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# Learning Profile of Intellectually Disabled Students Using e-LAPD with Individualized Strategies Via Liveworksheet on Atomic Theories

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**Abstract:** The digitalization of chemistry education is crucial for ensuring inclusivity and equal learning opportunities, particularly for students with intellectual disabilities. This study investigated students' functional learning profiles through digital student worksheets (e-LAPD) on atomic theories, integrated with individualized strategies based on Universal Design for Learning (UDL) via the Liveworksheet platform. A mixed-methods approach with a concurrent embedded design was applied, involving three students with intellectual disabilities at SMAN 10 Surabaya. Qualitative data were collected through semi-structured interviews and classroom observations, then thematically analyzed using NVivo 11, which yielded two major themes: the implementation of e-LAPD and students' learning profiles. The analysis revealed that the implementation of e-LAPD effectively supported students' understanding of the development of atomic theories, as evidenced by quantitative results obtained from questionnaire responses and pre-test/post-test instruments. Questionnaire data indicated that 100% of students reported improved conceptual understanding through e-LAPD. Furthermore, pre-test and post-test results showed a significant improvement with a high average N-gain score of 0.88. In addition, the findings highlighted students' learning abilities and learning profiles, such as their tendency to engage with interactive visual media, their preference for verbal explanations, and their reliance on physical interaction during learning activities.

**Keywords:** Implementation of e-LAPD; Learning abilities; Learning profiles; Universal design learning

## Introduction

Inclusive education emphasizes the importance of equal learning opportunities for all students, including those with intellectual disabilities. However, students with intellectual disabilities often struggle to understand and face obstacles in understanding learning materials because teaching methods and available resources are not fully adapted to their needs (Wulandari & Setiawan, 2023). This condition highlights the urgency of developing learning resources that are not only accessible but also capable of accommodating individual learning profiles and competencies. In line with technological advancements, the digitalization of education has become an important solution, enabling the creation of adaptive and interactive learning resources, including in chemistry education for students with intellectual disabilities.

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Intellectual disability is a developmental disorder characterized by limitations in performing tasks related to cognitive functions or problem-solving. It is typically indicated by more than one of the following characteristics: a slower learning pace, irregular learning patterns, difficulties with adaptive behavior, and challenges in understanding abstract concepts (Yuliani, 2021). Intellectual disability is generally known as a difficulty in learning, whereas mental retardation is considered a neurodevelopmental disorder characterized by significant limitations in both intellectual functioning and adaptive behavior (Shree & Shukla, 2016). Individuals with this condition typically show deficits in two or more areas of adaptive behavior, which include social skills and everyday practical abilities.

Children with intellectual disabilities can be classified based on the level of support they require in daily life (Marpaung & Simangunsong, 2023). The first category is intermittent support, which is provided only when necessary and usually for a short duration (Mayasari, 2019). The second category is limited support, where children need consistent but not intensive assistance (Afifah, 2021). The third is extensive support, which involves regular and ongoing assistance in specific settings such as school, work, or home, with no time limits (Rahmandhani et al., 2021). The final category is pervasive support, where the child requires highly intensive, constant help across multiple environments and aspects of daily functioning (Rahmandhani et al., 2021). Children with intellectual disabilities exhibit several distinct characteristics. They are often hyperactive and have attention difficulties, typically showing a tendency to focus on physical activity rather than paying attention to the teacher or instructor (Kusmiyati, 2021). They may display weaknesses in memory and thinking abilities, which includes difficulties with problem-solving and conceptual understanding. They often experience challenges in academic learning and perception, making it harder for them to process and retain educational material effectively (Mihmidaty, 2022).

Students with intellectual disabilities, who often have difficulties with memory, may struggle to understand the progression of atomic structure models. Since the models starting from Dalton, followed by Thomson, Rutherford, and then Bohr share certain similarities in appearance and concept, it can be challenging for them to differentiate and retain each stage of development (Afrianis & Ningsih, 2022). In addition, Low learning motivation and lack of interest among students often lead to difficulties in understanding the development of atomic theory (Afrianis & Ningsih, 2022). Children with intellectual disabilities have unique characteristics, such as difficulty focusing attention, limitations in thinking, and challenges in understanding academic concepts. However, they still have the potential to grow and develop through appropriate and adaptive teaching approaches (Desriyani et al., 2019). One of the fields of science that can contribute positively to the development of their cognitive abilities and life skills is chemistry. One of the fundamental topics in chemistry is atomic theory. Understanding atomic theory serves as a foundation for deeper comprehension of advanced concepts, particularly in areas such as the structure of matter, chemical bonding, and reactions (Sastrohamidjojo, 2018).

Learning media such as e-LAPD (Lembar Aktivitas Peserta Didik Elektornik) are essential for assisting teachers in improving the understanding of students with intellectual disabilities as well as in facilitating the observation of students' learning profiles during the learning process (Safitri, 2022). Liveworksheet is a digital platform for student worksheets that contains interactive features that attract students to learn deeply about the learning material, on which students can work based on the basic competencies easily, so that the intended learning objectives can be achieved (Safitri, 2022). The atomic theories material has animations to describe the structure, so it is essential to give good visualization to students, so it will be effective to implement individualized learning with e-LAPD as learning media for students with intellectual disabillities to help them understand the material easily, so we can know their learning profile from their learning process. (Mansor et al., 2019). Aligned with Sukarmin et al. (2020) the appropriate learning media such an interactive multimedia and kits for hearing-impaired students will improve learning outcomes. For students, Liveworksheets provides space to practice independently, reflect on learning, and receive immediate feedback. With features like voice recording, it can also reduce language anxiety. Unlike tools limited to multiple choice or gap filling, Liveworksheet offers diverse activities from matching, drag-and-drop, and crosswords to sentence reordering and puzzles making learning more engaging and versatile (Le & Prabjandee, 2023).

Appropriate learning media must be aligned with an appropriate learning model (Doyan et al., 2020; Sahasrabudhe & Kanungo, 2014). Individual learning strategy is learning model that provides personalized support and interventions that are adapted to student specific needs (Imran et al., 2023). Universal Design for Learning (UDL) is an instructional planning in individual learning strategy and delivery framework aimed at enhancing meaningful access and minimizing learning barriers for students with diverse educational needs (Abell & Lewis, 2005). UDL provides an approach to designing teaching methods, learning materials, instructional activities, and assessment procedures that support individuals with significant differences in their abilities to see, hear, speak, move, read, write, understand language, concentrate, self-regulate, engage, and remember (Abell & Lewis, 2005). Universal Design for Learning (UDL) is built on three core principles, which provide engagement to motivate learners, representation to ensure access to information, and action and expression to allow students to demonstrate their understanding in diverse ways (Canter et al., 2017). UDL can reduce students' learning failures because the instructional process provided by teachers is adjusted to students' learning styles, making the teaching and learning process easier (Firmansyah et al., 2016). Through the application of UDL in e-LAPD, the three core principles representation, engagement, and action and expression can be implemented in an integrated manner. The principle of representation enables the presentation of atomic theory material in various formats, such as text, animations, and simulations, allowing students with different learning styles to understand concepts more effectively. The principle of engagement provides opportunities for students to actively interact with the media, for instance through independent exploration thereby enhancing their motivation and curiosity. Meanwhile, the principle of action and expression allows students to demonstrate their understanding in multiple ways, such as answering interactive quizzes (Firmansyah et al., 2024). The integration of these three principles not only helps students grasp atomic theory more easily but also reveals their learning profiles, since each learning activity is designed in alignment with their initial competencies mapped through e-LAPD.

A learning profile refers to learning styles and students' characters. Learning style refers to how an individual receives, processes, retains, and applies information most effectively (Pashler et al., 2008). Visual learners understand material best through seeing, auditory learners through listening, and kinesthetic learners through physical activity and hands-on experiences (Syofyan & Siwi, 2018). Learning profiles serve two important policy functions. First, they provide insights into potential gains from extending years of schooling compared to improving the learning rate within those years, informing policy priorities. Second, they allow for identifying learning inequalities by disaggregating data based on gender, socioeconomic status, or ethnicity (Kaffenberger, Michelle, 2023).

Based on those explanations, the research questions of this study are how is the e-LAPD implemented using individualized learning strategies through Liveworksheet for students with intellectual disabilities in learning atomic theories? and how are the students' learning profiles when using the e-LAPD with Liveworksheet?

## Method

This study employed a mixed-method approach with concurrent embedded design types. The embedded model of research methodology combines quantitative and qualitative research methods simultaneously, but with differing weights. In this model, one method is primary while the other is secondary (Garcia et al., 2016). The primary method is used to gather essential data, while the secondary method is employed to support the data obtained from the primary method. This research selects qualitative data as the primary data, which will be supported by quantitative data (Almeida, 2018). The data analysis framework will be explained in Figure 1.

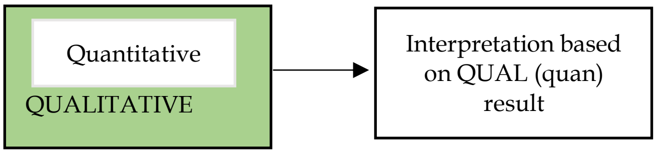

**Figure 1**. Analysis process in concurrent embedded design

The qualitative approach was applied to explore students' experiences, responses, and learning difficulties during the learning process using e-LAPD. This data was collected through interviews, observations, and video documentation. Following this, the quantitative approach was utilized to measure the improvement of learning outcomes for students with intellectual disabilities through pre-tests and post-tests. This combination of approaches was deemed appropriate to obtain more comprehensive findings, as the qualitative data served as the primary focus, while the quantitative data provided supportive numerical evidence regarding the learning process and students' responses.

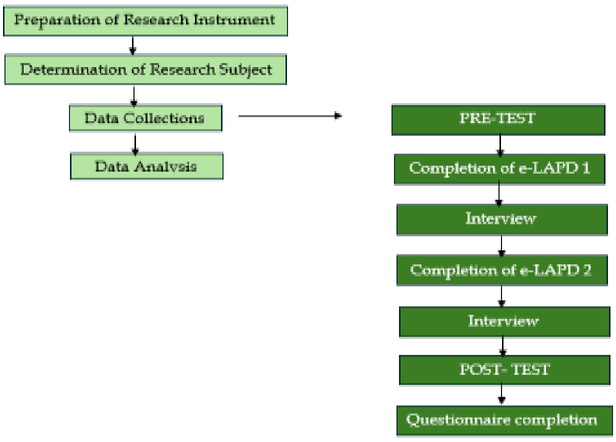

**Figure 2.** Research procedures

Qualitative data obtained from interviews and observations of students were analyzed using NVivo 11 software. With NVivo, researchers can organize and code the data, enabling them to identify themes, patterns, and categories emerging from students' experiences. This provides in-depth insights into the challenges and responses of students during the learning process. On the other hand, the improvement in learning outcomes was measured through pre-tests and post-tests, which were analyzed using the N-gain method. N-gain calculates the extent of score improvement. The research procedures of this study can be explained in Figure 2.

*Research Instruments*

This study developed several instruments to collect data, the instrument used are the instruments included Student Worksheets (e-LAPD), where two worksheets were created using digital media through Live Worksheet. E-LAPD 1 covered Dalton's and Thomson's atomic theories, while E-LAPD 2 focused on Rutherford's and Bohr's atomic theories. These worksheets were integrated with the Universal Design for Learning (UDL) model, emphasizing three principles: engagement, which enhances learners' motivation and interest; representation, which presents information in multiple formats to ensure accessibility; and action and expression, which provides diverse ways for learners to demonstrate understanding. Together, these stages promote inclusive, flexible, and learner-centered instruction. Additionally, pre-tests and post-tests were developed using Google Forms to assess cognitive levels from C2 to C5, measuring students' understanding and learning progress regarding atomic theory before and after using the e-LAPD. Semi-structured interview sheets were utilized to explore ease of use, clarity, completeness of content, design, and visual display, as well as conceptual understanding of atomic theories. Observers used an observation sheet to record each student's activities while completing the e-LAPD, which included questions related to the implementation of activities at every stage of the UDL model. This allowed the observer to gather information about students' learning styles, levels of engagement, and responses. Finally, student questionnaires collected feedback on the usability and accessibility of the e-LAPD, focusing on whether students found it easy to use and understand.

*Determination of Subjects*

This study was conducted at SMAN 10 Surabaya on August 4th, 2025. it focused on three 11th grade students with intellectual disabilities. The identities of participants described in table 1. Students identified with intellectual disabilities are those who have an intellectual quotient (IQ) below average, specifically under 70, with the onset occurring before the age of 18, alongside poor adaptive functioning (Lolk, 2013). Although these student with intellectual disabilities do not classified with an IQ below 70, these students exhibit difficulties in understanding material and specific characteristics indicative of intellectual disabilities. They often display hyperactivity and attention disorders, which lead them to focus more on physical activities rather than concentrating on the educator (Patel et al., 2020). Additionally, they may experience weaknesses in memory and thinking, including challenges in problem-solving and conceptualization. Furthermore, these students face difficulties in learning and academic perception.

**Table 1**. Identities of Students

| Initial Name | Gender | Age | IQ |
|---|---|---|---|
| E | Female | 18 | 87 |
| AHA | Male | 18 | 104 |
| DA | Male | 17 | 108 |

*Data Collections*

The fifth stage was data collection, which was conducted through the implementation of e-LAPD following the pretest, e-LAPD 1 covering Dalton's and Thomson's atomic theories was implemented, during which each student was accompanied by an observer who conducted interviews and observed the entire learning process. Students' engagement and responses were also recorded through video documentation. Interviews were conducted after e-LAPD 1 to explore students' experiences, difficulties, and understanding of the material. Next, e-LAPD 2, focusing on Rutherford's and Bohr's atomic theories, was applied, followed by interview 2 to gain further insights into students' learning experiences and comprehension. After completing both e-LAPDs and interviews, a posttest was administered to measure improvements in learning outcomes. Finally, students completed a questionnaire to provide feedback on the usability and accessibility of the e-LAPD. All data, including test results, interview transcripts, observations, questionnaires, and video recordings, were collected to analyze the implementation of e-LAPD and students' learning profiles and were analyzed both quantitatively and qualitatively.

*Data Analysis Techniques of Implementations of e-LAPD integrated UDL*

The data analysis techniques in this study were designed to address each research question systematically. For the first research question about the implementation of e-LAPD through Liveworksheet for students with intellectual disabilities in learning atomic theories, the analysis was conducted using correlation analysis with NVivo 11 by applying the Pearson correlation coefficient. This technique was employed to compare the results of interviews related to using the e-LAPD among different students. Through this process, the correlation values between students' responses could be identified, allowing the researcher to determine the degree of similarity or difference in their experiences and perceptions of the e-LAPD implementation. The correlations can be described in Figure 3.

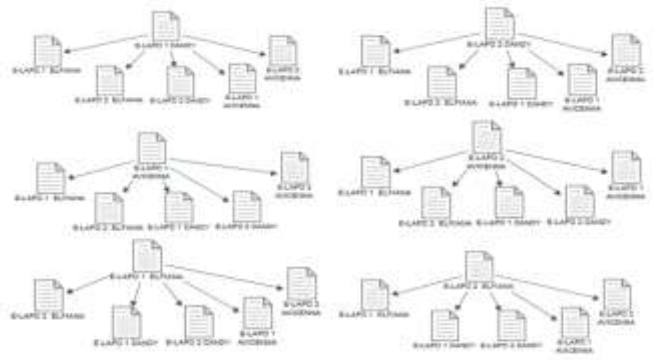

**Figure 3**. Correlation techniques

The category of correlation interpretation has some of classifications (Safitri, 2016). Which are described in table 2.

**Table 2**. Interpretation Coefficient of Correlation

| r Value | Interpretation |
|---|---|
| 0.00 | No correlation |
| 0.01-0.09 | Negligible correlation |
| 0.10-0.29 | Moderate correlation |
| 0.30-0.49 | Strong correlation |
| 0.50-0.69 | Very strong correlation |
| 0.70-1.00 | Approaching Perfect correlation |

The questionnaire responses also supported the analysis of the e-LAPD implementation among students. The questionnaire, consisting of 'Yes' and 'No' items, was analyzed using descriptive statistics. Frequencies and percentages were calculated for each item to describe students' perceptions and experiences regarding using the e-LAPD. For clarity, the results were presented in tables and figures. The successful implementation of intellectual disabled students reflected their learning outcomes after using the e-LAPD. The analysis was conducted by comparing the improvement between pretest and posttest results. Based on the analysis, it can be identified that students' understanding of atomic theory covers the basic concepts, atomic structure, and the strengths and limitations of the theory. These findings support the successful implementation of the e-LAPD.

*Data Analysis Techniques of Student Learning Profile*

Students' learning profiles when using the e-LAPD with Liveworksheet was analyzed using NVivo 11 by applying matrix coding query to determine the result of coding references count. The source of this analysis is observations, interviews, and outcomes of e-LAPD completion. The observers who monitored the student activities in detail during the e-LAPD tasks, as well as interviews related to how students understood or demonstrated their understanding. This data source can describe students' functional learning profiles, such as their tendency to engage with interactive visual media, preference for verbal explanations, or reliance on hands-on practice during learning activities. The analysis was carried out by mapping these tendencies from the data sources, so that the final results could be presented in a chart showing each student's learning style. In NVivo, the initial codes were labeled as 'auditory', 'visual', and 'kinesthetic'. However, for the purpose of this study, these categories were refined into functional learning profiles, such as 'tendency to engage with interactive visual media' or 'need for verbal explanation', to provide a more contextual description of students' learning behaviors.

The results of observations and interviews, as well as the outcomes of e-LAPD completion, will be analyzed and subsequently mapped using the NVivo application to identify students' learning styles. The mapping process integrates both interview data and observational findings to reveal patterns that characterize each student's learning style, as illustrated in Figure 4.

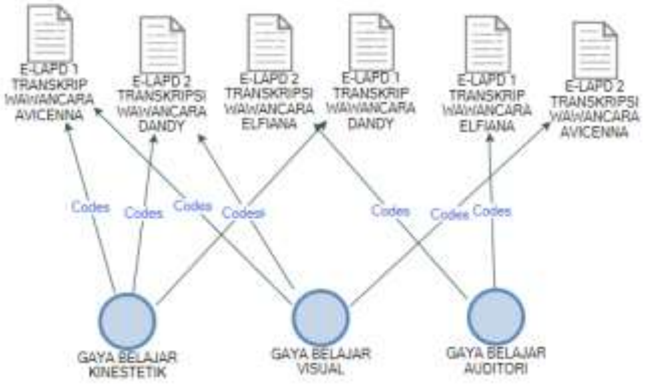

**Figure 4**. Mapping of observation and interview data on students' learning style

The results of this qualitative analysis will be supported by the answers and scores from the pre-test and post-test of the students based on the indicators of the questions, thereby highlighting the tendencies of student engagement in their learning styles. The analysis was conducted by comparing the improvement between pre-test and post-test results, complemented by oral interviews that explored students' understanding of atomic theory concepts, including their strengths and weaknesses. The quantitative data from the pre-test and post-test were further examined using the N-gain formula to measure the effectiveness of learning through e-LAPD. The categories of N-gain score described in table 3.

**Table 3.** N-gain Score Categories (Sukarelawan et al., 2024)

| N-gain Score | Interpretation |
|---|---|
| 0.70 ≤ g ≤ 1.00 | High |
| 0.30 ≤ g ≤ 0.70 | Moderate |
| 0.00 < g < 0.30 | Low |
| g = 0.00 | No improvement occurred |
| -1.00 ≤ g < 0.0 | The results showed a decrease |

## Result and Discussion

*Implementation of e-LAPD*

The implementation of E-LAPD integrated individualized learning strategies with UDL model through Liveworksheet was designed to facilitate students with intellectual disabilities in understanding the abstract concepts of atomic theories. This section discusses how the approach supports the learning process, highlights its effectiveness, and examines strengths and challenges encountered during its implementation, thereby requiring an analysis of E-LAPD's effectiveness to ensure its ease of use for students.

**Table 4.** Pearson Correlation Result

| Node A | Node B | Pearson correlation coefficient |
|---|---|---|
| e-LAPD 2 E | e-LAPD 2 AHA | 0.812951 |
| e-LAPD 1 E | e-LAPD 1 AHA | 0.808665 |
| e-LAPD 1 E | e-LAPD 1 DA | 0.807542 |
| e-LAPD 2 E | e-LAPD 1 E | 0.801099 |
| e-LAPD 2 E | e-LAPD 1 DA | 0.794844 |
| e-LAPD 2 E | e-LAPD 2 DA | 0.787159 |
| e-LAPD 1 DA | e-LAPD 1 AHA | 0.783421 |
| e-LAPD 2 DA | e-LAPD 2 AHA | 0.778063 |
| e-LAPD 2 AHA | e-LAPD 1 AHA | 0.755336 |
| e-LAPD 2 DA | e-LAPD 1 AHA | 0.748913 |
| e-LAPD 2 DA | e-LAPD 1 E | 0.736315 |
| e-LAPD 2 E | e-LAPD 1 AHA | 0.733795 |
| e-LAPD 2 DA | e-LAPD 1 DA | 0.719751 |
| e-LAPD 2 AHA | e-LAPD 1 E | 0.704458 |
| e-LAPD 2 AHA | e-LAPD 1 DA | 0.68652 |

The analysis using NVivo 11 by applying the Pearson correlation coefficient was conducted to compare interview results regarding using e-LAPD among different students. The findings revealed that students expressed positive responses, stating that the ease of use, clarity and completeness of content, design and visual display, as well as conceptual understanding of atomic theories were highly accessible and supportive in their learning process. This is evidenced by the correlation results of student interviews, which indicated similar responses regarding the positive use of e-LAPD.

Based on Table 4, the Pearson correlation coefficient ranged from 0.69652 to 0.812951, indicating that the results of each interview response regarding using e-LAPD consistently showed positive perceptions among students. The high degree of correlation demonstrates that students' statements were strongly interrelated, suggesting that e-LAPD can be categorized as effective in appearance, ease of use, and clarity of the presented material. An analysis was also conducted for each student to identify both positive and negative sentiments related to using e-LAPD, which was integrated UDL model in learning atomic theory.

*Student 1 (E)*

Based on the comparison of interview cases related to the use of e-LAPD 1 and 2, participant E expressed positive and highly positive statements regarding the four components of e-LAPD usage, which are represented by blue circles. This evidence is illustrated in Figure 5, where positive and highly positive statements were consistently conveyed in both interview sessions, namely during the use of e-LAPD 1 and e-LAPD 2. Thus, it can be concluded that participant E acknowledged the effectiveness of both e-LAPD implementations.

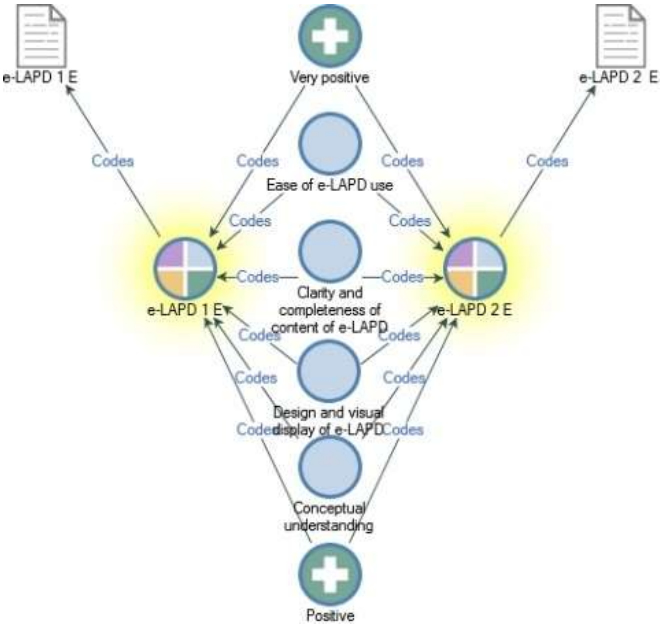

**Figure 5.** Case comparison for E (student 1)

The results of the questionnaire consisting of 12 items related to the ease of use, visual design, and clarity of the e-LAPD material showed that participant E achieved a perfect score of 12/12, or 100%. This indicates that participant E found the e-LAPD very easy to use and engaging. Such findings also serve as a positive sign that the developed e-LAPD is accessible for E, who notably has a physical limitation in her right hand. E stated that the features in the Liveworksheet platform were easily accessible. This aligned with study that said animation in e-LAPD enhance the student motivation in learning (Maysara et al., 2023). The animations helped her gain a deeper understanding of the concepts, as they made remembering the forms of each atom (Ghaisani & Setyasto, 2023).

*Student 2 (AHA)*

Based on the comparison of interview cases related to using e-LAPD 1 and 2, participant AHA expressed positive, very positive, and moderately positive statements in tasking both e-LAPD 1 and e-LAPD 2. However, AHA also expressed negative and moderately negative statements in the interview regarding using e-LAPD 1. The analysis found that these statements were due to difficulties experienced by AHA, particularly in the submission process, which required filling in extensive personal data and the teacher's email. Submission section is commonly considered as difficult part, such as give the student identity until enter teacher 's email (Formen et al., 2023). This challenge occurred because it was AHA's first time using the Liveworksheet platform in relation to e-LAPD. Nevertheless, the usage instructions provided within e-LAPD facilitated the submission process, so that in e-LAPD 2, no negative statements were reported, as AHA had already understood the correct procedure. Moreover, AHA explained that the e-LAPD platform in Liveworksheet was highly effective for learning subsequent materials since all content could be accessed easily for instance. Integrating YouTube-based materials directly or using interactive animations will enhance students' understanding (Ghaisani & Setyasto, 2023). AHA understand the structure and composition of atoms by animation provided in e-LAPD. This aligned with Caella et al. (2024) who said The use of animated video media makes science learning concrete this is because video media allows students to both see and hear the core subject matter being presented at that moment. When using worksheets, a student turns from a passive recipient of knowledge into an active participant in the teaching-learning process (Kopniak, 2018). The results of the questionnaire, consisting of 12 items related to the ease of use, visual design, and clarity of the e-LAPD material, showed that participant E achieved a perfect score of 12/12, or 100%. This indicates that participant AHA found the e-LAPD easy to use and engaging, even at first felt like difficult, but the provided instructions and guidance from the observer helped facilitate the process.

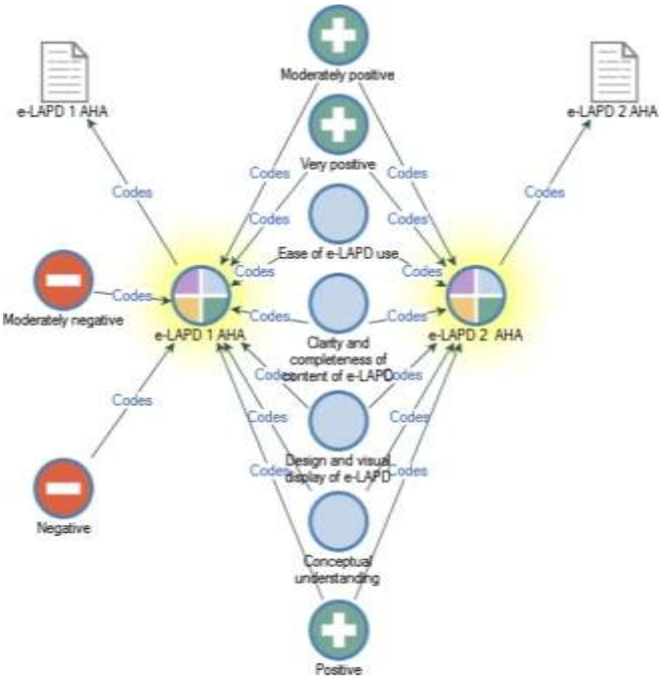

**Figure 6.** Case comparison for AHA (student 2)

*Student 3 (DA)*

Based on the comparison of interview cases related to the use of e-LAPD 1 and e-LAPD 2, participant DA consistently expressed positive and highly optimistic statements regarding the four components of e-LAPD usage, which are represented by blue circles in Figure 7. These findings indicate that DA conveyed positive perceptions during both interview sessions, reflecting the effectiveness of both e-LAPD implementations.

The questionnaire results, which consisted of 12 items related to ease of use, visual design, and material clarity, showed that DA obtained a perfect score of 12/12 (100%). This demonstrates that DA found the e-LAPD very easy to use and engaging. During the interview, DA explained that although it was his first time using the Liveworksheet platform as a medium for e-LAPD, he did not encounter difficulties because the provided user guidelines and question features were easy to follow. He further mentioned that he has been familiar with using a laptop since childhood, making digital media like e-LAPD not entirely new.

In addition, the observer noted that DA was attentive to details, particularly in identifying punctuation and font size errors. DA also stated that he liked the red color display but disliked the deafening sounds this aligned with Utami et al (2024) that the harmonious use of colors, the clarity of the fonts, and the supportive animations not only enhanced the material's comprehensibility. Furthermore, he emphasized that the overall appearance of e-LAPD was attractive and that the provided videos made him feel comfortable and not distracted during learning.

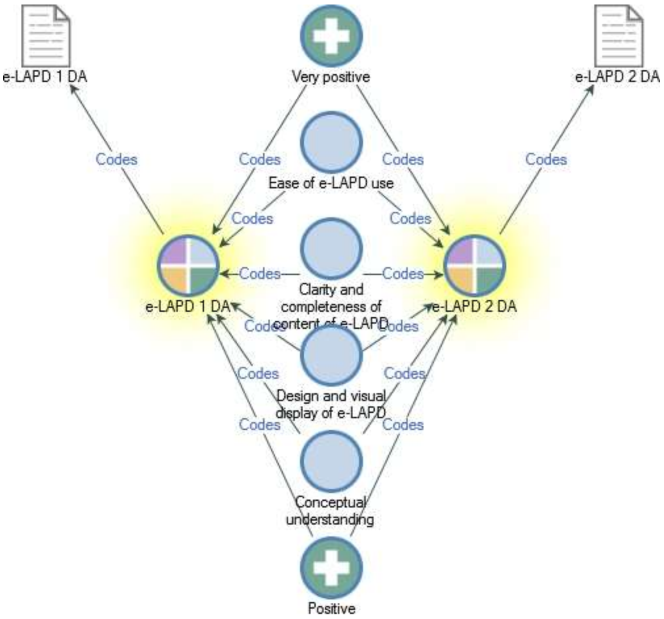

**Figure 7.** Case comparison for DA

Quantitative analysis was also conducted by comparing the pre-test and post-test results to determine the improvement of students' understanding of atomic theory, with the data presented in figure 8.

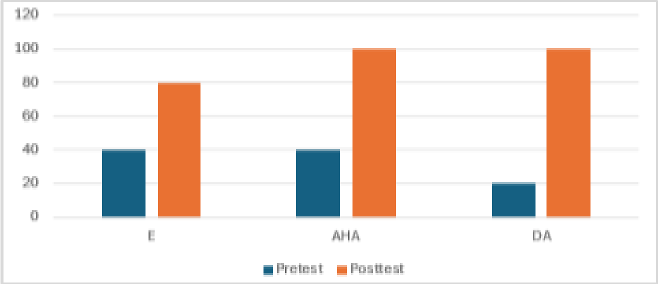

**Figure 8.** Pretest and posttest results

**Table 5.** N-gain Score

| Student | Pre-test | Post-test | N-gain |
|---|---|---|---|
| E | 40 | 80 | 0.67 |
| AHA | 40 | 100 | 1.00 |
| DA | 20 | 100 | 1.00 |
| Average | | | 0.88 |

The pretest and posttest results demonstrated a considerable improvement in students' understanding, assessed through a Google Form consisting of five multiple-choice items on atomic theory's concepts, structure, strengths, and weaknesses. The increase in scores confirms that implementing e-LAPD with individualized learning strategies effectively facilitated students' comprehension of atomic theory. Furthermore, e-LAPD one and e-LAPD 2 were developed based on Universal Design for Learning (UDL) principles, namely engagement, representation, and action and expression. These principles contributed to helping disabled intellectual students organize and strengthen their understanding (Wulayalin & Suprihatiningrum, 2024). At the engagement stage, students were encouraged through stimulus and apperception activities designed to enhance motivation. In the representation stage, instructional videos and animated illustrations were provided to visualize the structure of atomic theory more clearly. Finally, in the action and expression stage, interactive features such as drag-and-drop, matching, and multiple-choice exercises enabled students to demonstrate their learning, followed by a self-reflection activity that allowed them to consolidate and express their understanding (Atika et al., 2025).

Analysis results are reasonable indications that the three students gave positive responses to the implemented e-LAPD, which was easy to use, engaging, and presented in clear language, thereby facilitating the subsequent analysis of students' learning styles as reflected in their processes and activities during the completion of the e-LAPD with UDL model. Pre-test-post-test results showed good improvement for each student, so it can be concluded that implementing LAPD can help students understand atomic theories more easily. Positive results from implementing e-LAPD also facilitated the analysis of students' learning profiles, which were observed during the learning process and reflected in their e-LAPD performance.

### *Students' Learning Profile*

The results of observations and interviews also resulted in outcomes of e-LAPD completion, which were analyzed and subsequently mapped using the NVivo application by applying matrix coding query to determine the results of coding references count to identify students' learning profile. The process was analyzed by mapping the data results to reveal the students' learning profile tendencies.

### *Student 1 (E)*

Based on the analysis results, E has an auditory learning style, which is explained in the NVivo 11 analysis by mapping E's responses during the interview sessions and his answers in the E-LAPD. E tends to understand the material more easily when explained directly by the observer and struggles when asked to read and answer independently, even if the answers are provided in the text. Furthermore, observations show that E has reading difficulties; his reading level is still low, and he cannot read fluently like typical 18-year-old students. This also makes him comprehend better when the observer explains directly or when the material is presented in a video. Observational results also indicate that E requires more time to understand the material.

Data 1, which focused on how E understood Dalton's and Rutherford's atomic theories, it was found that E also had difficulty explaining in long sentences. E is better at remembering tones, rhythms, or words he has heard before. For example, when the observer asked what Dalton's atom could be compared to, E answered slowly until the observer prompted by saying the word "S*eperti bola …*" with intonation. Then, E was able to immediately respond that Dalton's atom is like a solid ball and directly associate it with the analogy of Thomson's atom as a raisin bread by saying, "*Dalton seperti bola pejal kalau roti kismis iu atom Thomson.*"

From Data 2, regarding how E understood Rutherford's and Bohr's atomic theories, E exhibited the same behavior. When the observer asked E to read, he would only read the text. After reading, E would request the observer to explain it verbally. Thus, both the observation and the completion of E-LAPD 2 still indicate E's tendency toward a verbal explanation. When faced with calculation problems, E performs the calculations while frequently communicating with the observer, seeking feedback to validate her answers.

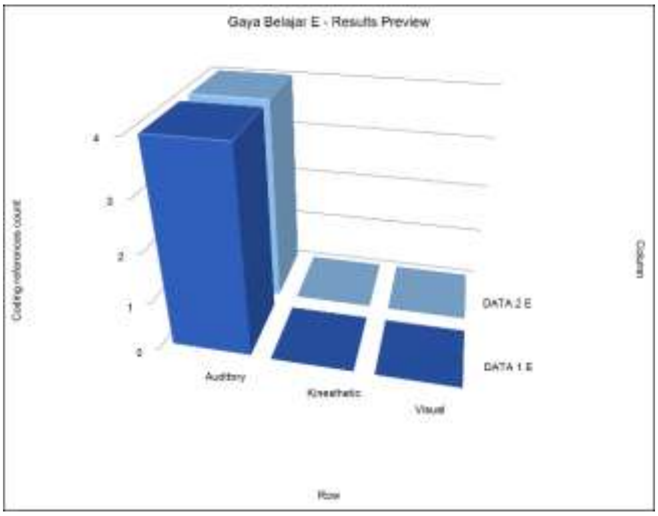

**Figure 9.** E's learning tendencies

Based on this analysis the highest frequency of observation and interviews in NVivo 11 by matrix coding query, it can be concluded that E preference for verbal preference. Therefore, strategies such as providing verbal explanations and allowing E to respond by recalling the explanation can be applied in future learning activities (Kayalar & Kayalar, 2017). Teachers should provide oral feedback rather than relying solely on written reports, as students will likely retain more information when it is communicated directly (Siswadi et al., 2018). E also doesn't focus on the visualization in e-LAPD and it aligned with Adhani et al. (2022) that student with tendency toward a verbal explanation show characteristics such as learning through listening, strong oral engagement, sensitivity to music, being easily distracted by noise, and weaknesses in visual tasks. E's learning tendencies was also evidenced by the improvement in pre-test and post-test results with N-gain score 0.67 showed in table 5 classified as moderate, after the implementation of the UDL learning model integrated into e-LAPD, in which the observer followed Student E's learning profile tendency toward verbal explanation.

### *Student 2 (AHA)*

Based on the analysis, AHA tends to engange with interactive visual media, as illustrated in Figure 10. AHA's dominant with interactive visual, which was obtained from observation data, E-LAPD completion results, and interview responses. Overall, AHA can explain atomic theory in detail, particularly when describing the structure of atomic theories. AHA can systematically explain the atomic structure from Dalton, Thomson, Rutherford, and Bohr, as he easily remembers visual representations. In addition to the dominant visual learning style, AHA also shows a slight tendency to learn through physical interaction, which is observed when answering interview questions. His gestures are active, such as hand movements while explaining.

From Data 1 regarding Dalton's and Thomson's atomic theories, AHA was able to correctly explain the limitations of Dalton's atomic theory based on the provided animation. AHA explained that Thomson refined the atomic theory after discovering protons and electrons, demonstrating an awareness of the differences between Dalton's and Thomson's atomic models. In understanding the material, AHA reads several sentences and then matches the information with the animation to reinforce comprehension. AHA is highly capable of explaining in long and detailed sentences.

From Data 2 regarding Rutherford's and Bohr's atomic theories, AHA demonstrated great attention to detail in the Rutherford atom animation. In E-LAPD 2, a video of Rutherford's atomic experiment was presented, and AHA could understand and even memorize how the experiment involved firing alpha particles at a gold foil. This was facilitated by the visual animations in the video, which were easy to comprehend. Regarding Bohr's atom, which was likened to a solar system, AHA explained that electrons are like planets orbiting the sun, where the sun represents the atomic nucleus. AHA was also able to answer questions about the maximum number of electrons in K, L, M, and N shells by counting the electrons in the animation rather than using the formula $2n^2$. For example, for the L shell, AHA counted the electrons directly from the animation instead of substituting $n=2$ into the formula to get 8. This indicates that AHA tends to observe and calculate manually based on the visual animations provided. The frequency of observation and interviews data showed in figure 10.

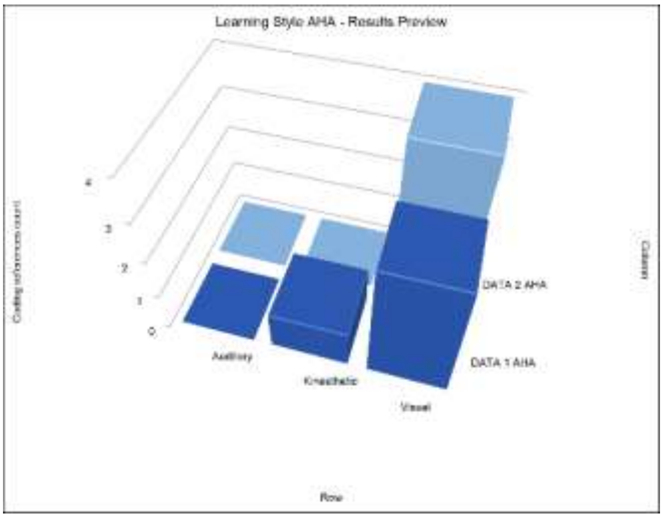

**Figure 10.** AHA's learning tendencies

Student with tendency to engage with visual representation retain information more effectively through pictures, diagrams, animations, or other visual media. This result is related with Aisami (2015) who said visual representation help student remember concrete information better than abstract words, are able to connect concepts with visual representations to enhance memory, and often actively request explanations presented visually. Visuals also help them engage in the learning process, increase motivation, and stimulate critical and creative thinking (Adi et al., 2023). The implementation of e-LAPD provides engaging visualizations that align with these findings, supporting AHA in comprehending the development of atomic theory. This is further evidenced by the improvement in AHA's score, which increased from 40 to 100, categorized as a high N-gain of 1 showed in table 5.

*Student 3 (DA)*

From Data 1, regarding Dalton's and Thomson's atomic theories, DA often directs the cursor toward text or animations to emphasize and reinforce his understanding. For example, in the animation of Thomson's atomic theory, DA consistently moves the cursor in a circular motion over the animation to help remember the structure of the atomic model. DA is also very attentive to the systematic organization within the E-LAPD. For instance, when completing matching tasks using the join feature, DA communicates with the observer, saying, *"Oh, bagaimana bisa ditarik ini Bu? Aku mau coba design kaya gini Bu di Rumah."* From Data 2, about Rutherford's and Bohr's Atom theories as observed during calculation tasks involving the maximum number of electrons in the K, L, M, and N shells of Bohr's atomic theory. DA immediately performs manual calculations by writing down the formula $2n^2$ and substituting the values of the respective shells to determine the maximum number of electrons in each shell. His calculation process is systematic and well-organized.

DA likes to organize items in his surroundings, ensuring that even slightly misplaced objects are returned to their original positions. DA is highly sensitive to excessively bright light and loud sounds. During the completion of the e-LAPD, it was observed that DA adjusts all laptop settings to his comfort, showing meticulous attention to detail when using the device. However, DA can become distracted while using the laptop, often exploring settings or being curious about the laptop's identity. DA shows great enthusiasm when asked to type answers or interact with features provided in the E-LAPD Liveworksheet, such as dragging and dropping lines. DA is also very attentive to punctuation errors and improper language use, enjoying opportunities to revise work and demonstrating active movement throughout the task. In addition to the tendency to learn through physical in interaction, DA shows a slight tendency toward a visual representation, as indicated by his interest in animations and the colorful design of the E-LAPD 2, particularly red. DA is also attentive to images that appear blurry.

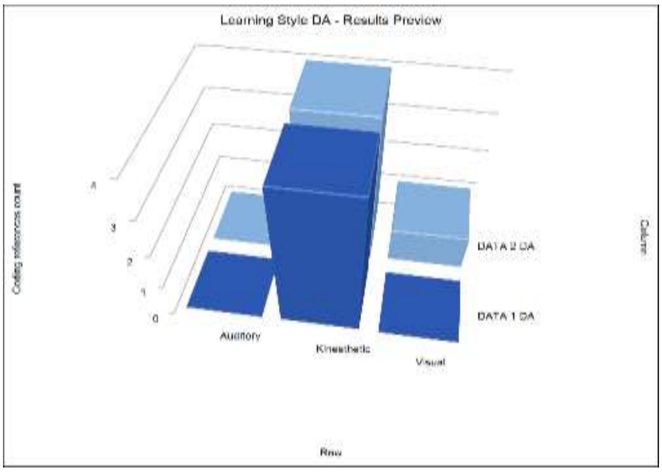

**Figure 11.** DA's learning tendencies

Based on the analysis, DA consistently enjoys the interactive features provided in e-LAPD, as they enable more active engagement in the learning process. This aligned with characteristics of individuals with a learning tendency toward physical movement include the use of learning aids during the instructional process to stimulate curiosity and to emphasize the understanding of key concepts (Tahira & Yamin, 2024). Those explanations also related with Abah et al. (2024) wo said such tendencies are most prominent when students learn through hands-on practice, movement, or sensory experiences. They typically acquire knowledge by manipulating and practicing tasks, remembering information through physical activity and observation, using their fingers as pointers while reading, employing frequent body gestures, finding it difficult to remain seated for extended periods, and enjoying engaging, active games (Hisnil Ain et al., 2023). The implemented e-LAPD also provides interactive features that facilitate DA's learning tendency through movement, thereby enhancing and simplifying the learning process. This is evidenced by the improvement in DA's test results, which increased from 20 in the pre-test to 100 in the post-test, with an N-gain of 1 categorized as high showed in table 5. Analyzing the students' learning profiles, particular attention was directed toward their characteristics and learning abilities.

*Student 1 (E)*

E shows sufficient concentration, motivation, and willingness to learn, though her mood often influences her emotions and self-confidence. Her intellectual capacity is average (87), indicating adequate thinking ability with occasional obstacles. She demonstrates fair interaction and communication skills but requires time to adapt. Parental support, warm communication, and appreciation are recommended to strengthen her confidence and emotional maturity. Additionally, she has a physical limitation in her right hand from a childhood accident, which hinders tasks requiring intensive use of that hand.

*Student 2 (AHA)*

AHA demonstrates adequate adaptability, AHA, with an IQ of 104, shows average intellectual potential and learns new concepts fairly well, yet his performance is highly influenced by emotional states. While he can complete tasks satisfactorily in positive moods, he becomes easily discouraged, attention-seeking, and stubborn when his wishes are unmet. His low achievement motivation leads to boredom and underperformance despite his actual capacity. Thus, consistent support and encouragement from parents, teachers, and the school environment are essential to optimize his abilities.

*Student 3 (DA)*

DA has an IQ of 108 (Average) on the WISC scale, with an originality score of 140 (Very Superior), indicating average intellectual capacity with higher potential that remains underutilized. Despite adequate comprehension, his neurological development affects overall performance, particularly in problem-solving and language processing. He shows characteristics of Specific Learning Difficulties, especially in oral, written, and social language, which hinder academic tasks and social interactions. Difficulties in writing, reading, and maintaining focus are evident, and reports also indicate frequent peer bullying. Nevertheless, he demonstrates strengths in spatial and sequencing abilities, particularly in visual-spatial reasoning and motor coordination.

## Conclusion

This study concludes that the implementation of e-LAPD integrated with UDL effectively enhanced the learning outcomes of students with intellectual disabilities in understanding the development of atomic theories. The qualitative findings revealed that the implementation of e-LAPD enabled students with intellectual disabilities to more easily comprehend atomic theory, while also highlighting their dominant learning profiles, including preferences for interactive visual media, verbal explanations, and reliance on physical interaction, as well as uncovering their general learning abilities and characteristics. These findings were supported by quantitative results, which showed that 100% of students reported improved conceptual understanding after learning with e-LAPD, and the pre-test and post-test scores demonstrated a high average N-gain of 0.88.

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**Author Contributions**
Z.F.A. served as the main author responsible for article writing, review, and editing, as well as contributing to the conceptualization of the research idea; K.A. acted as the data validator and contributed to project administration; R.F.S. supervised the process of research data collection; I.K.A. contributed to data validation and methodology; D.N. provided supervision and guidance in the development of research ideas and conceptualization. All authors have read and approved the published version of the manuscript.

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**Conflicts of Interest**
In writing this article, we sincerely declare that no conflict of interest may affect the objectivity and integrity of the results.

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