement by Ramos Castro, (2022) which states that multimodal learning from visual and auditory verbal can help students remember concepts and maintain concentration through explanation.

These findings suggest that E-LAPD integrated with individualized learning strategies may support conceptual understanding, participation, and learning engagement among slow learner students in inclusive chemistry learning environments. These findings are consistent with previous studies reporting that adaptive and interactive digital learning media can facilitate accessibility, conceptual understanding, and learning participation among students with diverse learning needs (Rahmayani & Atmazaki, 2025).

D. Conclusion

The findings of this study indicate that the implementation of E-LAPD integrated with individualized learning strategies supported diverse learning profiles and learning outcomes among slow learner students in inclusive chemistry learning. Visual learning tendencies were found to be the most dominant, while multimodal learning interactions combining visual and auditory elements also supported students' concentration, participation, and conceptual understanding during learning activities.

The implementation of E-LAPD contributed to improvements in students' understanding of periodic properties of elements, as reflected in the high category of N-gain results. These findings suggest that adaptive and interactive digital learning media can support accessibility, participation, and conceptual understanding among slow learner students by accommodating diverse learning needs in inclusive classrooms.

This study highlights the importance of individualized and adaptive digital learning environments in inclusive science education. Practically, the findings provide insight for teachers and schools regarding the development of accessible learning media that support student participation and engagement in inclusive classrooms. Nevertheless, the findings should be interpreted within the limitations of this exploratory study, particularly the small number of participants, the absence of a comparison group, and the limited scope of the learning outcome test. Further studies involving more participants, longer implementation periods, and more robust assessment procedures are needed to examine the effectiveness of E-LAPD in inclusive chemistry learning.

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The authors declare that Grammarly Artificial Intelligence (AI) tools were used solely to improve language clarity and readability during manuscript preparation. All research design, data collection, data analysis, interpretation of findings, and conclusions were conducted entirely by the authors.

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