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Fostering Self-Directed Learning through Local Wisdom Project-Based Learning

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Abstract

Purpose
This study aims to enhance the efficacy of Local Wisdom Problem-Based Learning (LWPBL) in fostering students' Self-Directed Learning (SDL). The PjBL elements proposed by Larmer and Mergendoller include Providing a problem, Involvement in the inquiry process, Authenticity, Students' Voice, Reflection, Critique and Revision, and Public Product were adopted.

Methodology
To accomplish the research goals, questionnaires were employed as the primary means of data gathering and disseminated to a sample of 100 students from four public high schools in South Sulawesi, who were taught using the LWPjBL method in their English class. The samples were chosen using the quota sampling technique. Garrison's model of the Self-Directed Learning Aptitude Scale (SDLAS) was used to measure the student's aptitude for SDL. The data were analyzed using Partial Least Squares (PLS).

Results/Findings
The findings of this study indicated that the eight elements mentioned above, have a favorable impact on students' SDL. The result of data analysis indicated that 98% of the eight elements could explain the influence on students' SDL.

Implications
The LWPjBL is strongly recommended for teachers, particularly those teaching English in high schools, to enhance the student's learning experience and SDL.

Keywords: Local wisdom; PjBL; ELT; SDLAS

1. Introduction

In the middle of the dynamics of modern education, enhancing student Self-Directed Learning (SDL) has emerged as one of the primary objectives in attempts to create a competent and adaptable new generation. SDL is not only to students' ability to learn independently, but also to how they manage their learning, solve difficulties, and take the initiative in their learning process (Kemp et al., 2022; Wong et al., 2021; Zhu et al., 2020). One approach that is gaining popularity is Project-Based Learning (PjBL), which uses local wisdom as a learning context.

PjBL is a teaching style that encourages students to learn by doing real-world projects (Karan & Brown, 2022; Pan et al., 2020; Puangpunsi, 2021; Rohm et al., 2021; Sanchez-Muñoz et al., 2022; Santana & de Deus Lopes, 2024). PjBL allows students to learn theory while also applying it to real-world circumstances, increasing their learning independence. PjBL allows students to explore, examine, and solve complicated problems that are relevant to their daily lives.

Local Wisdom (LW) is cultural heritage that includes values, traditions, and knowledge that originated in a specific location (Damayanti et al., 2020; Diab et al., 2022; N. A. Hidayati, Waluyo, Winarni, et al., 2020; Suastra & Pujani, 2021; Tohri et al., 2022). The use of local knowledge in learning not only enriches the material but also strengthens students' cultural identities. When students participate in local knowledge projects, they not only gain a deeper understanding of the subject topic, but they also develop a sense of responsibility for their community and environment.

One example of combining PjBL with local knowledge is a project that teaches students about traditional wedding simulation in Bugis culture. This project allows students to master the fundamentals of language use while also learning about their region's history and culture (Muskania et al., 2024; Setiawan et al., 2024; Susanto et al., 2021). This initiative teaches not only technical skills but also values like hard work, collaboration, and sustainability. As a result, students become more self-sufficient in their learning because they witness personally the benefits and usefulness of the information they acquire.

PjBL blends local wisdom and encourages students to be creative and analytical problem solvers (Hikmawati, 2023; Papilaya & Tuapattinaya, 2022; Widyaningrum & Prihastari, 2023). When students work on projects based on local contexts, they must identify specific difficulties, devise innovative solutions, and assess their efficacy. This procedure requires higher-order thinking skills, which are essential for independent learning (Awuor et al., 2022; Chu et al., 2011; Yamada, 2021). Furthermore, these projects frequently entail collaboration with community people, allowing students to benefit from others' experiences and practical expertise.

The significance of this research lies in the need to identify effective and long-term techniques for boosting student SDL. The combination of PjBL and local wisdom is a unique and relevant way to achieve this goal. This study presents not only a theoretical but also a practical contribution by demonstrating how this strategy can be used in a variety of educational settings. This research is unusual in that it takes a holistic approach, merging academic and cultural components to provide a full and useful picture for academics and educators.

2. Literature review

2.1. Self-directed learning (SDL) in English Language Teaching (ELT)

SDL is the ability of students to direct their learning process. According to Garrison, (1997) Garrison, SDL refers to external management of the learning process. In this scenario, the learners exerted considerable lot of independence in determining what is desirable to learn and how to approach the learning job. SDL allows students to create learning goals, select learning methods and resources, and assess their learning outcomes (Abduh et al., 2022; Anshu et al., 2022; Ge & Chua, 2019; Li et al., 2023; Loyens et al., 2008; Rosmayanti et al., 2022; Zhoc et al., 2018). SDL is essential in English education because it allows students to improve their language skills outside of the classroom (Lai, 2015, 2018; Lee et al., 2017; Siahaan, 2022). According to research, SDL can be promoted by encouraging students to actively participate in the learning process (Boyer et al., 2014; M. Hill et al., 2020; Lemmetty & Collin, 2020; Mamary & Charles, 2003; Robinson & Persky, 2020; Setlhodi, 2019; Sze-Yeng & Hussain, 2010). According to independently in Language Acquisition. PjBL is one way that can address this demand because it allows students to handle their projects from start to completion.

2.2. Integration of PjBL and local wisdom in English language teaching

PjBL has long been acknowledged as a successful pedagogical strategy for improving student SDL. In the context of English education, PjBL provides a fantastic opportunity to improve language skills through hands-on experience and relevant real-world projects (Karan & Brown, 2022; Pan et al., 2020; Rohm et al., 2021; Santana & de Deus Lopes, 2024; Žerovnik & Nančovska Šerbec, 2021). When PjBL is integrated with local wisdom, it not only enriches learning content but also strengthens students' cultural identities (Abduh et al., 2023; Muskania et al., 2024; Setiawan et al., 2024; Susanto et al., 2023), resulting in a more relevant and contextual learning environment. PjBL is a method for engaging students in demanding and meaningful projects that necessitate research, cooperation, and problem-solving. PjBL can be utilized in English language learning to help students improve their reading, writing, speaking, and listening abilities in a realistic setting.

According to Brooks & Kerschen (2022), PjBL promotes students to utilize the target language in real-world circumstances, which helps them understand the relevance and practical application of what they are learning. A project involving the creation of an English-language school magazine, for example, improves not only writing skills but also communication, organizational, and teamwork abilities (D. Hidayati et al., 2023; Probert, 2024; Puangpunsi, 2021; Rosmayanti et al., 2023; Sakkir et al., 2024; Yamada, 2021; Yimwilai, 2020).

Local wisdom is a community's knowledge, values, and traditions that are passed down over generations (Abas et al., 2022; N. A. Hidayati, Waluyo, & Winarni, 2020; Rosala & Budiman, 2020; Surip et al., 2021; Tohri et al., 2022). Integrating local wisdom into PjBL might improve students' learning experiences by giving a meaningful and relevant context. According to Mungmachon, (2012), incorporating local wisdom into education can help

students understand and appreciate their own culture while also developing academic and social abilities. Projects that include local wisdom in English language instruction can include activities such as creating documentary videos about local traditions, writing essays about area history, or presenting on local folklore. These programs not only improve students' language skills but also help them connect with their culture (Adiatmana & Hasan, 2022; Rosala & Budiman, 2020; Sandoval-Rivera, 2020; Saripudin et al., 2022; Suwito Eko et al., 2020). Research has demonstrated that PjBL, which incorporates local wisdom, helps promote student learning independence. For example, Madya & Ishartiwi (2018) highlighted that students engaging in local wisdom-based projects experienced significant gains in motivation and learning independence. This is because students see the initiative as relevant and meaningful.

2.3. Garrison's model of SDLAS

Garrison established the Self-Directed Learning (SDL) paradigm, which is one of the most prominent learning models in education. This concept highlights three key characteristics of independent learning: self-management, self-monitoring, and motivation (El-Fattah, 2010; Garrison, 1997b). In the context of English language learning that incorporates Project-Based Learning (PjBL) and local expertise, the Garrison SDL Model provides a solid framework for developing student learning freedom.

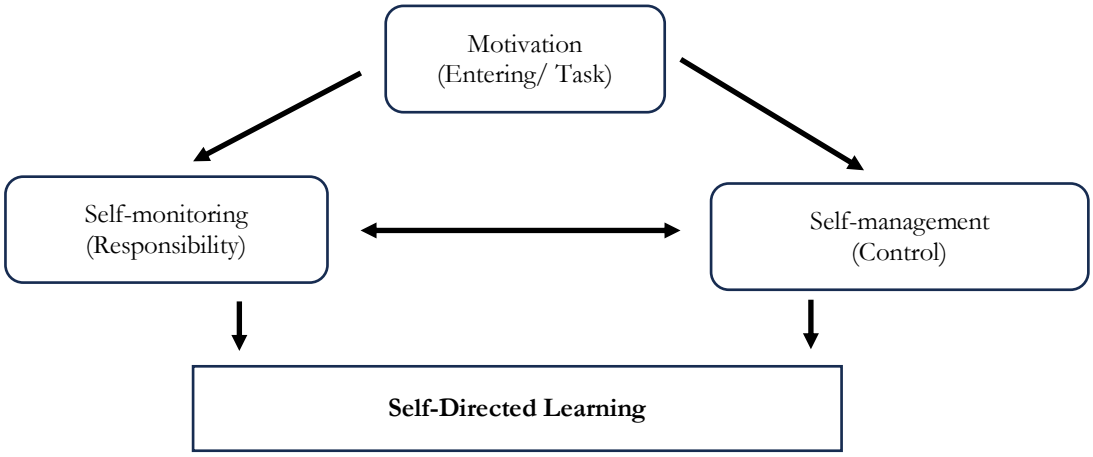

Figure 1: Dimensions of self-directed learning. Note restructured (Garrison, 1997)

Self-management refers to the ability to arrange and manage many components of the learning environment on one's initiative (Bourbeau & Effing, 2020; Eitel et al., 2020; Meng & Ning, 2021; Smith et al., 2022). Garrison (1997) underlined that self-management includes students' abilities to create learning objectives, select appropriate tactics, and organize available resources. In the framework of PjBL, students working on local wisdom-based initiatives must be able to manage their time, divide responsibilities properly, and oversee projects from beginning to end. Zhu & Doo (2022) pointed out that students with strong self-management skills are more likely to succeed in independent learning because they have control over their learning environment.

Self-monitoring entails ongoing reflection on the learning process and the adjustment of techniques in response to feedback. According to (Garrison, 1997), self-monitoring is a metacognitive part of learning that enables students to assess their progress, identify impediments, and make appropriate adjustments. In the context of PjBL, which incorporates local wisdom, students must constantly assess the development of their projects, solicit input from teachers and peers, and make changes based on these assessments. Guo (2022) highlighted that students who practice active self-monitoring are more likely to attain their learning objectives because they may change their learning strategies as needed.

Motivation: Motivation is the primary factor that keeps pupils engaged and motivated during the learning process. Garrison (1997) recognized motivation as an important factor influencing students' commitment to independent study. In PjBL, intrinsic motivation can be improved by involving students in projects that are relevant and important to them. Integrating local knowledge into projects can boost student motivation because they believe what they are learning is directly relevant to their lives and communities (Deng & Shi, 2024; Nuramalina et al., 2022; Simbolon & Koeswanti, 2020). Ryan & Deci (2020) research on Self-Determination Theory supports this viewpoint, demonstrating that intrinsic motivation increases when students perceive agency and significance in their learning (Chiu et al., 2022; Ryan et al., 2022).

2.4. Partial least square

Partial Least Squares (PLS) is a statistical tool for examining complex interactions between latent variables that cannot be directly assessed (Usakli & Rasoolimanesh, 2023; Wold et al., 2001). Herman Wold introduced PLS in the 1970s, and it has since gained popularity in fields including marketing, management, psychology, and computer science. PLS excels at handling small sample sizes and overcoming multicollinearity, which occurs when independent variables are strongly correlated. In contrast to covariance-based methods like Structural Equation Modeling (SEM), PLS aims to maximize the variance explained in the dependent variable, making it appropriate for exploratory and predictive research (Götz et al., 2009; Hair et al., 2019).

PLS employs two primary models: a measurement model (outer model), which defines the link between latent variables and their indicators, and a structural model (inner model), which specifies the relationship between latent variables themselves (Noonan & Wold, 1980; Wold et al., 2001). In reality, PLS is frequently used in marketing research to assess customer satisfaction and loyalty using variables like service quality and buy intent. In psychology and education, PLS is used to represent complex constructs including attitudes, perceptions, and motivations (do Valle & Assaker, 2016; Mohammadi et al., 2023). Meanwhile, in computer science, PLS is used for predictive modeling and pattern identification, particularly when the data contains a large number of variables and tiny samples (Ghosh et al., 2020; Shmueli et al., 2019).

However, PLS does have some limits. One of the main complaints is that PLS lacks robust statistical inference when compared to SEM (Sarstedt et al., 2020), making it more suited for prediction rather than hypothesis testing. Furthermore, PLS results might be difficult to comprehend, particularly for models with multiple latent variables and complex pathways (Rönkkö et al., 2016). Overfitting is also a concern, as PLS focuses on increasing explained variance, which might limit the model's generalizability (Shmueli et al., 2019).

Overall, Partial Least Squares is an extremely valuable tool in research scenarios involving complex data and small sample sizes. With its better flexibility, ability to overcome multicollinearity, and ability to model complex components, PLS has emerged as a significant tool for academics in a variety of disciplines. Researchers should assess the context of their research to determine if PLS is the best method for their analysis, while also being aware of its limits. Further study and development are projected to broaden the application and dependability of PLS in numerous scientific research environments.

3. Methods

3.1. Research design

This research is classified as a qualitative study since it tries to investigate the effect of Providing a problem (Pb), Involvement (I), Authenticity (Au), Students' voice (Sv), Reflection (R), Critique and Revision (CR), and Public product (Pp) towards the students' Self-Directed Learning (SDL). The participants of this study were the students of public high schools in South Sulawesi, Indonesia in the academic year of 2023/2024.

3.2. Respondents

Respondents for this study came from four state secondary schools in South Sulawesi that have been actively adopting project-based learning that incorporates local wisdom. The number of students from four schools is 1.120 consisting of 416 students from school A, 105 from school B, 234 from school C, and 365 from school D. To collect the quantitative data from the research, the researcher selected 286 students as samples following the table of sampling size by Israel (2013), with 95% confidence level and 5% precision.

The samples were selected using quota sampling technique. Quota sampling is a type of non-probability sampling where the samples are chosen based on the probability proportionate to the distribution of a variable in the population. The quota sampling was adopted due to its accuracy, it also makes the samples representative of the population in each school. The objective of quota sampling is to improve the representation of all components in the population (Moser, C & Stuart, 2014).

3.3. Procedure

In collecting the data, the researcher distributed an online questionnaire in the Google form to 1.120 respondents who are engaged with local wisdom project-based learning. The questionnaire was distributed to see the effect of Providing a problem (Pb), Involvement (I), Authenticity (Au), Students' voice (Sv), Reflection (R), Critique and Revision (CR), and Public product (Pp) towards the students' Self-Directed Learning (SDL). The questionnaire is adopted from the elements of PjBL proposed by Larmer et al. (2015) and the self-directed learning aptitude scale (SDLAS) proposed by Garrison, (1997).

The adaptation of questionnaire items was carried out to obtain the validity of the items that made up the construct of the research (construct validity). Compilation of research questionnaires based on the adaptation of items then adjusted to the research objectives. After determining the original items taken, then the items are

adjusted to the place of research. The items used in the questionnaire were 57 items consisting of 31 items from PjBL elements and 26 items for SDLAS.

The procedure for collecting data in this study consists of three stages. The first stage is to manage permits to conduct research at the South Sulawesi education office. The second stage is Asking the teachers' and students' willingness to participate in the research as a participant, and the third or the main stage is collecting the data by Administering the questionnaire to the students.

3.4. Validity and reliability

The data collected through the questionnaire were analyzed quantitatively using Partial Least Square model. The result of the questionnaires was calculated using smart PLS software as follows:

The structural model also known as the inner model describes the theoretical link between latent constructs. The framing of the problem or research hypothesis serves as the foundation for developing a structural model of the interaction between latent constructs. The measurement model, also known as the outer model, defines how each indicator block connects to its latent construct. The measurement model's design establishes the indicator qualities of each latent construct, which are dependent on the variable's operational definition.

Evaluating the outer model: There are three criteria for evaluating the outer model: convergent validity, discriminant validity, and composite reliability. The PLS-calculated correlation between item scores was used to examine the convergent validity of the measurement model using reflexive indicators. The size of a reflexive individual is classified as high if it is more than 0.70 correlated with the concept being measured. However, Ghozali (2006) states that for the early research stage of designing a loading value measurement scale ranging from 0.5 to 0.6 is appropriate. The discriminant validity of the measurement model with reflexive indicators was evaluated using cross-loading measurements. If the construct correlation with the measurement item is greater than the size of the other constructs, it indicates that the latent constructs predict the size of their blocks more accurately than the other blocks. The Composite Reliability indicator block, which maintains a construct, can be evaluated using the PLS output. Unlike the Cronbach Alpha, this measure does not require tau equivalence between measures if all indicators are weighted equally.

Evaluating the inner model or structural model with PLS began with the R-squared value for each dependent latent variable. R-squared changes can be used to determine whether the independent latent variables have a substantial effect on the dependent latent variable.

Hypothesis test (resampling bootstrapping): The bootstrap resampling method was used to test hypotheses between constructs, specifically between the exogenous and endogenous constructions (γ and β, respectively). The test statistic utilized is the t or t-test. The resampling method allows the application to be freely distributed (distribution-free), does not require the assumption of a normal distribution, and does not necessitate a huge sample size

4. Results

4.1. The description of respondents

The data description offered is intended to provide a general overview of the data distribution that was carried out in the field. This study included 286 students from four public high schools in South Sulawesi who participated in local knowledge project-based learning in their classes. The questionnaire was distributed starting June 1, 2024, and the findings were analyzed on July 19, 2020. The researcher distributed the questionnaire directly by sharing the Google form URL with the student WhatsApp group. The surveys were sent directly in order to determine the general level of response. When filling out the questionnaire, students are given the option of asking researchers directly via WhatsApp Group, which is designed to help respondents comprehend the filling system or the aim of the questionnaire. Because there is no unfinished questionnaire, the completed questionnaire meets the processing requirements.

The participants in this study consisted of 100 students from four public high schools in South Sulawesi. The respondents' characteristics encompass gender, age, and school affiliation. The characteristics of 100 responders can be identified as follows:

4.1.1 Gender

The respondents of this study were public high school students in South Sulawesi registered in the academic year 2023/2024. The respondents who were selected in this study were selected by using a quota sampling technique. The distribution of respondents can be seen in the following table:

Table 1: Respondent characteristics based on gender

Gender	Number of Respondent	Percentage
Male	437	39%
Female	683	61%
Total	1.120	100%

Table 1. shows that 39% of respondents were male and 61% of others were female respondents. It may be concluded that the majority of students who filled out the questionnaire from four schools were female.

4.1.2 Age

Respondents in this study were between the ages of 16 and 19. The following table shows the distribution of respondent characteristic data by age:

Table 2: Respondent characteristics based on age

Age	Number of Respondent	Percentage
< 16 years old	16	1%
16-17 years old	470	42%
17-18 years old	540	48%
18-19 years old	94	9%
Total	1.120	100%

Based on the characteristic data based on age in Table 2, it can be determined that the majority of respondents between the ages of 17 and 18 were 80% of the total respondents. While respondents aged 16-17 years old were 42% of the total respondents, respondents aged 18-19 years old were 9% of the total respondents, and respondents aged less than 16 years old were 1% of the total respondents. It can be concluded that the majority of students participating in the research were between the ages of 16 and 18 years old.

4.1.3 School affiliation

The students who participated in this study came from four public schools in South Sulawesi Indonesia. The schools represent the district and its culture. The distribution of respondent characteristic data by school affiliation can be seen in the following table:

Table 3: Respondent characteristics based on origin

School Affiliation	Number of Respondent	Percentage
SMA N 1 Luwu Utara	365	33%
SMAN 21 Makassar	416	37%
SMKN 5 Gowa	234	21%
SMA N 9 Jeneponto	105	9%
Total	1.120	100%

Based on Table 3, it can be seen that the respondents of this study were dominated by students from Makassar, or 37% of students. 365 or 33% of respondents were from the Luwu Utara district, 234, or 21% of respondents were from the Gowa district, and 105, or 9% respondents were from Jeneponto district.

4.2. The analysis of construct

The following constructs were analyzed using the Partial Least Square model using Smart PLS4 software. There were eight constructs to be analyzed including Providing problem (Pp), Involvement (I), Authenticity (Au), Students' voice (Sv), Reflection (R), Critic and Revision (CR), Public Product (Pp), and Self-directed Learning (SDL).

4.2.1. The construct of providing problem (Pb)

The data of the Pb construct was derived from a set of closed questionnaires consisting of 5 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 5 to a maximum of 35.

4.2.2. The construct of involvement (I)

The data of the I construct was derived from a set of closed questionnaires consisting of 6 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 6 to a maximum of 42.

4.2.3. The construct of authenticity (Au)

The data of the Au construct was derived from a set of closed questionnaires consisting of 4 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 4 to a maximum of 28.

4.2.4. The construct of students' voice (Sv)

The data of the Sv construct was derived from a set of closed questionnaires consisting of 4 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 4 to a maximum of 28.

4.2.5. The construct of reflection (R)

The data of the R construct was derived from a set of closed questionnaires consisting of 5 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 5 to a maximum of 35.

4.2.6. The construct of critic and revision (CR)

The data of the CR construct was derived from a set of closed questionnaires consisting of 3 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 3 to a maximum of 21.

4.2.7. The construct of public product (Pp)

The data of the Pp construct was derived from a set of closed questionnaires consisting of 4 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 4 to a maximum of 28

4.2.8. The construct of self-directed learning (SDL)

The data of the Pp construct was derived from a set of closed questionnaires consisting of 12 questions. The surveys used a 7-point answer choice scale, with 7 alternative answers available. The theoretical score for each questionnaire ranged from a minimum of 12 to a maximum of 84.

4.3. Data analysis

4.3.1. Inner model design

The design of the inner model of the interaction between constructs is derived from the formulation of the problem or research hypothesis. The inner model's design, created using smartPLS 4 software, is displayed in the Figure below:

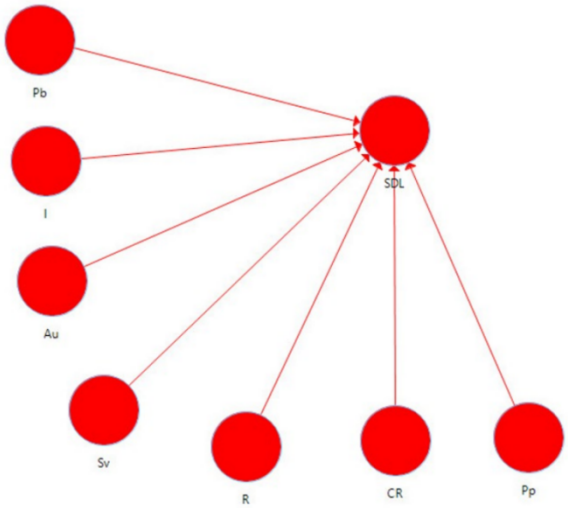

Figure 2: Inner model design

4.3.2. Outer model design

The indicators of each construct in the Pb, I, Au, Sv, R, CR, Pp, and SDL constructs on the outer model exhibit reflexivity. The arrow in the measuring model points from the construct to the indicator. The graphic below displays the outside model design created using smartPLS 4 software:

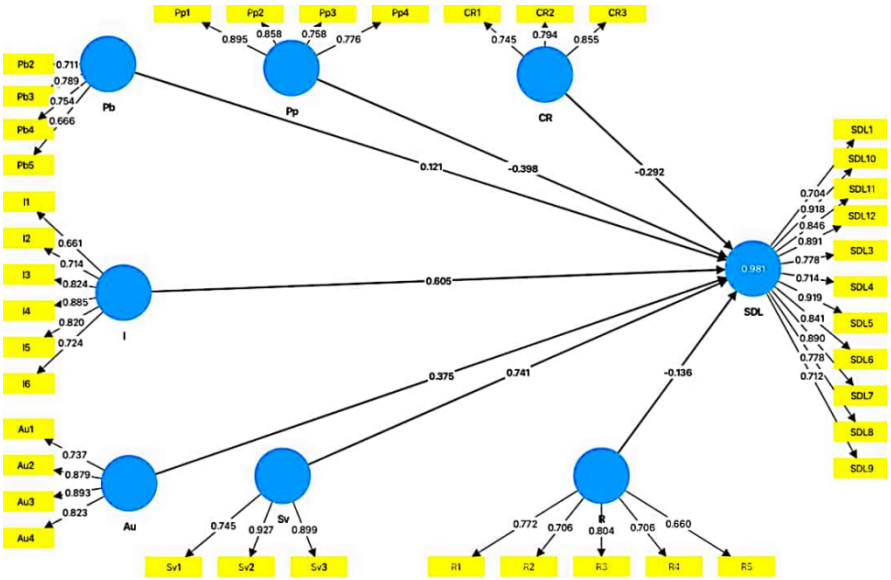

Figure 3: Outer model design

The parameter estimate approach employed in this work utilizes the Partial Least Squares (PLS) Algorithm on the smartPLS 4 software. The inclusion of measures to assess the unidimensionality of each construct through an examination of convergent validity. A high individual reflexive measure criterion is defined as having a correlation of over 0.70 with the construct being measured.

4.3.3. Model evaluation

The evaluation of both the outer model and the inner model is conducted by examining the report results generated by the PLS Algorithm.

4.3.3.1. Convergent validity

To assess the outer model using reflexive indicators, three criteria need to be considered: convergent validity, discriminant validity, and composite reliability. The convergent validity of the measuring model with reflexive indicators is demonstrated by the correlation between the score item/indicator and its concept, as indicated by the output outer loading. The output of the initial loading of the estimation results from the Partial Least Squares (PLS) Algorithm is as follows:

Table 4: The output of outer loading.

	Au	CR	I	Pb	Pp	R	SDL	Sv
Au1	0.737							
Au2	0.879							
Au3	0.893							
Au4	0.823							
CR1		0.744						
CR2		0.794						
CR3		0.855						
I2			0.723					
I3			0.836					
I4			0.892					
I5			0.833					
I6			0.732					
Pb2				0.776				
Pb3				0.753				
Pb4				0.834				
Pp1					0.895			

	Au	CR	I	Pb	Pp	R	SDL	Sv
Pp2					0.858			
Pp3					0.758			
Pp4					0.776			
R1						0.772		
R2						0.758		
R3						0.784		
R4						0.763		
SDL1							0.705	
SDL10							0.918	
SDL11							0.846	
SDL12							0.891	
SDL3							0.779	
SDL4							0.712	
SDL5							0.919	
SDL6							0.840	
SDL7							0.891	
SDL8							0.779	
SDL9							0.710	
Sv1								0.744
Sv2								0.927
Sv3								0.899

The indicator of I1, Pb1, and SDL2 have been eliminated based on the output of the outer loading. After removing the indicator with a low correlation, it is evident that the loading factor results for all indicators in each construct demonstrate convergent validity since all the loading factor values for each indicator exceed 0.50.

4.3.3.2. Discriminant validity

To evaluate discriminant validity, one can compare the square root of the Average Variance Extracted ($\sqrt{AVE}$) for each construct with the correlation value between the construct and other constructs (latent variable correlation). The model exhibits adequate discriminant validity when the average variance extracted (AVE) root value for each construct surpasses the correlation value of the hidden variable. The relationship between the root of AVE (Average Variance Extracted) and the correlation of latent variables, as determined by the PLS (Partial Least Squares) Algorithm, is presented in the Fornell-Larcker Criterion table:

Table 5: The output of fornell-larcker criterion

	Au	CR	I	Pb	Pp	R	SDL	Sv
Au	0.835							
CR	0.731	0.799						
I	0.853	0.882	0.806					
Pb	0.710	0.645	0.737	0.788				
Pp	0.874	0.797	0.968	0.714	0.824			
R	0.692	0.655	0.729	0.970	0.705	0.770		
SDL	0.804	0.605	0.691	0.573	0.682	0.568	0.821	
Sv	0.663	0.530	0.570	0.463	0.561	0.475	0.861	0.961

By comparing the AVE roots and the correlations of each construct in the table above, it is evident that the AVE root value of each construct is greater than the correlation value of each construct with the other constructs. The AVE root value of the Sv construct is 0.961, which surpasses the correlation values between Sv and SDL (0.861), Sv and R (0.475), Sv and Pp (0.561), Sv and Pb (0.463), Sv and I (0.570), Sv and CR (0.530), and Sv and Au (0.663). Therefore, it may be inferred that all elements in the computed model satisfy the discriminant validity criterion.

4.3.3.3. Reliability testing

Furthermore, alongside the construct validity test, a construct reliability test was conducted. This test assessed the reliability of the construct using two criteria: composite reliability and Cronbach's alpha. These criteria were examined based on the indicator block that evaluated the construct. A construct is considered reliable if both the composite reliability and Cronbach's alpha values are more than 0.70. The results of composite reliability and Cronbach's alpha are as follows:

Table 6: The output of cronbach's alpha and composite reliability

	Cronbach's alpha	Composite reliability
Au	0.856	0.878
CR	0.716	0.728
I	0.865	0.886
Pb	0.796	0.705
Pp	0.844	0.874
R	0.772	0.776
SDL	0.950	0.953
Sv	0.821	0.842

The composite reliability and Cronbach's alpha values indicate that each construct has a reliability score exceeding 0.70. Therefore, it can be inferred that every component in the calculated model is dependable.

4.3.3.4. R-Square

Once the calculated model satisfies the criteria for discriminant validity. In addition, the evaluation of the structural model (inner model) is conducted by examining the R-square (R2) value of endogenous constructs. The structural model with an R-square (R2) of 0.67 is considered to be "good", while a model with an R-square (R2) of 0.33 is considered to be "moderate", and a model with an R-square (R2) of 0.19 is considered to be "weak". The R-square (R2) value for each endogenous component in the estimated model is displayed in the following Table:

Table 7: R-square

	R Square
SDL	0.980

The R-square (R2) values in the table above suggest that the structural model (inner model) in this study falls into the "Strong" category. The obtained R-square (R2) value for the SDL endogenous construct in this study model is 0.987. These factors, Pb, I, Au, R, CR, Sv, Pp, and SDL, account for 98% of the explanation, while the remaining portion is attributed to other variables not included in the model.

4.3.3.5. Hypothesis testing

The bootstrap resampling approach was employed to conduct hypothesis testing between exogenous constructions and endogenous constructs (γ), as well as between endogenous constructs (β). The employed test statistic is the t statistic, sometimes known as the t-test. The t-value used for comparison in this study was derived from the t table. The t-table value at a significance level of 5% and 59 degrees of freedom was found to be 2,001. Hypothesis testing is conducted by examining the output path coefficient derived from the bootstrap resampling findings, which are presented in the subsequent Table:

Table 8: Path coefficients (Mean, STDEV, T-Values)

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)
Au -> SDL	0.327	0.325	0.048	6.811
CR -> SDL	0.155	0.151	0.047	3.314
I -> SDL	0.409	0.395	0.139	2.945
Pb -> SDL	0.113	0.109	0.099	2.140
Pp -> SDL	0.309	0.298	0.104	2.988
R -> SDL	0.111	0.099	0.093	2.189
Sv -> SDL	0.767	0.764	0.032	24.351

4.3.3.5.1. Effect of Au on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between Au and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between Au and SDL. The Table below displays the Path Coefficients for the link between Au and SDL.

Table 9: Path coefficients of Au against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
Au -> SDL	0.327	0.325	0.048	6.811

Table 9 demonstrates a substantial positive relationship between the Au construct and SDL, with a coefficient value of 0.32. This relationship is statistically significant at the 5% level. The evidence of the value of the t-statistic for the Au construct for SDL being over 2.001 is demonstrated by its value of 6.811. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.2. Effect of CR on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between CR and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between CR and SDL.

The Table below displays the Path Coefficients for the link between CR and SDL.

Table 10: Path coefficients of CR against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
CR -> SDL	0.155	0.151	0.047	3.314

Table 10 demonstrates a substantial positive relationship between the CR construct and SDL, with a coefficient value of 0.151. This relationship is statistically significant at the 5% level. The evidence of the value of the t-statistic for the CR construct for SDL being over 2.001 is demonstrated by its value of 6.314. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.3. Effect of I on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between I and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between I and SDL.

The Table below displays the Path Coefficients for the link between I and SDL.

Table 11: Path coefficients of I against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
I -> SDL	0.409	0.395	0.139	2.945

Table 11 demonstrates a substantial positive relationship between the I construct and SDL, with a coefficient value of 0.395. This relationship is statistically significant at the 5% level. The evidence of the value of the t-statistic for the I construct for SDL being over 2.001 is demonstrated by its value of 2.945. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.4. Effect of Pb on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between Pb and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between Pb and SDL.

The Table below displays the Path Coefficients for the link between Pb and SDL.

Table 12: Path coefficients of Pb against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
Pb -> SDL	0.113	0.109	0.099	2.140

Table 12 demonstrates a substantial positive relationship between the Pb construct and SDL, with a coefficient value of 0.103. This relationship is statistically not significant at the 5% level. The evidence of the value of the t-statistic for the Pb construct for SDL being over 2.001 is demonstrated by its value of 2.140. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.5. Effect of Pp on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between Pp and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between Pp and SDL.

The Table below displays the Path Coefficients for the link between Pb and SDL.

Table 13: Path coefficients of Pp against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
Pp -> SDL	0.309	0.298	0.104	2.988

Table 13 demonstrates a substantial positive relationship between the Pp construct and SDL, with a coefficient value of -0.298. This relationship is statistically not significant at the 5% level. The evidence of the value of the t-statistic for the Pp construct for SDL being over 2.001 is demonstrated by its value of 2.988. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.6. Effect of R on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between R and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between R and SDL.

The Table below displays the Path Coefficients for the link between R and SDL.

Table 14: Path coefficients of R against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
R -> SDL	0.111	0.099	0.093	2.189

Table 14 demonstrates a substantial positive relationship between the R construct and SDL, with a coefficient value of -0.299. This relationship is statistically significant at the 5% level. The evidence of the value of the t-statistic for the R construct for SDL being over 2.001 is demonstrated by its value of 2.189. Therefore, it might be inferred that Ha is deemed acceptable.

3.3.3.5.7. Effect of I on SDL. The hypotheses proposed in this study are:

- Ho (nil hypothesis): $\gamma_1 = 0$; it means that there is no positive effect between Sv and SDL.
- Ha (alternative hypothesis): $\gamma_1 \neq 0$; it means that there is a positive influence between I and SDL.

The Table below displays the Path Coefficients for the link between Sv and SDL.

Table 15: Path coefficients of Sv against SDL

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)
Sv -> SDL	0.767	0.764	0.032	24.351

Table 15 demonstrates a substantial positive relationship between the Sv construct and SDL, with a coefficient value of 0.76. This relationship is statistically significant at the 5% level. The evidence of the value of the t-statistic for the Sv construct for SDL being over 2.001 is demonstrated by its value of 24.351. Therefore, it might be inferred that Ha is deemed acceptable.

5. Discussion

5.1. The effect of Au on SDL

The data analysis utilizing the PLS model demonstrates that the authenticity (Au) feature in PjBL has a substantial impact on student SDL. The authenticity of cultural heritage in the context of PjBL pertains to the genuineness and pertinence of the project assigned to students, wherein the project mirrors real-life scenarios and issues. Lattimer & Riordan (2011) found that students exhibit higher levels of motivation and engagement in the

learning process when they are assigned tasks that have direct relevance to their lives. These findings align with some other research, which suggests that true PjBL fosters the growth of critical thinking, problem-solving, and time management abilities (Hilvonen & Ovaska, 2010; Ngereja et al., 2020; Schaddelee & McConnell, 2018). These skills are crucial for autonomous learning.

The applicability of instructional content to real-life situations related to the culture and tradition of students enhances the significance and retention of knowledge. (Erbaggio et al., 2012) asserted that students who engage in authentic projects demonstrate enhanced comprehension and independent application of learned concepts. Authenticity in Local Wisdom PjBL (LWPjBL) offers a distinct framework that enables students to not only acquire theoretical knowledge but also develop the skills to effectively apply it in practical, real-world scenarios (Chang et al., 2024; Duke et al., 2021; Erbaggio et al., 2012). By observing the direct practical use of the knowledge they acquire, students' capacity to learn autonomously is enhanced (Thomas & Rohwer, 2020).

The PjBL approach enables contextual learning, allowing students to perceive direct connections between theory and practice (Almulla, 2020; Markula & Aksela, 2022; Yamada, 2021). This genuine learning encounter facilitates the cultivation of a sense of accountability and possession over one's learning among students (Larmer et al., 2015). Therefore, students engaged in genuine projects exhibit a greater degree of autonomy in contrast to those who acquire knowledge through traditional approaches.

The ramifications of these findings hold significant importance for the realm of education, particularly in the areas of curriculum development and instructional methodologies. Teachers and educational policymakers should incorporate local wisdom and PjBL methods into the curriculum to foster the growth of student autonomy in learning. The genuine use of PjBL not only enhances student involvement and drive but also equips students with the capacity to learn autonomously and effectively tackle real-life obstacles. Therefore, the incorporation of authenticity of culture and tradition of students into PjBL is anticipated to yield more efficient and enduring learning results (Hilvonen & Ovaska, 2010).

5.2. The effect of CR on SDL

The incorporation of critique and revision (CR) in the context of PjBL has a notable impact on fostering students' autonomy in the learning process. Criticism and revision play vital roles in PjBL , as students are provided with critical input from both teachers and peers. They then utilize this feedback to enhance and advance their projects. Dutta et al. (2023) stated that appropriate feedback assists students in comprehending their strengths and limitations, promotes self-reflection, and enhances their capacity to govern their learning.

Within the framework of PjBL, criticism and revision serve as both assessment tools and ongoing learning opportunities Hill & West (2020). According to Molloy et al. (2020), students who engage in a revision process that incorporates feedback are more likely to develop a thorough understanding of the content and become capable of independently applying these concepts. Moreover, this procedure facilitates the cultivation of critical thinking and problem-solving abilities in pupils, which are important for self-directed learning. According to Carless (2022), when students get constructive criticism and make adjustments, they develop the ability to take ownership of their learning. This process enhances their self-confidence and empowers them to autonomously conquer academic problems.

Critique and revision foster collaboration and communication among students, so enhancing their capacity for independent learning. According to Pellisa et al. (2021), students are more likely to accept and make use of comments given by their peers due to the presence of a supportive and collaborative environment, which makes them feel more at ease. This technique also enhances student participation in learning, as it fosters a sense of accountability for both giving and accepting constructive criticism. Teachers must offer unambiguous, precise, and beneficial comments while motivating students to engage in purposeful changes. Hence, the act of critiquing and modifying not only enhances the academic achievements of students but also fosters the cultivation of self-reliant and enduring learning abilities. Implementing this technique is anticipated to cultivate students who possess greater autonomy, analytical thinking skills, and enhanced ability to confront academic obstacles.

5.3. The effect of I on SDL

The level of student involvement (I) in the learning process within the PjBL framework has a substantial impact on students' ability to learn independently. Student engagement encompasses the active involvement of students in educational tasks, characterized by their enthusiasm, perseverance, and curiosity towards the subject matter (Chukwuedo et al., 2021; Erickson et al., 2020). According to the research conducted by Tao et al. (2022) , there is a positive correlation between strong student involvement and both improved academic accomplishment and the cultivation of independent learning abilities. The students' engagement is observed through the active involvement of students in the creation, execution, and assessment of projects that have direct relevance to their actual experiences (Asif et al., 2020).

Participating actively in PjBL offers students the chance to cultivate their critical thinking and problem-solving abilities, which are crucial aspects of self-directed learning (Putri et al., 2022). (Bureau et al., 2022) found that students who engage in important and demanding projects have a greater intrinsic drive to study and finish assignments autonomously. In addition, participation in PjBL enables students to engage in collaborative work, exchange ideas, and offer constructive feedback (Almulla, 2020; Ngereja et al., 2020; Puangpunsi, 2021; Yamada, 2021). These activities foster the growth of social skills and promote independent learning.

Student engagement in PjBL enhances their feeling of possession and accountability for their educational journey (Paristiowati et al., 2022; Park & Scanlon, 2024). Students are more encouraged to take initiative and work independently when they perceive that they have control over their assignments. Ryan & Deci (2020) research supports the notion that autonomy and active engagement in learning enhance intrinsic motivation and foster independent learning.

5.4. The effect of Pb on SDL

Providing problems (Pb) to students within the framework of PjBL has a substantial impact on fostering student autonomy in learning. Presenting genuine and pertinent challenges enables students to actively engage in the process of addressing difficulties, thereby fostering critical and creative thinking. According to Shanta & Wells (2022), students are more driven to develop independent thinking skills when they encounter real challenges and are compelled to find solutions. For PjBL, the challenges assigned to students should be intricate and demanding, necessitating thorough exploration, and encompassing diverse scientific fields. The study by Blumenfeld et al. Providing problems promotes students' proactivity in collecting information, examining facts, and formulating solutions (Almulla, 2020; Erickson et al., 2020). This technique facilitates the cultivation of a sense of accountability and possession over their learning among students, as they are required to effectively manage their own time and resources to successfully do the project. Providing problems facilitates students' comprehension of the significance of teamwork and communication in problem-solving, both of which are crucial competencies in self-directed learning (Anshu et al., 2022; Tang, 2024).

In addition, presenting problems that are pertinent to the real-life context of students enhances the significance and practicality of learning. Boss & Larmer (2018) found that students who perceive a clear correlation between their learning and the real world are more inclined to be self-motivated in acquiring and utilizing their information. This aligns with Ryan & Deci (2020), the notion of intrinsic motivation, which posits that granting autonomy and problem-solving chances enhances intrinsic motivation and fosters independent learning.

The significance of these findings holds great importance for educational practice. Teachers must create intricate and pertinent tasks to be assigned to students within the PjBL framework. This will not only enhance student involvement and motivation but also foster the development of sustained learning autonomy. Teachers can facilitate the development of student's skills to effectively confront academic and real-life obstacles by offering suitable problem-solving tasks (Karan & Brown, 2022; Rohm et al., 2021; Santana & de Deus Lopes, 2024). Hence, it is imperative to prioritize the incorporation of challenges in PjBL as the central objective in curriculum design and instructional approaches to effectively foster the cultivation of students' autonomy in learning.

5.5. The effect of Pp on SDL

The publication of a product (Pp) in the PjBL component has a notable impact on students' ability to study independently. Product publication is the act of students sharing the outcomes of their projects with a broader audience, including their peers, educators, parents, or the community. Ngereja et al. (2020) stated that the publication process allows students to showcase the knowledge and skills they have acquired, leading to a boost in their self-assurance and accountability for their learning. In PjBL, the act of publishing a product catalyzes increased student motivation and independence, since they are aware that their work will be evaluated by an authentic audience Markula & Aksela (2022). According to Barron and Darling-Hammond (2008), students were motivated to spend more time and effort on their tasks when they knew that their work would be published. This technique additionally facilitates the cultivation of communication and presenting aptitudes in pupils, which are crucial for self-directed learning. As students are ready to present their projects, they develop the ability to express their thoughts clearly and persuasively (Puangpunsi, 2021).

The dissemination of products in PjBL offers students useful feedback. Yamada (2021) argue that feedback received from external audiences might facilitate students' comprehension of their strengths and limitations, hence promoting self-reflection and fostering greater autonomy in the learning process. Publications foster a collaborative learning environment that facilitates knowledge exchange among students, stimulating the generation of novel ideas and diverse problem-solving approaches (Larmer et al., 2015).

The significance of these findings has great importance for the development of curriculum design and instructional methodologies. Teachers should often offer students the chance to publish the outcomes of their efforts. This not only enhances student interest and involvement but also fosters the development of sustained

learning autonomy. Therefore, including product publishing into PjBL can foster the development of students who possess greater autonomy, self-assurance, and preparedness to tackle both academic and real-world obstacles (Pan et al., 2020; Puangpunsi, 2021). Thus, incorporating product publication into the implementation of LWPjBL is crucial for efficiently fostering the growth of student autonomy in learning.

5.6. The effect of R on SDL

The inclusion of reflection (R) in the component of Project-based Learning (PjBL) has a substantial impact on fostering student autonomy in the learning process. Reflection is a cognitive process in which students critically analyze and contemplate their learning experiences, discerning the knowledge and abilities they have acquired, and determining how they might effectively utilize them in future contexts. Gorski & Dalton (2020) asserts that reflection is an essential element in profound and ongoing learning as it enables students to establish connections between practical experiences and theoretical notions.

In PjBL, reflection plays a crucial role in fostering the development of metacognitive skills in students, specifically their capacity to engage in introspection and analyze their thought processes (Almulla, 2020; Lukitasari et al., 2021). According to a study conducted by DeMink-Carthew et al. (2020), consistent reflection by students leads to increased self-awareness of their learning process, the ability to recognize their strengths and flaws, and the development of more efficient learning strategies. This fosters learning autonomy as students acquire the skills to structure and guide their learning (Carden et al., 2022).

Reflection also fosters a sense of accountability in pupils, prompting them to assume more ownership over their learning. Howell (2021) asserts that engaging in systematic and comprehensive reflection enables students to critically assess their progress and establish attainable learning objectives. In PjBL, students can engage in the process of reflection through the use of reflective notebooks, group discussions, or final project presentations. These activities allow students to contemplate the difficulties encountered during the project and the strategies employed to overcome them (J. Hill & West, 2020). The act of reflecting in Project-based Learning (PjBL) enhances student involvement since it instills a sense of worth and acknowledgment. Providing students with the chance to contemplate their experiences enhances their sense of connection to the subject matter and increases their self-driven motivation to study.

The significance of these discoveries holds great importance for educational practice. To foster the development of learning independence among students, it is essential for teachers to routinely incorporate reflection activities into PjBL. Students can engage in reflective practices using several approaches, like keeping reflective notebooks, participating in group discussions, or delivering project presentations. These strategies foster a profound introspection into their learning experiences. Reflection enhances both student learning outcomes and the development of sustainable learning independence (Howell, 2021; Veine et al., 2020). Hence, the incorporation of introspection in Project-Based Learning (PjBL) must be a fundamental component of instructional approaches to efficiently foster the cultivation of student autonomy in learning.

5.7. The effect of Sv on SDL

The presence of student voice (Sv) in the component of PjBL has a substantial impact on fostering SDL. Student voice encompasses the active involvement of students in making decisions related to the projects they engage in, such as choosing the topic, determining research techniques, and deciding how to communicate the findings (Caetano et al., 2020; Dobson & Dobson, 2021). (Lauermann & Berger, 2021)found that when students are involved in decision-making, it enhances their sense of ownership and responsibility for their learning, leading to the development of learning independence.

Granting students agency within the framework of Project-based Learning (PjBL) enables them to delve into their curiosities and enthusiasms. This aligns with the theory of intrinsic motivation proposed by Ryan & Deci (2020), which asserts that autonomy in learning enhances student drive and self-reliance. Bureau et al. (2022), when students are given autonomy over their projects, they are more inclined to be motivated, take initiative, and assume responsibility for their learning process. This approach additionally facilitates the cultivation of students' critical thinking and problem-solving abilities, as they are required to make significant decisions about their projects De Loof et al. (2021)

Teachers must facilitate student participation in decision-making processes related to projects to create an environment that allows for student voice in PjBL. This can be accomplished using class discussions, questionnaires, or small group gatherings, wherein students can articulate their thoughts and preferences. Therefore, the inclusion of student voices not only enhances their motivation and engagement but also fosters the development of enduring learning autonomy (Caetano et al., 2020; Dobson & Dobson, 2021; Mendes & Hammett, 2023). Hence, incorporating student input into PjBL is crucial for teaching methods to effectively foster the growth of student autonomy in learning.

6. Conclusions

This research concludes that seven aspects of PjBL which are integrated with local wisdom namely authenticity, criticism and revision, student involvement, problem-solving, product publication, reflection, and student voice - have a significant effect on student learning independence. The integration of local wisdom in PjBL provides a relevant and meaningful context for students, which increases their involvement and motivation in learning. Authenticity enriched with local wisdom makes learning materials closer to students' daily lives. Contextual criticism and revision teach students to appreciate local values while developing critical thinking skills. Student involvement in local wisdom-based projects increases their sense of responsibility and active participation. Providing problems that are relevant to local culture encourages deeper problem-solving skills. Publication of products that pay attention to local wisdom provides more meaningful feedback and increases students' self-confidence. Reflection in the local context helps students develop strong metacognition, while valued student voice in their cultural context strengthens motivation and autonomy.

Suggestions and recommendations from these findings are for educators to consistently integrate local wisdom in the seven aspects of PjBL. Teachers need to design projects that are authentic and relevant to students' cultural contexts, encourage critique and revision processes that respect local values, and ensure students' active involvement in contextualized projects. Additionally, it is important to provide problems that reflect local challenges, provide opportunities for product publication within the community, encourage contextual reflection, and ensure that student voices are valued in project-related decision-making. Thus, the integration of local wisdom in PjBL will support the optimal and sustainable development of student learning independence.

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