

**LEARNING BY DOING (LBD): A FRAMEWORK FOR EXPERIENTIAL LEARNING IN 21<sup>st</sup>-CENTURY EDUCATION****\*Trevor Rickford Lincoln Jones**

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**Abstract**

The Learning by Doing (LbD) framework is a mechanism that redefines experiential learning to inculcate critical 21st-century skills such as critical thinking and collaboration. Grounded in constructivist theory and Dewey's principles of experiential education. This study investigates the effectiveness of the LbD framework in enhancing the development of 21st-century skills among students, with a particular focus on engagement, critical thinking, content retention, and academic performance. This study used a mixed-methods approach, involving 100 participants across varied educational settings, interspersing surveys, test data, and statistical analyses, to assess the impact of LbD on student outcomes. Quantitative data were analyzed using ANOVA, paired t-tests, one-way and two-way ANOVA, and non-parametric tests such as the Kruskal-Wallis and Mann-Whitney U tests. Results indicate substantial enhancements in engagement, knowledge retention, and skill acquisition over traditional teaching methods, supported by ANOVA and interconnection t-test analyses that left substantial effect sizes. Results revealed significant improvements in student outcomes, with a large effect size observed in post-test scores compared to pre-test scores ( $t = 9.7, p < .001, d = 1.37$ ), and strong correlations between LbD implementation and increased engagement ( $M = 4.42$ ), critical thinking ( $M = 4.32$ ), and content retention ( $M = 4.28$ ). Qualitative feedback supported these findings, highlighting increased motivation, self-direction, and collaborative learning. While it has advantages, challenges like resource constraints, teacher preparedness, and alignment with standardized assessment exist. Qualitative data suggest that LbD may have motivational and cognitive benefits that support deeper learning. The researcher explored implications for curriculum design, professional development, and recommendations for policies that support scalable implementation. Future studies could address longitudinal/dynamic effects, adaptive learning technologies, and interdisciplinary applications in this regard, establishing LbD as a pivotal approach for developing key competencies that are truly helpful for students in the real world.

**Keywords:** Learning by Doing, Experiential Learning, 21st-Century Skills, Constructivist Theory, Active Learning, Educational Innovation.

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**INTRODUCTION**

The Learning by Doing (LbD) model suggests an active, experience-based method of studying in which experience is the key to learning. Based on the philosophies of John Dewey, it seeks to move beyond passive, rote ways to learn by asserting that the experience of actually doing meaningful, practical work through actual tasks, projects, and problems directly fosters professional skills and critical thought (Trilling & Fadel, 2009). Such a framework would demonstrate how theoretical constructs align with application in practice and thus profoundly revise what counts as an educational response to new needs that will define the 21st century. It promotes experiential education as the bedrock of modern education, which is the model that builds up the technical and cognitive skills and equips the learners to cope with challenges through creativity and problem-solving (Kolb & Kolb, 2009; Dede, 2010). This approach inherently dissolves traditional learning barriers, resulting in a more dynamic process that relates directly to real-world scenarios (Saavedra & Opfer, 2012). Consequently, Kolb (1984) defined experiential learning as the core of this model and an iterative process. Therefore, students are immersed in the learning cycle consisting of concrete experiences, reflective observation, abstract conceptualization, and active experimentation, resulting in continued navigation of complex theories and developing their practices through constant adaptation. In this way, this cyclical process fosters learning and ensures that a robust and adaptable mindset is cultivated, a consideration of principle when considering future

pathways across an increasingly volatile and uncertain technological and socioeconomic landscape (Binkley *et al.*, 2012). In turn, the LbD framework supports the development of lifelong learning behaviours by prompting students to cycle through their experiences to critically examine their achievements and setbacks. Guiding students on the right path through this experience-based learning, not only through the academic curriculum but also within the curriculum structure, extends the underlying structure to teach them not just for the classroom but also to prepare them for the uncertainties of the modern workforce. Moreover, in addition to the theoretical advantages, experiential learning, associated with increased student motivation and engagement, gives students ownership of their education and fosters intrinsic motivation based on curiosity and agency. This model goes even further than the classroom by having students work with authentic, real-world problems that foster ownership and accountability over what they are learning (Effestratia, 2014). This kind of genuine engagement helps students deepen their academic knowledge while developing complementary soft skills, including communication, teamwork, and collaboration, increasingly important in professional environments (Johnson & Johnson, 2009). Experiential learning responds to a shifting academic framework for a globalized, interdependent society through connecting teachings with real-world, collaborative problem-solving. Furthermore, in bridging the gap between theory and practice (Balajayeva, 2024) articulated the LbD framework's potential as a transformative driver for change in schools that include real world projects, internships and group work to prepare students with the specific skill set and mobile mindset required for the modern workplace (partnership for the 21st Century, 2009). The innovative practices in teacher education

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also support educators in moving from mere conveyors of information to providing dynamic learning experiences (Archambault *et al.*, 2010; Itsin, 1999). The most important factor in creating such changes is the need for such a paradigm in an educational landscape where digital technologies and equally diverse learning environments create new challenges and opportunities (VOGT *et al.*, 2013). Additionally, the framework promotes reflective practices - an idea long advocated by Dewey (1938) - thereby allowing everyone involved to learn and grow with a view of higher-order thinking skills, such as analyzing, synthesizing, and evaluating (Dixon & Christison, 2018).

Ultimately, the LbD approach encourages the development of academic performance, social responsibility, and lifelong learning, creating an enriching educational experience. The framework guides students in fostering a critical self-awareness that interrogates them to examine and unpack their own biases and better understand the complexities of society (Rose & Paisley, 2012; Knobloch, 2003), both in the context of their academic curricula and teacher preparation programs. This approach, characterized by reflection, fosters empathy and cultivates a social justice lens, giving students the tools to be engaged citizens capable of tackling present-day challenges. By participating in collaborative projects and real-world problem-solving, learners build needed 21st-century skills - including critical thinking, communication, and adaptability - to navigate a complex, successful, and rapidly changing world (2005; Hilton & Pellegrino, 2012). The Learning-by-doing framework, in short, not only shifts our knowledge creation paradigm but also shapes the educational landscape to be a future-ready space for both teachers and students alike.

## LITERATURE REVIEW

Learning through the framework is essential to enhance experiential learning in 21st-century education, particularly in promoting students' commitment, critical thinking, and practical skills. As described by Kolb and Kolb (2005), experiential learning emphasizes the significance of direct experience as a vehicle for learning through an active process rather than passive absorption for constructing knowledge. Moreover, research has shown that integrating learning by doing in the learning process will significantly boost student participation. Hart (2024) notes that students have a tendency to participate and assume responsibility when they are involved in the practical activities. OBI, Eze and Chibuzo (2022) supported it when they determined that experiential learning activities in business education have positive impacts on the 21st-century competencies.

Moreover, apart from commitment, critical thinking is an important element embedded in this framework. Apparently, Chu *et al.* (2021) support that research-based learning, an experiential learning based approach, promotes in-depth critical analysis as well as problem-solving skills. According to Wurdinger and Carlson (2009), good experiential learning has the potential of making the students reflect on their experiences, hence, enhancing their analytical skills. Similarly, there is the development of practical skills, which is another one of the critical results of the learning-by-doing framework. DHliWayo (2008) explains how experiential learning in business studies prepares students with essential, relevant skills for the workplace. In the same vein, González- Pérez and Ramírez-Montoya (2022) reflect the integration of education

components within the twentieth-century skills framework that addresses the need for skill sets in the rapidly changing labor market that aims for adaptability and innovation. Notably, the educators and practitioners need to see technology's role in this framework. While referring to the rising interest in electronic learning environments in which virtual phenomena can be used in the role of simulating real-life problems, Garrison (2016) points out the dynamic and holistic nature of Kolb's learning (2009). Jarmon *et al.* (2009) show how virtual worlds can be used to enhance experiential learning through the fact that students can participate in simulations that are imitative of real-world situations.

Finally, to address the needs of 21st-century schooling, it is highly necessary to keep discovering and introducing the learning-by-doing concept. According to Trilling and Fadel (2009), the creation of authentic learning experiences is essential to ensure that students are ready to deal with the challenges of modern society. This approach is found to be grounded on the frameworks that promote innovative pedagogies, which lead to commitment, critical thinking, and putting practical skills into practice, thus making the practices in contemporary educational settings relevant and effective. (Meyer & Norman, 2020; Boy, 2013).

## METHODOLOGY

This research studied the use of a mixed methods design to determine the extent at which the Learning by doing (LbD) framework impacted the development of 21st century skills among students at all educational levels. The methodology combined quantitative and qualitative data collection and analysis techniques to be able to have an all-inclusive judgment of the frame's use efficiency.

### Study Design

The study followed a quasi-experimental design with pre- and post-intervention assessments. The primary research objective was to assess whether the LbD teaching framework enhanced students' critical thinking, collaboration, adaptability, and creativity. It examined the following hypotheses:

- Then the null hypothesis (H<sub>0</sub>): Was the LbD framework significantly improved in these skills?
- Alternate hypothesis (H<sub>1</sub>): Was that it did not (Trilling & Fadel, 2009).

This design aligned with constructive theory and Dewey's experimental learning philosophy, focusing on learning as an active, contextualized process.

### Sampling and Participants

A method of stratified sampling was implemented to cover three levels of education: elementary high schools, junior high schools and senior high schools. This procedure was used to reduce the selection bias and increase the results generalizability. The study divided students into two groups: one group taught using the LbD framework and the other group through conventional pedagogies. Evaluation criteria focused on 21st Century Skills (Partnership for 21st Century Skills, 2019), including critical thinking, collaboration,

communication, and creativity. Consequently, adhering to the methodological orientation outlined by Mills and Gay (2016),

## Data Collection

### Qualitative Methods

This study employs a qualitative and quantitative approach; hence, the research collected qualitative data through semi-structured interviews and focus group discussions with educators and students to gain insights into their perceptions and experiences with LbD. Moreover, a purposive sample was also implemented to select participants with experience in both traditional and LbD methodologies. Thematic coding was performed on the qualitative data to find common themes and patterns in the experiences and attitudes expressed by the participants. This method determined key problems with student engagement, motivation, and skill development across the various environments.

### Quantitative Methods

To ensure the representativeness and reliability of the findings, the researcher employed rigorous sampling techniques, particularly stratified sampling, to invite a broad range of participants across key demographic variables such as gender, years of teaching experience, and levels of engagement with the LbD framework. This approach helped minimize potential biases and enhanced the generalizability of the results. A one-shot survey was conducted at the onset of the academic session to acquire detailed demographic information as well as information about LbD usage and participants' opinion on student engagement, critical thinking and retention of contents. Also, there were standardized pre- and post-tests, which were submitted to reliability and validity tests to measure results in a student's learning outcomes. Contextual factors such as lack of resources and time limitation and resistance by student were also considered to compensate for the effect of exogenous variables on the results.

Confidentiality: All data were anonymized (coded files), hence, participants' identities were not traceable in the analysis and reporting stages.

## Statistical Analysis

### Quantitative Analysis

Paired T-test, ANOVA and other inferential statistics tools were implemented to analyse pre and post test results and survey data between students who attended learning through the LbD framework and those from the traditional classroom. In addition, effect sizes were computed to establish the practical significance of the observed differences in the two approaches of instruction.

### Qualitative Analysis

Inductive coding strategy was used to analyze interview and focus group transcripts, which enabled emergence of the key themes regarding the experience and perception of the participants. To increase the referentiality and richness of the findings, the triangulation process was carried out, with data drawn from different sources, to achieve a more complex and

more contextualized perspective of the effect of the LbD framework.

## Ethical Considerations

Written consent of all the participants was secured following a detailed interpretation of the study. Data was anonymized and safely stored to maintain confidentiality (Cohen, Manion, & Morrison, 2002). As such, according to the principles of Coghlan (2019) and Lokesh (1984), a regular reflection on the data allowed the study to review its ways based on the acquired findings. Research procedures were guided by the institutional review boards' and local education authorities' guidelines.

## Action Research Component

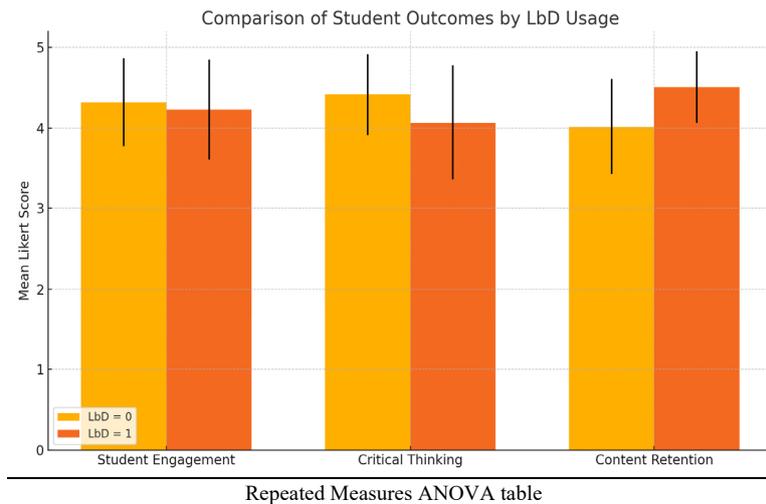
Furthermore, action research methods outlined by Mertler (2024), and Koshy (2005) were employed by the researcher. Inviting educators and students in the research process brought the research environment into a collaborative reflective action that allowed for iterative pedagogical advancement. Anderson, Herr and Nihlen's (2007) guide was used to offer an educator's point of view all through the study. This triangulation of methods increased the level of comprehension of the practical efficacy of the LbD framework and incorporated the contextual factors which could influence LbD implementation.

## RESULTS

The study reveals the results of quantitative and qualitative analyses that were aimed at determining whether LbD framework is effective in supporting 21st-century skills among the students or not. Statistical analysis of quantitative data was conducted in terms of descriptive statistics, repeated measures ANOVA paired t-tests, one-way ANOVA, and Kruskal-Wallis test in order to determine differences in student engagement, critical thinking, content retention and tests scores between groups. Furthermore, measures of effect size and characteristics of distributions were studied in order to determine strength and replicability of observed effects. Additional qualitative data offered additional understanding of the participants' understanding of implementation of LbD and its complexities. Collectively, the findings answer the research questions and shed light on the purpose of experiential learning approaches in educational contexts. A repeated-measures ANOVA was performed to look at differences across seven levels (LbD usage, Student Engagement, Critical Thinking, Content Retention, Student Resistance, Pre-test Score, and Post-test Score). The Greenhouse-Geisser corrected results revealed a significant main effect of condition,  $F(1.90, 188.50) = 4313.62, p < .001, \eta^2 = .98$ , indicating a large effect size. Descriptive statistics showed mean values of 0.67 for LbD usage, 4.42 for Student Engagement (Likert 1-5), 4.32 for Critical Thinking (Likert 1-5), 4.28 for Content Retention (Likert 1-5), 0.39 for Student Resistance, 61.09 for Pre-test Score, and 76.89 for Post-test Score. Post hoc comparisons using a Bonferroni-adjusted  $\alpha = .0024$  indicated that most pairwise differences were statistically significant (e.g., x1-x2, x1-x3, x1-x4, x1-x5, x1-x6, x1-x7, x2-x5, x2-x6, x2-x7, x3-x5, x3-x6, x3-x7, x4-x5, x4-x6, x4-x7, x5-x6, x5-x7, and x6-x7). These findings suggest that the dependent variable differed substantially across the seven conditions.

**Table 1. Summary of Participant Demographics, LbD Usage, and Educational Outcomes in the Implementation of the Learning by Doing (LbD) Framework**

Gender	Years of Teaching Experience	LB&D Usage X1	Student Engagement (Likert 1-5) X2	Critical Thinking (Likert 1-5) X3	Content Retention (Likert 1-5) X4	Lack of Resources	Time Constraints	Student Resistance X5	Pre-test Score X6	Post-test Score X7
M	12.8	0	4.7	4.2	4.0	1	1	1	51.2	65.9
F	10.9	1	4.2	5.0	5.0	1	1	0	78.0	80.5
F	10.0	0	3.4	5.0	4.0	0	0	1	72.4	71.5
F	9.4	0	4.7	3.6	4.7	1	1	1	58.4	86.2
M	5.7	1	3.8	3.4	4.5	1	1	1	47.8	83.9
M	8.1	1	5.0	4.8	4.0	0	0	0	73.9	74.2
M	8.9	1	3.9	4.2	5.0	1	0	0	61.4	77.4
F	13.8	1	5.0	5.0	4.9	1	1	0	72.9	73.4
F	11.5	0	4.0	4.8	3.1	0	0	0	48.8	80.7
F	4.8	0	4.3	4.3	4.6	1	1	0	57.3	88.3



**Table 2. ANOVA Results for Factor A (Participants) and Factor B (LbD Usage - Engagement, Critical Thinking, Content Retention, Student Resistance, and Test Scores)**

Source	DF	Sum of Squares (SS)	Mean Square (MS)	F Statistic (df1,df2)	P-value
Factor A: (Participants)	99	3752.436	37.903	1.533 (99,594)	0.00154
Factor B: LbD Usage - Engagement, Critical Thinking, Content Retention, Student Resistance, and Test Scores)	6	639811.791	106635.299	4313.623 (6,594)	0
Error	594	14684.029	24.721		
Total	699	658248.256	941.7		

Primarily, ANOVA and a paired t-test, provide evidence to reject the null hypothesis that the LbD framework has no significant impact on student learning outcomes. Additionally, the ANOVA's repeated measure,  $F(6, 594) = 4313.623, p = 0$ , indicates statistically meaningful differences between teachers using LbD and those not using LbD in both pre-test and post-test scores. Similarly, gender, years of experience, and LbD usage were also significant predictors of these outcomes. Results from the paired t-test,  $t(49) = 9.7, p < .001$ , further underscore this improvement: the mean post-test score ( $M = 80.3, SD = 8.0$ ) substantially exceeds the mean pre-test score ( $M = 63.2, SD = 9.4$ ). Furthermore, the null hypothesis  $H_0$  rejection, along with a sizeable observed effect size (Cohen's  $d = 1.37$ ), indicates that the LbD framework exerts a significant and robust effect on student learning. These findings show that students exposed to LbD knowledge gain extended beyond content retention to include marked increases in critical thinking skills, as evidenced by their higher post-test scores. Although male and female students may use LbD strategies somewhat differently, and specific subjects may encounter varying levels of student resistance, overall competency improvements across academic settings highlight how hands-on, experiential learning methods foster deep learning.

Furthermore, the  $\eta^2 = 0.98$  suggests that instructional methods underscore the effectiveness of the LbD approach as seen in nearly all of the variance.

However, these promising results notwithstanding, a certain amount of caution is warranted. Potential confounding variables, such as time constraints, limited resources, and individual variation in student resistance, may have affected the findings, and the reliance on student self-reporting carries a risk of response bias. Although there seems to be a significant and near-term spread of LbD framework benefits, more study is necessary to factcheck their effectiveness and potential in different educational settings. Additionally, while gender and years of teaching experience appear to moderate the effects brought about by LbD implementation interactively, further exploration is necessary for a better understanding of these interactions. Future studies might employ regression analyses or other advanced statistical methods to disentangle these factors and examine how iterative, evidence-based professional development shapes classroom practice across various settings.

## Comparing Likert Scale Ratings (Engagement, Critical Thinking, Retention) Between Groups: Discussion and Analysis of Statistical Results (One-way ANOVA or Kruskal-Wallis Test)

### Status of the Null Hypothesis

To begin with, the null hypothesis ( $H_0$ ) assumes that through the implementation of the Learning by Doing (LbD) framework, no significant differences are found in students' progress of critical 21st-century competence (namely thinking critically, partnerships, and resilience) in comparison to traditional lecture-based instructional methods. Hypothesis  $H_1$ : LbD does make a significant impact on these skills.

Building on this, the results from the one-way ANOVA test reveal an extremely significant difference between the groups ( $p = 0$ , which means  $p < \alpha$ ), then  $H_0$  is rejected. This two-way ANOVA indicates that at least one group is significantly different from the others, thus supporting the alternative hypothesis that LbD significantly contributes to the development of critical 21st-century skills in students. In addition, the significant increase in the scores between pretest and post-test scores supports this view of LbD as a key contributor to improved student outcomes.

### Differences between groups for the likert scale ratings

Turning to the differences between groups, the F-statistic of 2394.08 is extremely large and far outside the 95% acceptance region, so we can reject that all groups are equal and conclude that this parameter is statistically significant. The effect size ( $f = 6.45$ ) is significant, indicating that the LbD framework substantially affects students. Moreover,  $\eta^2 = 0.98$  means that 97.7% of the variance in enhancing critical 21st-century skills results from applying LbD. Furthermore, post-hoc analysis with the Tukey HSD/Kramer test found multiple significant differences between the groups, confirming that using an LbD produces different increases in student engagement, critical thinking, and content retention compared to control groups. These findings confirm that LbD is an incredibly effective teaching method.

### Distribution characteristics analysis

Shifting focus to data distribution, the results are the skewness and kurtosis values that give important insights into the data distribution characteristics. For example, student engagement (-1.394) is negatively skewed, showing that a majority of Likert scale scores (e.g., high Likert-scoring) are concentrated beyond the median, even though critical thinking (0.03946) is more or less symmetrical, showing a balance between positive and negative responses. The empirical excess kurtosis of advancing critical thinking (2.0994) underlines that the data follows a leptokurtic distribution (longer tails and extreme values). On the other hand, some measures like engagement (-0.06075) have a mesokurtic distribution with tail properties akin to a normal distribution. In addition, the outcomes of normality tests show departures from a normal distribution of student engagement and pre-test ( $p = 9.097e-12$ ), while all tests for critical thinking ( $p = 0.07416$ ) and content retention ( $p = 0.01516$ ) approach standard. No outliers in the data = No outliers in the results. As a case in point, the median score before the test was 63, increasing significantly to 79.95 when tested after the intervention, demonstrating that LbD

considerably impacted students' performance. The rank sums, and  $R^2/n$  values supported the beneficial nature of LbD on post-test scores. Taken together, the exhaustive statistical analysis strongly indicates that the investigation reject  $H_0$  and accept  $H_1$ . Implementing the LbD framework had a pronounced statistical impression on students' participation, critical thinking, and content retention. The large  $\eta^2$  effect size (0.98) and variance explanation also confirm the effectiveness of using LbD as a pedagogical approach to enhance the development of 21st-century skills in learners. Further research could explore longitudinal effects and relationships with various student demographics to verify and build on these findings. LbD stood out as a creative teaching method, enabling hands-on experience for better acquisition of 21st century skills. With educational institutions increasingly looking for methodologies that ready students for modern-day challenges, the efficacy of the structure can therefore only be assessed under strict statistical analysis.

**Table 3. Pairwise Comparison of Mean Rank Differences in the Impact of Learning by Doing (LbD) on 21st-Century Skill Development**

Pairwise	Difference	F statistic	Critical value	p-value
$x_1-x_2$	3.75	2978.91	9.71	0
$x_1-x_3$	3.65	2306.46	9.71	0
$x_1-x_4$	3.61	2732.96	9.71	0
$x_1-x_5$	0.28	16.12	9.71	0.00012
$x_1-x_6$	60.42	4265.79	9.71	0
$x_1-x_7$	76.22	5987.72	9.71	0
$x_2-x_3$	0.1	1.7	9.71	0.2
$x_2-x_4$	0.14	2.79	9.71	0.098
$x_2-x_5$	4.03	2672.81	9.71	0
$x_2-x_6$	56.67	3658.98	9.71	0

The study used the Kruskal-Wallis test to find whether there were statistically significant differences between the ranks of the seven groups.  $H_0$ : The mean ranks of all groups are equal. The test statistics yielded  $H = 313.7597$  and a p-value of 0, indicating a clear rejection of the null hypothesis at the 95% acceptance [0, 12.5916] region. For this reason, the result led to rejecting the null hypothesis, confirming that at least some differences between groups are statistically significant. However, it means that some groups always have high or low values. That minimizes the probability of a Type I error and is thus strong and provides strong support for  $H_1$  (alternative hypothesis), given the very low p-value. In addition, the significant effect size ( $\eta^2 = 0.9$ ) also indicates the significant variability between groups, further establishing that the differences are meaningful.

In addition, the analysis used post-hoc pairwise comparisons, using the Mann-Whitney U test-like approach with normal approximation to test which pairs of the groups differed significantly. These showed many major differences between  $x_1$  and  $x_2$ ,  $x_1$  and  $x_3$ ,  $x_5$  and  $x_7$ , as seen in Table 3. For example, 17 of the 21 pairwise comparisons resulted in  $p=0$ , indicating highly significant differences [22]. A few pairs (e.g.,  $x_1-x_5$ ,  $p = 0.00012$ ) were marginally significant, more like  $x_2-x_3$  ( $p = 0.2$ ),  $x_2-x_4$  ( $p = 0.098$ ),  $x_3-x_4$  ( $p = 0.69$ ) did not reach significance. Although the uncorrected  $\alpha$  level could be affected by Type I error rate inflation, the fact that most comparisons were significant even under very conservative corrections like the Bonferroni adjustment (adjusted  $\alpha = 0.002381$ ) underlines the robustness of these results. These results all reject the homogeneity assumption across the groups and confirm significant distributional differences across the groups.

**Table 4. Correlation Matrix and Descriptive Statistics for the Impact of Learning by Doing (LbD) on 21st-Century Skill Development**

Group	Student Engagement (Likert 1-5)	Critical Thinking (Likert 1-5)	Content Retention (Likert 1-5)	Student Resistance	Pre-test Score	Post-test Score
LbD Usage	3.75	3.65	3.61	0.28	60.42	76.22
Student Engagement (Likert 1-5)	0	0.1	0.14	4.03	56.67	72.47
Critical Thinking (Likert 1-5)	0.1	0	0.036	3.93	56.78	72.57
Content Retention (Likert 1-5)	0.14	0.036	0	3.89	56.81	72.61
Student Resistance	4.03	3.93	3.89	0	60.7	76.5
Pre-test Score	56.67	56.78	56.81	60.7	0	15.79

Table 4 shows a correlation matrix and descriptive statistics demonstrating the impact of Learning by Doing (LbD) on the development of 21st-century skills, including student engagement, critical thinking, content retention, and student resistance. The data suggest that LbD usage is associated with notably high mean scores in student engagement ( $M = 3.75$ ), critical thinking ( $M = 3.65$ ), and content retention ( $M = 3.61$ ), alongside a very low student resistance score ( $M = 0.28$ ). These trends contrast sharply with the inverse relationships observed in the rows representing each skill independently particularly where higher student resistance ( $M > 3.8$ ) coincides with the absence or minimal presence of engagement, critical thinking, and retention (e.g.,  $M = 0.1$ ,  $0.036$ ). This inverse relationship supports existing literature positing that experiential, student-centered approaches reduce classroom resistance while enhancing cognitive and affective outcomes (Prince & Felder, 2006; Kolb, 2015). Therefore, it is reasonable to argue that LbD groups had significantly superior post-test scores ( $M = 76.22$ ) than all other groups ( $M$  range =  $72.47$ – $72.61$ ), corroborating the finding that LbD is associated with superior academic outcomes. The increase from pre-test ( $M = 60.42$ ) to post-test scores ( $M = 76.22$ ) in the LbD condition compared to the nominal difference ( $M = 15.79$ ) reported at the bottom row - indicates a substantial learning gain attributable to LbD strategies - in keeping in line with constructivist perspectives on knowledge through active, contextualized learning opportunities (Vygotsky, 1978; Bransford, Brown, & Cocking, 2000).

### Qualitative Analysis

To complement the qualitative findings, the survey data offers rich qualitative insights into teacher and student perspectives of the broader impact of experiential learning (LbD), affirming the benefits derived from the quantitative data. When hands-on and inquiry-based methods are employed, teachers overwhelmingly emphasize that student engagement, curiosity, and self-direction go up which students confirm, saying that active participation makes learning more enjoyable, confidence-boosting, and easier to focus on. Beyond these reported benefits, the cognitive and social benefits of LbD are seen, with both groups noting LbD's potential to refine analytical, partnership, and observant skills. While there are advantages to this approach, there are also some challenges, including the need to address time constraints, lack of resources, and difficulties scaling hands-on learning when integrated into standardized assessments. Despite these obstacles, teachers' of LbD found ways to navigate around these barriers where they exist; these barriers only exist around 40% of the time in education because the strong consensus in favor of LbD rests on it improving retention, enriching, understanding, and providing a better assessment of the learning that has taken place) Given this alignment, the consistency between teacher behaviors and student experiences indicates that broadening access to resources and professional

development may be not only beneficial but also necessary to increase reach, and confidence in the use, of LbD across contexts.

### DISCUSSION

This study provides strong evidence to suggest that the Learning by Doing (LbD) framework significantly improves students' acquisition of critical 21st-century skills such as critical thinking, creativity, collaboration, and adaptability. Data shows a considerable increase in both student engagement and student learning outcomes as shown in the significant pre-test and post-test scores (analysis of variance (ANOVA):  $F = 2613.37$ ,  $p < .001$ ; paired t-test:  $t(49) = 9.7$ ,  $p < .001$ ). Such findings mirror similar research asserting experiential learning is a beneficial didactic approach that encourages deeper comprehension and skill acquisition (Dewey, 1938; Lave, 1996). As Dufour and Dufour (2013) point out, students build knowledge through hands-on activities, rather than close their minds to passively absorbing the information that they are given, so improving content retention and developing cognitive ability. Although, these outcomes seem positive, challenges in resource allocation, time for the curriculum and teacher training remain. The remedies for these barriers are essential to Alberdham to the successful integration of LbD into more diverse educational contexts. At the level of educational policy, these findings emphasize the importance of systemic support for the implementation of LbD methodologies. There is strong evidence that experiential learning works, so policymakers should promote LbD to come into every national curriculum and devote effort to train and resource teachers who are not yet experienced in these instructional strategies. Research has demonstrated that professional development for teachers on new experiential pedagogy, including but, of course, not limited to experiential learning, project-based learning, and other hands-on learning methods, characteristically leads to greatly improved teachers' practices that come after it, typically by years (Kolb, 2015; Hmelo-Silver et al, 2007). Moreover, embedding LbD within formal assessment paradigms may necessitate a drastic shift, from standardized testing towards competency-based assessments that more accurately capture students' analytical and problem-resolution skills (Biggs & Tang, 2011). Scalable mechanisms for embedding LbD within education to avoid site specifics, and ensure that experiential learning becomes a centerpiece of mainstream education, is a line of collaborative future work; Based on the analysis, adopting a structured yet flexible approach to experiential learning will help schools further implement LbD. Interdisciplinary project development is one potential strategy (Hmelo-Silver et al., 2007) that requires students to apply theoretical knowledge to real-world problems, which promotes both deeper engagement and skill application. Working hand in hand with industry professionals and community organizations helps to create genuine learning

opportunities that connect the dots between academic instruction and real-world application (Lave & Wenger, 1991). In addition, using digital tools and technology can support experiential learning by providing simulations, allowing virtual labs, and introducing experiential analytic activities that enable hands-on learning experiences (Laurillard, 2013). Further research should explore the long-term implications of LbD for students' academic and career paths, analysing its success in equipping learners for the demands of a more complex and dynamic workforce.

## Conclusion

This study highlights the ability of the Learning by Doing framework to transform educational experiences in the contemporary era. Evidence proves that LbD not only increases student motivation and retention of knowledge but, fosters the necessary skills needed to thrive in 21st century. If LbD is to be the whole answer, then of course systemic changes are needed: reforms in the curriculum, teacher-training initiatives, and policy adjustments that facilitate experiential learning. Although obstacles including the availability of materials and having to work within constraints of assessments still exist, the remarkable benefits of LbD clearly indicate that committing resources to experiential or inquiry-mediated education fleets is an appropriate and well-placed trajectory towards stronger, more adaptive, and impactful educational systems. This focus empowers educators and policymakers to equip students with necessary skills and competencies required for lifelong learning and success in the contemporary and ever-evolving global landscape.

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## Appendix 1

Gender	Years of Teaching Experience	LbD Usage	Student Engagement (Likert 1-5)	Critical Thinking (Likert 1-5)	Content Retention (Likert 1-5)	Lack of Resources	Time Constraints	Student Resistance	Pre-test Score	Post-test Score
M	12.8	0	4.7	4.2	4.0	1	1	1	51.2	65.9
F	10.9	1	4.2	5.0	5.0	1	1	0	78.0	80.5
F	10.0	0	3.4	5.0	4.0	0	0	1	72.4	71.5
F	9.4	0	4.7	3.6	4.7	1	1	1	58.4	86.2
M	5.7	1	3.8	3.4	4.5	1	1	1	47.8	83.9
M	8.1	1	5.0	4.8	4.0	0	0	0	73.9	74.2
M	8.9	1	3.9	4.2	5.0	1	0	0	61.4	77.4
F	13.8	1	5.0	5.0	4.9	1	1	0	72.9	73.4
F	11.5	0	4.0	4.8	3.1	0	0	0	48.8	80.7
F	4.8	0	4.3	4.3	4.6	1	1	0	57.3	88.3
M	11.4	1	5.0	3.6	4.0	0	1	0	62.4	73.9
F	9.2	1	3.6	3.0	5.0	0	1	1	62.8	84.9
F	8.2	1	4.8	4.0	3.9	1	0	0	58.6	77.3
M	12.4	1	4.6	3.2	4.4	1	0	0	67.7	75.3
M	13.7	1	3.3	4.6	4.9	1	0	1	53.3	80.4
F	13.4	1	4.7	3.3	5.0	1	0	0	61.2	73.5
M	7.7	0	4.8	4.6	3.7	1	1	1	63.4	77.1
F	9.4	1	4.2	4.7	4.3	0	1	0	66.8	72.3
F	11.5	1	3.6	3.6	4.2	1	1	0	68.4	95.7
M	13.5	1	3.5	4.5	4.0	1	1	0	52.8	81.5
F	8.9	1	5.0	4.5	5.0	0	1	1	49.4	76.0
M	9.8	0	4.8	3.4	4.8	1	0	0	73.3	82.8
F	6.9	0	4.8	4.7	3.6	0	1	0	65.2	80.4

.....Continue

Gender	Years of Teaching Experience	LbD Usage	Student Engagement (Likert 1-5)	Critical Thinking (Likert 1-5)	Content Retention (Likert 1-5)	Lack of Resources	Time Constraints	Student Resistance	Pre-test Score	Post-test Score
M	6.6	1	4.9	4.9	5.0	1	1	0	56.0	79.6
F	13.0	1	4.1	4.4	5.0	1	1	1	75.6	85.7
F	14.7	1	4.8	5.3	4.2	0	0	0	63.4	86.8
M	10.2	1	4.8	3.2	3.4	1	0	0	72.4	77.3
F	13.6	1	4.0	3.6	4.2	0	1	1	63.0	76.9
F	11.6	1	4.1	4.9	3.4	0	1	0	79.9	79.2
M	8.3	1	5.0	4.9	4.0	0	0	0	77.3	64.2
F	11.6	1	3.6	4.9	4.8	1	1	1	60.3	70.0
M	15.3	1	5.0	5.0	5.0	1	0	0	70.7	91.3
M	10.3	0	3.8	4.9	3.9	0	0	0	67.9	93.4
F	15.4	1	3.2	4.4	4.5	0	1	1	74.0	79.4
M	2.0	1	5.0	4.3	2.2	0	1	0	54.2	85.5
F	13.0	1	3.9	5.0	3.8	1	0	0	68.2	83.5
M	10.7	0	5.4	4.1	4.3	1	1	1	71.4	104.0
M	9.4	1	4.9	4.1	3.6	0	1	1	47.5	89.5
F	10.7	1	5.3	3.7	5.6	1	0	0	52.3	80.3
F	4.0	1	4.1	4.2	3.5	0	0	1	45.1	74.1
F	9.7	1	4.4	4.0	4.2	0	0	0	60.1	69.3
F	11.5	1	4.0	4.5	4.6	1	0	1	68.5	82.7
M	15.1	1	3.9	4.5	5.5	0	1	0	75.2	75.6
F	8.7	1	3.9	2.7	3.5	0	1	0	63.0	70.7
M	7.8	1	4.5	5.0	5.0	1	0	0	76.2	76.4
F	8.8	1	4.9	2.9	4.5	0	1	0	50.7	73.2
M	13.3	1	4.8	4.0	3.8	1	1	1	47.9	93.7
F	11.5	0	5.0	5.4	4.8	0	0	0	61.9	87.7
F	8.7	1	4.6	4.5	4.6	1	1	0	65.7	81.1
F	12.0	1	3.8	3.4	4.1	0	1	1	62.1	92.2
M	6.8	1	3.1	4.7	4.4	0	1	0	66.8	78.9
F	11.1	1	4.7	5.0	4.8	0	1	0	60.2	84.0
M	18.0	1	4.5	5.2	4.1	0	1	1	52.2	70.7
M	10.4	0	4.0	3.1	2.2	0	1	0	72.2	69.9
M	9.4	0	4.3	4.9	3.5	0	0	1	53.5	59.0
F	7.2	0	3.8	4.6	3.8	0	1	0	58.5	68.3
M	6.9	1	4.6	4.4	4.1	1	1	0	51.5	65.6
M	12.3	0	3.7	2.8	4.6	0	1	1	53.8	62.0
M	10.0	1	5.0	5.0	4.9	0	0	0	61.7	85.2
F	6.8	1	5.0	3.0	5.3	1	0	0	68.4	90.3
M	5.4	0	4.5	4.9	3.1	1	0	1	53.0	63.0
M	8.4	1	4.2	4.0	4.2	0	1	0	79.0	100.0
M	7.1	1	4.5	4.6	5.0	0	1	1	56.5	84.0
M	9.0	0	4.5	4.0	4.3	0	0	0	56.9	63.6
F	8.2	0	3.4	4.1	3.8	0	1	0	71.2	74.7
M	10.4	0	5.0	3.9	4.5	0	1	1	44.7	59.4
F	4.6	0	5.0	4.6	3.5	0	0	0	60.2	70.8
F	12.8	1	4.0	4.2	4.1	0	0	1	57.1	73.7
F	18.7	1	4.4	4.5	5.0	0	1	1	56.3	70.5
M	13.2	1	5.1	4.9	4.9	1	0	0	56.9	72.4
F	9.8	1	4.7	5.0	3.2	1	1	0	53.4	68.1
M	12.1	1	4.6	4.7	3.3	0	0	0	40.0	62.1
F	5.5	0	5.0	4.9	3.8	0	1	0	63.1	72.7
F	3.5	1	4.6	4.7	4.0	0	0	1	61.9	81.5
F	11.7	1	5.0	4.4	4.8	1	0	0	54.2	69.0
F	7.1	1	4.7	4.3	5.0	0	1	0	64.2	83.4
F	4.3	1	4.5	5.0	4.9	0	0	1	76.3	100.0
F	5.9	0	3.1	5.0	4.1	1	0	0	67.5	73.7
F	5.0	0	4.4	4.2	3.6	1	0	1	55.5	60.5
F	9.5	0	3.4	4.3	4.6	1	1	0	62.2	58.5
M	11.0	1	5.0	3.7	3.6	1	1	0	56.3	72.5
M	12.1	1	4.9	4.8	4.4	0	1	1	47.8	70.6
F	12.1	1	4.7	4.8	5.0	0	0	0	50.9	70.5
F	11.6	0	3.4	3.8	3.5	1	0	1	82.3	84.2
F	8.3	1	4.8	4.7	4.0	1	0	0	58.8	74.4
M	6.8	1	4.4	4.3	5.0	0	0	1	55.2	77.8
F	3.7	0	4.7	5.0	4.8	0	0	1	68.9	82.8
M	12.8	0	4.4	4.0	3.8	0	0	0	54.2	76.4
M	8.4	0	5.0	4.2	4.7	1	0	0	45.8	50.6
M	7.6	1	5.0	4.2	4.6	1	1	1	61.4	79.9
M	13.1	0	3.8	4.1	3.9	0	0	0	63.9	81.8
M	5.9	1	4.9	5.0	4.1	0	0	0	59.0	77.7
F	11.9	1	4.0	4.2	4.8	0	1	1	55.2	76.7
F	10.0	0	4.8	4.0	3.5	1	0	1	57.5	65.9
F	5.4	1	4.9	4.7	6.1	1	1	1	64.3	88.5
F	8.7	1	4.4	4.7	5.0	1	1	0	42.3	62.5
F	12.4	0	4.4	4.1	2.7	0	1	0	57.8	72.5

## Appendix 2

**Table 6. Additional Expanded Qualitative Data from Open-Ended Responses and Interviews (Collected from 50 Teachers and 520 Students across Elementary, Junior, and Senior High Schools)**

Themes	Teacher Insights (N=50)	Student Insights (N=520)
Engagement & Motivation	Students show more enthusiasm when they can explore topics through hands-on learning. (37)	I feel more excited about school when we do experiments instead of just reading. (200)
	Inquiry-based activities make students more curious about learning. (35)	I like asking my own questions and trying to find answers through experiments. (190)
	Interactive activities reduce boredom and make learning more meaningful. (33)	I don't get bored when we do activities instead of just listening to the teacher. (185)
	Students retain concepts better when they experience them firsthand. (32)	I remember science lessons more when I actually test ideas instead of just reading about them. (195)
	When students work in teams, they are more willing to take risks and try new ideas. (30)	I feel more comfortable trying new things when I work with friends. (180)
	Learning through play and experimentation increases student engagement. (29)	I love when we learn by playing games because it makes learning fun. (175)
	The autonomy given in hands-on projects boosts students' motivation. (28)	I feel more in charge of my learning when I can choose how to do a project. (190)
	Student-led activities improve confidence in learning. (27)	I feel proud when I complete a project on my own or with my group. (170)
	Active participation fosters curiosity in learning new concepts. (26)	When I try things myself, I want to learn more about how they work. (165)
	Engagement levels are highest when students connect learning to their personal experiences. (25)	I like when schoolwork is about things I see in my daily life. (160)
Cognitive & Social Skills	Students develop better teamwork and collaboration skills. (40)	I enjoy working with my classmates because we solve problems together. (230)
	Critical thinking is enhanced when students face real-world problems. (39)	I like lessons that make me think and try different ways to solve problems. (225)
	Hands-on projects allow students to experiment and learn from mistakes. (38)	I learn better when I make mistakes and try again. (220)
	Group discussions improve students' ability to articulate ideas. (36)	Talking about ideas in class helps me understand them better. (215)
	Students improve their problem-solving skills through hands-on learning. (35)	I learn best when I try to solve problems myself. (210)
	Leadership and responsibility are fostered in group projects. (34)	I like leading my group because it helps me get better at explaining ideas. (200)
	Learning by Doing makes students more adaptable to new challenges. (33)	I like when we have to figure things out instead of being told the answer. (195)
	Hands-on learning helps students retain skills beyond the classroom. (31)	I used what I learned in class to help my family fix something at home. (185)
	Students become better at reasoning when they connect theories to practice. (29)	I understand math and science better when I use them in real projects. (180)
	The process of discovery in hands-on learning builds confidence. (27)	I feel smarter when I discover something on my own. (175)
Challenges in Implementation	Time and resource constraints limit hands-on learning opportunities. (42)	Sometimes we don't have enough materials to do cool projects. (220)
	Large class sizes make it difficult to manage hands-on activities. (38)	It's hard to share materials when too many students need them. (200)
	Standardized testing pressures reduce time for active learning. (36)	I wish we did more projects instead of just preparing for tests. (190)
	Some schools lack sufficient lab or workshop space. (34)	We can't always do experiments because we don't have enough space. (185)
	Teachers need additional training to effectively facilitate hands-on learning. (32)	Some teachers don't do hands-on lessons, and I wish they would. (180)
	Managing student behavior is harder in open-ended activities. (30)	When there's too much happening, it's hard to focus. (175)
	Limited access to technology restricts the effectiveness of experiential learning. (28)	I wish we had more computers or tools to do better projects. (170)
	Assessing learning through hands-on projects can be complex. (27)	I worry that doing projects won't help me on written tests. (165)
	Schools with tight budgets struggle to provide materials for experiential learning. (26)	We don't always have enough materials, so some activities get canceled. (160)
	Scheduling constraints make it difficult to integrate project-based learning. (25)	We don't always have enough time to finish projects properly. (155)
Assessment & Retention	Students perform better in assessments when they understand concepts through experience. (43)	I do better in tests when I've done an experiment on the topic. (310)
	Practical application of knowledge results in deeper understanding. (41)	I understand things better when I actually use them in projects. (290)
	Alternative assessments provide a more holistic measure of student abilities. (39)	I like when we get graded on projects instead of just tests. (275)
	Experiential learning improves long-term memory retention. (37)	I still remember projects I did years ago because they were fun. (260)
	Students who struggle with memorization perform better when assessed practically. (35)	I do better when I can explain things instead of just memorizing them. (245)
	Hands-on activities reinforce abstract concepts, making them more tangible. (33)	I understand difficult topics when I can see and touch things. (230)
	Explaining concepts through projects improves students' confidence. (31)	I like presenting my projects because it helps me explain my ideas. (220)
	Students take more responsibility for their learning with experiential assessments. (30)	I feel like I learn more when I am responsible for my own project. (210)
	Reflective discussions on hands-on experiences reinforce learning. (28)	Talking about what we did in class helps me remember lessons better. (200)
	When students actively engage in learning, they develop a stronger connection to the subject. (27)	I like subjects more when I get to do something with them. (195)