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Learning Profile of Students with Intellectual Disabilities through the E-LAPD Live Worksheet on Chemical Reactions Material

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Abstract: Students with intellectual disabilities experience difficulties in understanding abstract concepts such as chemical equations and reaction balancing. This study aims to describe the learning profile and determine the learning outcomes of students with intellectual disabilities using E-LAPD based on Liveworksheet integrated with the Individualized Education Program (IEP). This research employed a mixed methods approach with an embedded design. Quantitative data were obtained from pre-test and post-test to measure the improvement in learning outcomes, while qualitative data were collected through students' interviews after completing the E-LAPD using N-Vivo 11 to identify responses and challenges during the learning process. The research subjects consisted of three students with intellectual disabilities at SMAN 10 Surabaya. The results revealed that students experienced difficulties in understanding chemical symbols, connecting reactants and products, and balancing equations independently. The implementation of E-LAPD based on Liveworksheet, which provides visual support, step-by-step guidance, and interactive exercises, helped students better understand the process of reaction balancing. An improvement in learning outcomes was demonstrated by higher post-test scores in all subjects. In conclusion, the E-LAPD based on Liveworksheet has promising potential as an adaptive learning medium for students with intellectual disabilities, although further development is required regarding content refinement and learning assistance strategies.

Keywords: Intellectual disabilities; Learning profile; Learning outcomes; Liveworksheet

Introduction

In the 21st century, learning in the world of education is crucial for students to have the skills to learn and innovate using technology and information media (Dilekçi & Karatay, 2023). Given the abundance of information that can be easily disseminated, accessed, and communicated anywhere, modern students must utilize technology to meet their learning needs, one such tool is E-LAPD as a learning resource (Gupta & Jain, 2017). Inclusive education is a global agenda emphasized in the SDGs, particularly Goal 4, namely quality education for all (Naami & Mort, 2023). UNESCO data (2021) show that more than 240 million children worldwide have disabilities, and the majority live in developing countries (Olusanya et al., 2020). The

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development of digital technology is increasingly opening up opportunities for more inclusive learning (Rodríguez Herrero et al., 2021). Although its efficacy is heavily determined by the instructional design employed, recent research demonstrates that digital technology can enhance motivation and science learning outcomes for students with disabilities (Mikropoulos & Iatraki, 2023). An Individual Education Program (IEP) can be used to help children with intellectual impairments achieve their unique learning requirements (Rashid & Wong, 2022). The IEP makes accommodations for the specialized curriculum that children with IQs below average require (Kern et al., 2019). This is due to the fact that research on the strategies required based on each student's condition comes before the IEP development process (Biggane et al., 2019).

Students can better grasp abstract ideas, like chemistry, by using technology-based learning resources like interactive worksheets and e-learning (Kumala Dewi et al., 2019). Since chemistry is associated with concepts, symbols, and computations, students frequently view it as challenging (Vladušić et al., 2016). One chemistry topic that students find challenging is Reaction Equations and Balancing Chemical Reactions, as it requires a high level of logical thinking, analytical skills, and a strong understanding of symbolic meaning (King-Sears & Johnson, 2020).

Children with slow learning are known as Borderline Intellectual Function (BIF), namely children with an intelligence category that shows below-average cognitive abilities (generally having an IQ range between 70-85) (Pulina et al., 2019). According to Patel (2020), the category of difficulty in terms of intelligence is not as severe as intellectual disability/mental retardation (IQ < 70). Kim et al. (2024) state that BIF individuals experience cognitive impairment problems. Students with intellectual disabilities face greater challenges in understanding abstract concepts such as chemistry because they have limitations in memory and information processing speed, so learning needs to be designed to be more concrete, simple, and directed (Grigorenko et al., 2020).

Tümay (2016) in chemistry learning, particularly abstract topics such as chemical equations and balancing chemical reactions, students with intellectual disabilities face significant challenges. They often struggle to understand symbols, remember concepts, and reason logically (Quílez, 2019). Interactive digital media such as Liveworksheet can be a solution because it provides a hands-on, interactive learning experience with real-time feedback (Sothayapetch & Lavonen, 2022). One study found that using augmented reality in teaching chemical reaction balancing significantly improved student understanding, particularly in addressing conceptual difficulties (Girón-Gambero & Franco-Mariscal, 2023).

Research by Fidalgo-Blanco et al. (2021) indicates that students are often passive in completing teacher assignments. Niswah et al. (2024) state that Liveworksheet is a site for creating e-worksheets, making it easier for users to design learning tools. E-worksheets can be completed online. Liveworksheet is highly engaging and easy to use. Liveworksheet is an application that can transform traditional printable worksheets (documents, PDFs, and JPGs) into interactive online exercises because it can include videos, images, and audio (Widiyani & Pramudiani, 2021). Arifianti et al. (2025) he types of inquiries that may be created with this application vary, such as multiple choice, short answer, true or false, and matching. This student worksheet gives pupils the chance to learn on their own (Prabowo, 2021).

A gap analysis shows that previously used technologies and strategies have provided benefits. However, no research has specifically combined these two approaches to address chemistry learning challenges for students with intellectual disabilities. Glencross et al. (2021) previous research has not explored how learning patterns in students with intellectual disabilities develop when using digital media, particularly Liveworksheet-based Electronic Student Activity Sheets (E-LAPD), which offer interactive features and immediate feedback (Alfredsson Ågren et al., 2020). This gap points to an urgent need to examine how E-LAPD can be an innovative and effective solution. Liveworksheet-based E-LAPD was chosen because it allows for problem alignment, concept visualization, and immediate feedback, all of which are essential to supporting the learning process of students with intellectual disabilities.

Based on research observations conducted at SMAN 10 Surabaya, three students were identified as having intellectual disabilities or being slow learners, one of whom experienced complications of ADHD. One effort to address this issue is to create a Liveworksheet-based E-LAPD, which focuses on chemistry learning in chemical equations and balancing chemical reactions.

With the conditions that have been described, it can be concluded that the objectives of this study are (a) to describe the learning profile of students with intellectual disabilities in understanding the material on reaction equations and chemical reaction balancing using Liveworksheet-based E-LAPD with individual education learning, (b) to determine the learning outcomes of students with intellectual disabilities after participating in learning using Liveworksheet-based E-LAPD on the material on reaction equations and chemical reaction balancing with individual education learning.

Method

This study was designed to obtain a comprehensive overview of the learning profiles and learning outcomes of students with intellectual disabilities on chemical equations and balancing reactions using Liveworksheet-based E-LAPD. A mixed methods approach with an embedded design was used to achieve this objective, where quantitative and qualitative data were systematically combined. This research methods section details the participants, research design, instruments, procedures, and data analysis techniques, so that other researchers can replicate this study.

Participants

Three SMAN 10 Surabaya students with intellectual impairments participated in this study. Purposive sampling was used to choose participants based on their skills and unique circumstances in order to provide data that might characterize the learning profiles of children with intellectual impairments. While the other two students only had intellectual deficiencies and no other illnesses, one student experienced complications from Attention Deficit Hyperactivity Disorder (ADHD).

Table 1. Short Student Profile

Name	Gender	IQ	Special Conditions
AH	Male	104	Intellectual Disability
DA	Male	108	Intellectual Disability & ADHD
WL	Female	87	Intellectual Disability

Research Procedure

This study employed a mixed-methods approach employing an embedded design strategy. Both quantitative and qualitative methods were used in this design. Pretests and posttests were used to gather quantitative data on the learning outcomes of children with intellectual disabilities. On the other hand, qualitative information about the learning characteristics of children with intellectual impairments was gathered through interviews. This method was selected in order to gain a thorough understanding of how Liveworksheet-based E-LAPD may be used to enhance comprehension of chemical equation concepts and balance chemical reactions, while also gaining insight into the learning styles of students.

Research Instruments

The tools employed in this study were designed to gather both qualitative and quantitative data, giving researchers a thorough picture of the learning outcomes and profiles of children with intellectual impairments. The first tool was a pretest and posttest designed to evaluate the learning results of chemical equations and balancing reactions as well as the starting skills of students with intellectual impairments. This multiple-choice test was designed to evaluate pupils with intellectual impairments' comprehension.

Qualitative information about students' learning profiles was gathered through the use of the second tool, namely an interview. Researchers conducted interviews with students with intellectual impairments to learn more about their motivations, challenges, and responses to using Liveworksheet-based E-LAPD. Interpreting the learning results derived from the pretest and posttest might be aided by the interview data.

This study employed observation as a supplementary tool in addition to these two main tools. To document how students with intellectual impairments interacted with the learning materials and how engaged they were in each learning task, observations were made. This observational data helped strengthen the researchers' understanding of the learning process of students with intellectual disabilities.

Research Procedure

The research procedure explains the steps taken by the researcher, from problem formulation to data analysis. These steps are structured based on a mixed methods approach with an embedded design, combining quantitative and qualitative approaches for data collection and analysis. The following is a research flowchart for the embedded design model.

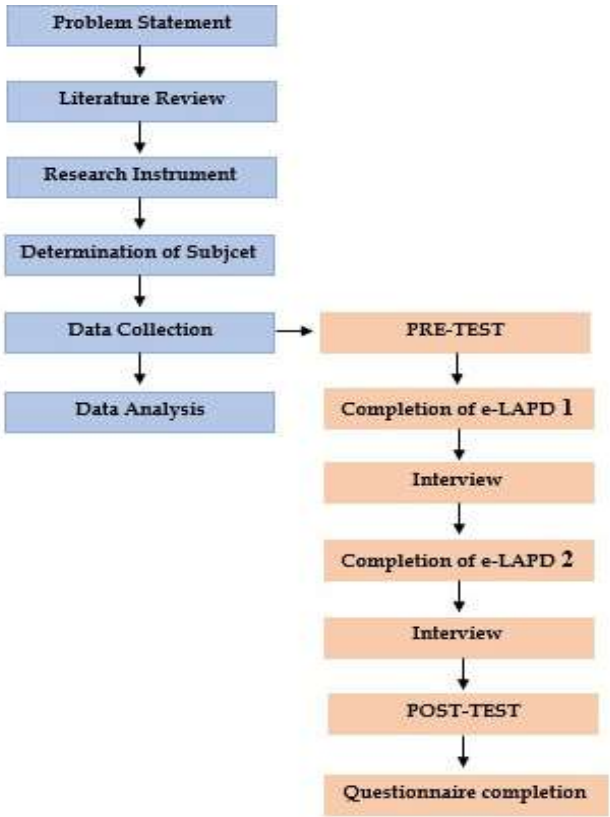

Figure 1. Embedded design model flow

The research generally begins with problem formulation, which requires an in-depth understanding by combining quantitative and qualitative data. The problem formulation is derived from the observations of SMAN 10 Surabaya, which show quantitative and qualitative data results that focus on the learning profiles and outcomes of students with intellectual disabilities using Liveworksheet-based E-LAPD. Next, a literature review was conducted to strengthen the theoretical foundation of intellectual disabilities, Individualized Education Learning (IEL), digital learning media such as Liveworksheet, and relevant previous research.

The next stage is the preparation of research instruments, in this study the instruments used include learning outcome tests in the form of pretests and posttests, interview guidelines used to gather information about student learning profiles, which in this study focused on the learning styles of students with intellectual disabilities, as well as response questionnaires to obtain responses from students with intellectual disabilities to Liveworksheet-based E-LAPD. After the instruments were prepared, the research subjects were determined, in this study, the focus was on three students with intellectual disabilities, one of whom had ADHD complications at SMAN 10 Surabaya. Students sampled in this study already had a foundation in chemistry learning. Student data can be seen in Table 1.

The data collection process was carried out sequentially, starting with a pretest to determine students' initial understanding of chemical reaction equations. After that, students with intellectual disabilities completed the Liveworksheet-based E-LAPD 1 on chemical reaction equations, followed by interviews to obtain qualitative data regarding their experiences and learning styles. Next, students with intellectual disabilities completed the Liveworksheet-based E-LAPD 2, followed by interviews to assess further changes and responses.

A posttest measuring the learning results of students with intellectual impairments who had used the Liveworksheet-based E-LAPD was administered after they had finished all of the aforementioned activities. Completing a questionnaire to gauge their reactions to the instructional materials was the last step.

Both quantitative and qualitative methods were then used to analyze the collected data. Descriptive analysis of the quantitative data from the pretest and posttest revealed increases in the learning outcomes of children with intellectual disabilities. In order to determine learning profiles, NVivo analytic techniques were used to gather qualitative data from interviews with students who had intellectual impairments. This study concentrated on the difficulties and learning styles that students faced. A more thorough picture of the learning profiles and learning outcomes of children with intellectual impairments using E-LAPD was subsequently produced by combining the findings of the two analyses.

Data Analysis Techniques

Both quantitative and qualitative methods were used in this study's data analysis procedures. In order to quantify changes and gains in student learning outcomes, quantitative data were analyzed by computing each student's pretest and posttest scores. In the meanwhile, NVivo 11 software was used to evaluate qualitative data using a thematic analysis technique. To find patterns, themes, and descriptions of the learning profiles of students with intellectual impairments, a matrix coding query was used for the study. According to Guetterman et al. (2015), an embedded research methodology was then used to combine the findings of the quantitative and qualitative analyses, enabling a more thorough comprehension of the connection between the learning outcomes and learning profiles of children with intellectual impairments.

Results and Discussion

Student Profile

After completing the E-LAPD materials on chemical reaction equations and chemical reaction balancing to determine their learning profiles, students with intellectual impairments were interviewed to gather qualitative data for this study. The interview results were analyzed using Nvivo software, so that the data could be systematically categorized into four main aspects, namely (i) Clarity or completeness of the material, (ii) Ease of use of E-LAPD, (iii) Understanding of concepts, and (iv) the appearance of E-LAPD. This analysis shows that the learning profiles of students with intellectual disabilities tend to be dominated by visual learning styles.

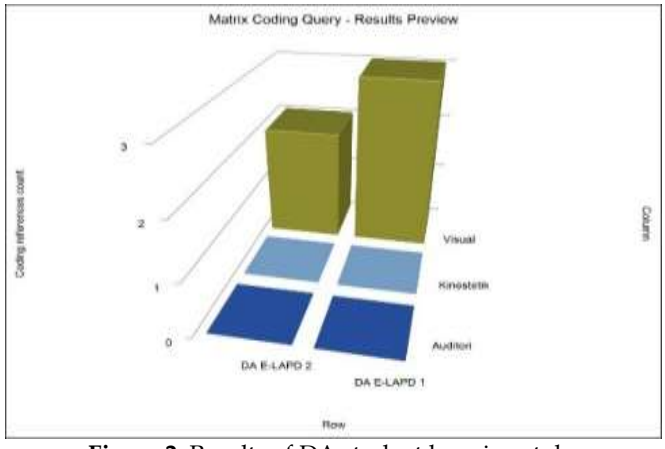

Figure 2. Results of DA student learning styles

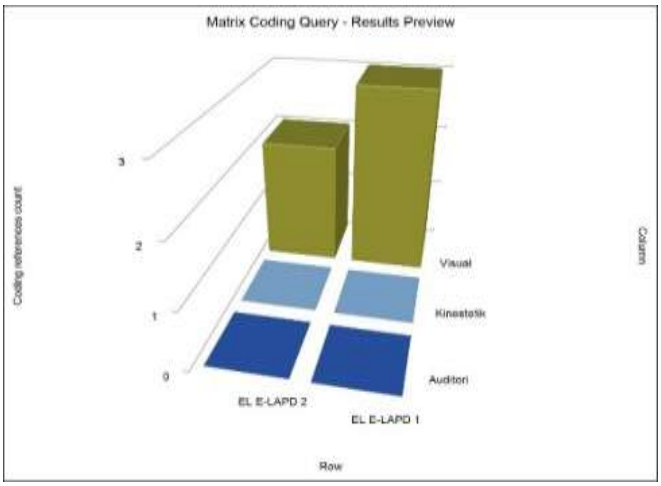

Figure 3. Results of EL student learning styles

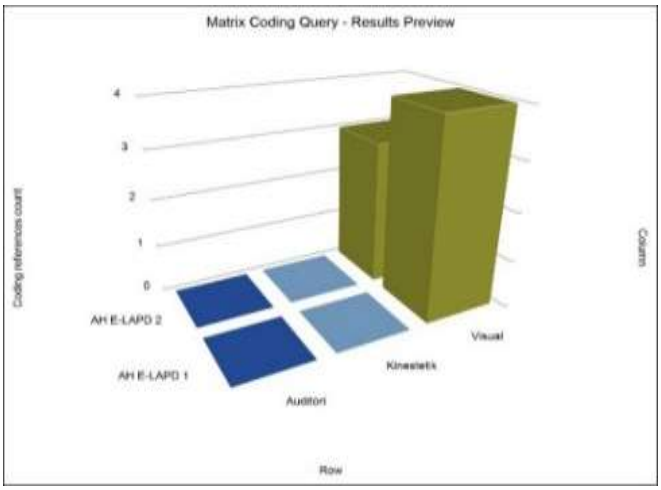

Figure 4. Results of AH student learning styles

Regarding the clarity and completeness of the material, students stated that the material presented through E-LAPD, including chemical reaction equations and balancing chemical reactions, was more explicit than conventional explanations. They found the presence of images, symbols, and colors helpful, emphasizing the content. Students with intellectual disabilities found it easier to understand the steps for balancing chemical reactions and equations when accompanied by visual examples, rather than verbal explanations.

Furthermore, in terms of the ease of use of E-LAPD for chemical reaction equations and chemical reaction balancing, students reported that it was easy to use because the display was simple and the instructions were clear. They were interested in working on the questions because of the attractive visualization.

Furthermore, conceptual understanding showed that students with intellectual disabilities improved after using Liveworksheet-based E-LAPD. Although they still had difficulty understanding chemical symbols, they grasped concepts more easily when combined with images and visual representations. This confirms that visual learning styles are the primary pathway in helping them connect abstract symbols with concrete examples.

Finally, regarding the E-LAPD's visual appearance, the attractive visuals for chemical equations and chemical reaction balancing were important factors that encouraged learning motivation. The colorful icons and interactive design made students with intellectual disabilities more comfortable and enthusiastic when working on the problems. For students with Attention Deficit Hyperactivity Disorder (ADHD), the varied displays also helped them maintain attention longer. Overall, the visual display serves as both an aesthetic element and a primary stimulus that suits their visual learning style.

Learning Outcomes

In this study, quantitative analysis showed an increase in the learning outcomes of three students with intellectual disabilities after using the Liveworksheet-based E-LAPD as a learning tool. The scores obtained were higher on the posttest than on the pretest, indicating improved conceptual understanding.

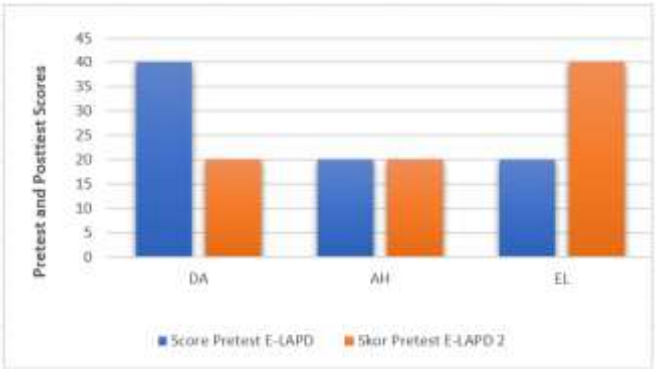

Figure 5. Pretest and posttest scores

Table 2. Pretest Score

Name	Pretest Score		
	E-LAPD Chemical reaction equations	E-LAPD Balancing of chemical reactions	Total
DA	40	20	60
AH	20	20	40
EL	20	40	60

Table 3. Posttest Score

Name	Posttest Score		
	E-LAPD Chemical reaction equations	E-LAPD Balancing of chemical reactions	Total
DA	60	40	100
AH	60	40	100
EL	60	40	100

The diagram compares three students' pretest and posttest scores (DA, AH, and EL). All students have an intellectual disability, with DA experiencing ADHD complications. For the student named DA (intellectual disability with ADHD) who had a pretest score of 60, in the pretest of the chemical reaction equation material he got a score of 40, and in the pretest of the chemical reaction balancing material he got a score of 20. After learning using Liveworksheet-based E-LAPD and then taking the posttest, the score obtained increased to 100, with an increase of 40 points, where in the posttest of the chemical reaction equation material he got a score of 60 and in the posttest of the reaction balancing material he got a score of 40. Despite having obstacles in focusing on learning due to ADHD, DA still showed significant improvement after using E-LAPD.

For the student named AH (intellectual disability) who had a pretest score of 40, in the pretest of the chemical reaction equation material he got a score of 20, and in the pretest of the chemical reaction balancing material he got a score of 20. After learning using Liveworksheet-based E-LAPD and then taking the posttest, the score obtained increased to 100, with an increase of 60 points, where in the posttest of the chemical reaction equation material he got a score of 60 and in the posttest of the reaction balancing material he got a score of 40 — AH obtained the most significant increase among the three students. The low initial score indicates initial limitations in understanding the material, but after using the Liveworksheet-based E-LAPD, understanding increased sharply to reach the maximum score.

Students with the name EL (intellectual disability) had a pretest score of 60; in the pretest of the chemical reaction equation material, she got a score of 20, and in the pretest of the chemical reaction balancing material, she scored 40. After learning using Liveworksheet-based E-LAPD and answering the posttest questions, the score obtained increased to 100, with an increase of 40 points. However, EL scored 60 on the posttest on chemical reaction equations and 40 on the posttest on chemical reaction balancing. EL was able to achieve the maximum score on the posttest with a relatively high improvement, just like DA.

These findings show that E-LAPD based on Liveworksheet greatly enhances the comprehension of chemical concepts by students with intellectual impairments. With a posttest score that was 60 points higher than the prior pretest score, AH showed the most improvement. According to Cinquin (2019), this adds credence to the idea that students with intellectual impairments might benefit from interactive digital learning materials that lower learning obstacles.

These results are consistent with earlier studies that demonstrate how interactive digital media may enhance students with special needs' motivation and academic performance (Hurwitz & Schmitt, 2020). The Individualized Education Learning Strategy, which allows each student to learn based on their needs and skills, is also supported by this method.

Conclusion

Based on the results of the study, the application of E-LAPD based on Liveworksheet proved to be effective in improving the learning outcomes of students with intellectual disabilities in the subject of chemical equations and reactions. This effectiveness was demonstrated by an increase in pre-test and post-test scores and qualitative analysis findings that revealed that students had a dominant visual learning style. The visual-based interactive media used in E-LAPD was able to improve students' conceptual understanding, learning focus, and motivation during the learning process, making learning more accessible and meaningful for students with special needs. These findings have important implications for chemistry teaching practices for students with intellectual disabilities, particularly regarding the need to use media that aligns with their learning profile characteristics. However, this study has limitations in terms of the limited number of subjects and the narrow scope of the material, so the results cannot be generalized widely. Therefore, further research could expand the number of students, extend the duration of the intervention, and develop more adaptive E-LAPD features such as the addition of supporting audio or gamification to further optimize the learning experience of students with intellectual disabilities.

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Author Contributions

This article was written by five authors, namely J. S. A., S., R. F. S., I. K. A., and D. N. All authors worked together in carrying out each stage of the article writing.

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Conflicts of Interest
The authors declare no conflict of interest.

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