SCOPE
Journal of English Language Teaching
| p-ISSN 2541-0326 | e-ISSN 2541-0334 |
https://journal.lppmunindra.ac.id/index.php/SCOPE/

Research Article

Development of Learning Trajectory for Project-Based Learning (PjBL) Model to Construct Foundational Literacies for Elementary School Students

Fatkhur Rohman[1], Nelly Astuti[2], Eka Maryam[3], Erni[4], Mia Azzahra[5], Jody Setya Hermawan[6].

[1,2,4,5,6] *Universitas Lampung, Jl. Prof. Dr. Ir. Sumantri Brojonegoro No.1, Bandar Lampung 35141, Indonesia*
[3] *Universitas Bina Insan Lubuklinggau, Jl. HM Soeharto No.Kel, Lubuk Kupang, Kec. Lubuk Linggau Sel. I, Kota Lubuklinggau, Sumatera Selatan 31626, Indonesia*

KEYWORDS

Hypothetical Learning Trajectory (HLT);
PjBL Model;
Foundational Literacies

CORRESPONDING AUTHOR(S):

E-mail: fatkhur.rohman@fkip.unila.ac.id

A B S T R A C T

Learning trajectories oriented towards Foundational Literacies such as reading literacy, communication skills, and critical thinking need to be developed to prepare learners to face the changes of the 21st century. Learning access in Phase C requires the student to have the ability to adapt to the purpose and social context, show an interest in the text, and be able to understand, process, and interpret information. While the thinking stage of the SD pupil according to Piaget's theory, is in the concrete operational stage, therefore learning in Phase C is considered difficult for SD pupils. Teachers have not fully implemented the development of learning actively, and creatively in involving students and have not used various learning models based on the character of the learning material. That affects the achievement of the Foundational Literacies of the lower pupils. This research aims to develop a learning trajectory model of PjBL that can build the Foundational Literacies of the students in studying a topic set in Phase C. Design research used in this research comprises three stages, namely: (1) preparing for the experiment; (2) design experiment; and (3) retrospective analysis. The results of the implementation of the first prototype give a significant impact on the change in the Foundational Literacies before and after learning, but when referring to the criteria of achievement of the learning objective holistically is still in fairly good interpretation. Re-development of the learning trajectory resulting in prototype II. The implementation of the second prototype achieved an average N-Gain score of the experimental class of 78.31% and the control class has a score of 54.20%, the results of this study indicate that the Learning Trajectory for the PjBL Model effectively imply building Foundational Literacies.

INTRODUCTION

The changes in science and world civilisation that are taking place so rapidly in the 21st century are currently in the era of the Industrial Revolution 4.0 and Society 5.0, which are having an impact on the world of education, leading to the era of Education 4.0 (Pozdnyakova et al., 2019; Ragulina et al., 2019). The implementation of learning must prepare learners for the skills needed in

DOI: http://dx.doi.org/10.30998/scope.v8i2.22365

Industry 4.0 and Society 5.0 (Lusiyana, et.al., 2020). The implementation of education in the era of Society 5.0 requires students to have creative, innovative, productive, adaptive, collaborative and competitive skills (Aquilani et al., 2020; Hikmat, 2022; Oktaviana et.al., 2022 and Paschek et al., 2022). Creative, innovative, productive, adaptive, collaborative and competitive skills are implicitly based on good Foundational Literacies (Adnan, 2021; Hernawati, et.al., 2019; and Novaristiana, et .al., 2019). Good Foundational Literacies can help learners to distinguish scientific facts from a wealth of information, and to identify, analyse, organise and interpret data (Oktaviana et.al., 2022).

The results of the PISA assessment report in 2018 and 2022 for students in grades 7-12 showed that education in Indonesia is currently experiencing problems in achieving the Foundational Literacies.This is evidenced by the results of the assessment rankings from PISA showing that reading literacy, science literacy, and mathematics literacy of students in Indonesia are at the lowest level (below level). This state of affairs can be interpreted as meaning that the teaching of Foundational Literacies has been very weak since primary education.

The results of the 2022 PISA assessment are in fact consistent with the results of the initial research conducted by researchers at SD Negeri Cluster 6 Kec. Gedong Tataan Kab. Pesawaran in Phase C learning in Grade V. The results of the observations that the researchers made on the learning process in Phase C found several problems, including 1) students are less able to understand, reveal and relate information obtained from various situations, data or events with their own interpretations; 2) learners are less able to identify and connect statements, questions and concepts to express opinion judgements obtained in the learning process; 3) learners still have difficulty in evaluating, making solutions and conclusions from situations or problems encountered in the learning process; and 4) teachers have not developed differentiated learning oriented to the diversity and needs of learners' characteristics. These findings indicate that learners' foundational literacies are still low, which has implications for critical thinking and for analysing and formulating solutions to problems in learning.

Based on the results of the literature study, the researchers obtained several alternative solutions that could be proposed to solve the above problems, including implementing a project-based learning model. (Wulandari et al. 2019). In Winarni's research, and Koto's (2020), it was found that the implementation of the PjBL model could help learners to build the ability to analyze and interpret concepts. The PjBL model is designed by integrating constructive learning theory and problem-based and project-based learning strategies. (Rohman, 2020). However, according to Hugerat, (2016) implementation of project-based learning is based on a fairly complex scientific performance, whereas students at the elementary school level only use reasoning by observing objects of a concrete nature in accordance with the cognitive development theory of Piaget, J. (1954).

The phenomenon of the above problems can be unraveled by developing a learning trajectory for the PjBL model. The development of a learning trajectory for the PjBL model is designed to describe the development or progress of learners in learning a particular topic/project. This development model emphasises the planning and organisation of learning so that it can assist teachers in designing effective learning activities for learners (Simon, and Tzur, 2004). A learning trajectory is a route to learning that provides a description of the prerequisite knowledge learners already have (as a starting point) and each step from one point to the next, describing the thought processes learners use, the methods learners use or the levels of thinking learners demonstrate (Douglas and Sarama 2004; Gravemeijer and Coob 2006; Susan and Whitacre 2010).

The development of the learning trajectory of the PjBL model helps students in building Foundational Literacies such as observing, analyzing, interpreting, inferencing, evaluating and explaining. Project-based learning can also help learners develop critical skills in dealing with problems faced in the real world (Pramudiyanti et.al 2023). Moreover (Rohman et.al, 2018 and Rohman et.al 2023) critical thinking skills through project and problem oriented learning can help students solve problems and make appropriate decisions.

Based on the above study, the development of the PjBL learning trajectory model can help teachers facilitate student-centred learning and help students build Foundational Literacies in the learning process.

METHOD

The method used in this research is Design Research from Gravemeijer and Cobb (2006) which includes three stages, namely: (1) preparing for the experiment; (2) design experiment; and (3) retrospective analysis which can be explained as follows.

1. Preparing for the experiment

The implementation of the preparation for the experiment in this study includes two activities, namely: (1) needs analysis based on literature review by reviewing the literature to design the learning trajectory, analysis of materials, learning outcomes, and learning objectives in Phase C in Primary V, as well as the design of PjBL model steps that are appropriate and suitable for teaching materials in Phase C at Primary level; and (2) design of

Hypothetical Learning Trajectory (HLT). The design of the HLT has three important components that need to be designed, namely: learning objectives, learning activities, and hypotheses or assertions about the learning process of the students (Akker, et.al 2006).

2. Design experiment

The second phase of this research is the design experiment. The implementation of HLT is divided into two phases, namely: (1) pilot experiment aimed at testing HLT design trials, as well as collection of data related to HLT adjustments to be used in teaching experiments and (2) teaching experiment, aimed to collect data as a basis in answering research questions. (Gravemeijer, 2004; Plomp, and Nieveen. 2013; dan Susan dan Whitacre 2010).

3. Retrospective analysis

The third stage in this research is retrospective analysis. In the retrospective analysis stage all the data that had been obtained at the design experiment stage was analysed. The results of the analysis were then used to improve the HLT that would be used in the next cycle. Data analysis was obtained from transcripts. Based on the data analysis, the actual learning flow of students will be obtained. The purpose of retrospective analysis in general is to develop local instructional theory according to the cycle that can be seen in Figure 1.

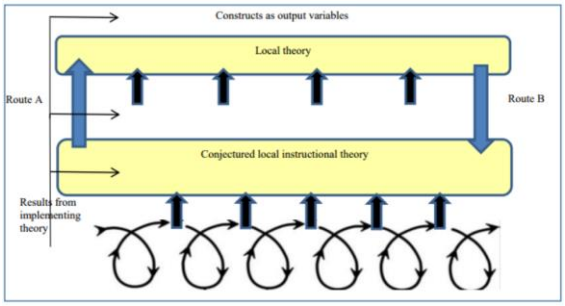

Figure 1. Cycle of Design Research (Gravemeijer and Cobb, 2006)

4. Subjek Penelitian

The implementation of this research was carried out at SD Negeri Cluster 6 Kec. Gedong Tataan Kab. Pesawaran. The students involved as a sample were 13 from SDN 34 Gedong Tataan at the design experiment stage. The development of hypothetical learning trajectory at the pilot experiment stage in this study involved 21 students from SDN 50 Gedong Tataan and in the implementation of teaching experiments researchers involved 40 students from SDN 21 Gedong Tataan. The research subjects come from three schools that have similar characteristics based on accreditation status and socio-cultural status. An overview of the samples in this study can be presented in Table 1.

Table 1. Sample of Research

No	Name of Schools	Sample size	Research phase
1	SDN 34 Gedong Tataan	13	*Preparing for the experiment*
2	SDN 50 Gedong Tataan	21	*Pilot experiment*
3	SDN 21 Gedong Tataan	40	*Teaching experiment*

5. Aspect of Foundational Literacies Assessment

Foundational Literacies generally cover the basic skills and knowledge that individuals need to acquire before proceeding to further learning. Assessment indicators for foundational literacies can help evaluate the extent to which individuals have developed basic skills in a variety of fields. Based on the results of a study of research literature from (Brumfield J.E., Stojanović M. 2021: Lee McCallum, 2021: Owens 2014 Rachel and Derek 2022), the indicators for assessing Foundational Literacies can be presented in table 2.

Table 2. Aspect of Foundational Literacies Assessment

Aspect of Assessment	Indicator
Reading Literacy	1. Text comprehension: Learners can understand the ideas and information presented in a written text. 2. Analysing text structure: Learners can identify elements such as introduction, body and conclusion. 3. Inference skills: Learners can draw conclusions or inferences from information not explicitly given in the text.
Writing Literacy	1. Grammar skills: learners will be able to master grammar rules and use words correctly. 2. Organising writing: learners will be able to organise ideas logically and coherently in a piece of writing. 3. Creativity: learners will be able to evaluate their ability to communicate ideas in original and creative ways.
Skill of Communi-cation	1. The ability to communicate ideas effectively through speech. 2. Ability to express ideas clearly and persuasively in writing.
Critical Thinking	1. Critical analysis: Learners' ability to analyse information in depth. 2. Problem solving: Learners' ability to identify, specify and solve problems.

DOI: http://dx.doi.org/10.30998/scope.v8i2.22365

Aspect of Assessment	Indicator
	3. Argumentation: Learners' ability to construct arguments based on logic and evidence.

b. Research Data Analysis Technique

The data analysis technique used in this study was qualitative analysis, which was carried out by paying attention to the results of the data collection, which consisted of the students' work, the results of the interviews with the students, the documentation of the learning process and the observation notes of the learning outcomes during the design experiment, the pilot experiment and the teaching experiment. The data were analysed using different methods as follows.

1) Descriptive method, where this method is used to describe information that occurs during the implementation of learning activities in the classroom.
2) Transcription method used to transfer recorded information into written language.
3) Classification method where this method is used to interpret the results of observations obtained during learning activities with criteria for achieving learning objectives (KKTP) adapted from the results of KKG SD Negeri Cluster 6 Kec. Gedong Tataan Kab. Pesawaran in Table 3.

Tabele 3. Criteria of Leraning Objective

Aspect of Foundational Literacies Assessment	Interval	Interpretation
Reading Literacy	(0 – 68)	Need guidance
Writing Literacy	(68 – 78)	Enough
Communication Skills	(79 – 89)	Good
Critical thinking	(90 – 100)	Very Good

4) Testing the effectiveness of the learning trajectory of the PjBL model, testing the efficiency of the development of the Learning Trajectory of the N-Gain Score in the form of percentages, then interpreting the percentage value of N-Gain Score according to the categorization of the interpretation of the access to the N - Gain efficiency by reference to table 4.

Tabel 4. N-Gain Effectiveness Interpretation Category

Persentage (%)	Interpretation
< 40	Ineffective
40-55	Less Effective
56-75	Moderately Effective
>76	Effective

Hake (1999)

RESULTS AND DISCUSSION

RESULTS

1. Result of Preparing for the Experiment

The initial stage of this study involves preparing for the experiment. Researchers conducted several activities during this stage, including: Conduct a needs analysis based on a literature review to design a learning trajectory for teaching the material of form and its changes in grade V elementary school. Also, design appropriate PjBL model steps for teaching the material and use them to formulate initial conjectures for learning (Akker, et.al 2006).

The initial stage of this study involved preparing for the experiment by designing a Learning Trajectory (LT) based on PjBL learning delivered by Gerhana (2017). The LT consists of six stages: 1) Determining the theme/project topic; 2) Identifying fundamental questions; 3) Designing project plans; 4) Arranging the schedule; 5) Completing and preparing project reports; and 6) Evaluating the process and project results. The Learning Trajectory (LT) of the PjBL model is based on the PjBL syntax from Eclipse 2017, it is illustrated in Figure 2.

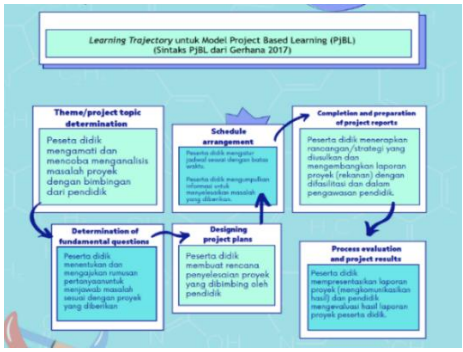

Figure 2. Learning Trajectory Prototype 1 Model PjBL Berorientasi Foundational Literacies.

The LT presented in Figure 2 was then developed in the form of a Hypothetical Learning Trajectory (HLT), which includes the flow of learning objectives, learning activities and assessment of students' Foundational Literacies in the learning process. The preparation of the HLT is based on the results of initial observations of students' foundational literacy skills and interviews/discussions conducted by the researchers with classroom teachers in relation to the implementation of learning that is frequently done, the use of learning resources and materials.

a. **The researcher should select project topics that are relevant to the material and the cognitive**

development level of the learners. It is important to choose topics or projects that are both relevant to the curriculum and interesting for the learners. The study material focuses on the nature of objects and changes in their form. Figure 4 shows prototype 1 of the project learning trajectory that students will work on.

Figure 4. Learning Trajectory Project in Phase C fifth-grade

b. **Material Design Description.** The aim of the design in HLT is to assist learners in obtaining information to complete the project topic. The material design is tailored to the PjBL learning activities. The details of the material design can be found in the figure 5.

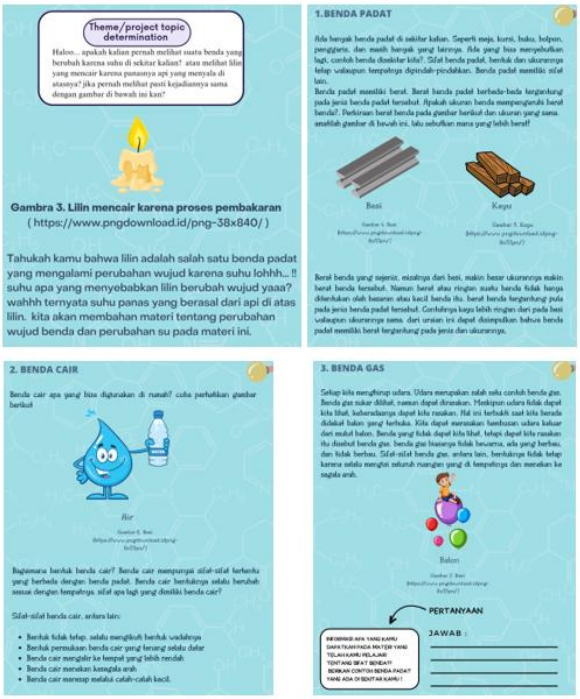

Figure 5. Theme/Project Topic Determination

Figure 6. Determination of Fundamental Questions

Figure 7. Designing Project Plans

DOI: http://dx.doi.org/10.30998/scope.v8i2.22365

Figure 8. Schedule Arrangement

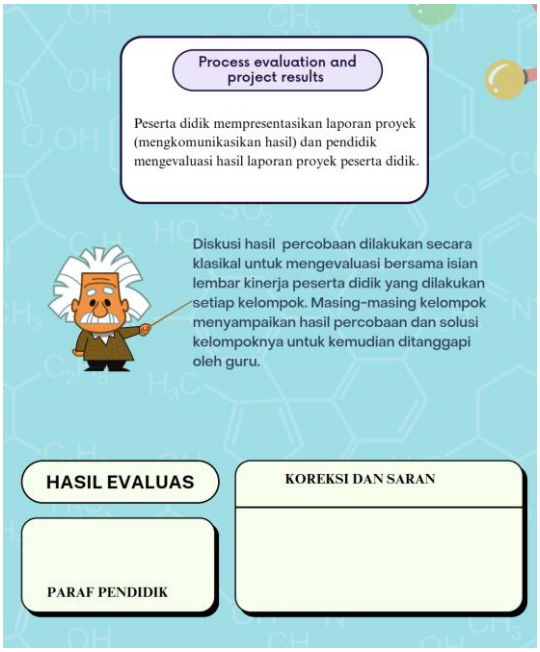

Figure 9. Process Evaluation and Project Results

Hypothetical Learning Trajectory (HLT) was designed by referring to literature studies as well as the results of learning observations and students' initial Foundational Literacies abilities from HLT prototype I. The results obtained further became material for discussion with class teachers in Cluster 6 District. Gedong Tataan District. Pesawaran to obtain an HLT plan in implementing the PjBL model as planned in Figures 5 to 9.

2. Result of Design Experiment

Design experiment (implementation of design) is the second stage in this research. The design implementation stage is the implementation of the Hypothetical Learning Trajectory (HLT) design. The implementation of HLT is divided into two stages, namely: (a) pilot experiment which aims to test the HLT design, as well as collecting data related to HLT adjustments that will be used in the teaching experiment and (b) teaching experiment, which aims to collect data as a basis for answering research questions (Gravemeijer, 2004; Plomp, and Nieveen. 2013; and Susan and Whitacre 2010). The research subjects involved in the pilot experiment stage can be presented in Table 10.

Tabel 10. Subject of Research in Phase of Pilot Experiment

Name of School	Grade	Sample size	Dimention of Assessment
SDN 50 Gedong Tataan	V a	21	Foundational Literacies

The learning trajectory (LT) in Figure 2 that has been prepared is then tested in a teaching experiment to see the impact of learning activities on the Foundational Literacies of fifth grade elementary school students. The results of the Foundational Literacies assessment measured at the Pilot Experiment Stage can be presented in Figure 10.

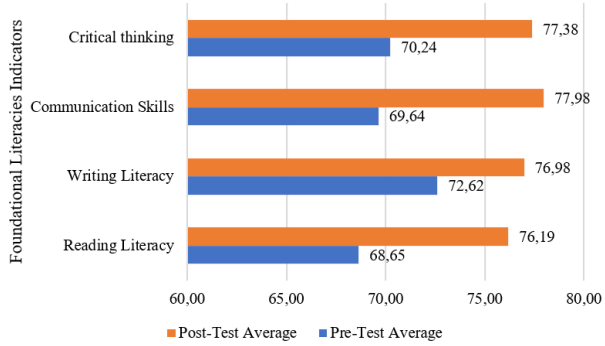

Figure 10. Average of Foundational Literacies in Implementation of LT PjBL

Based on Figure 10, The initial problem designed in activities I and II was how to understand the changes in the six forms that occur in objects. Activities I and II are of course not easy for students to carry out, students must identify, analyze and formulate projects that will be implemented in learning.

Furthermore, in activities III and IV, from the results of identification, analysis and formulation of the project to be implemented, with the guidance of the teacher, students make a project completion plan and set a schedule according to the time limit. The aim of this activity is to involve students in innovation to identify variables related to the project, as well as explain the problems that occur on the project. Activities V and VI the teacher guides students to implement the proposed design/strategy and develop a project report, as well as present and communicate the results of the project facilitated by the teacher.

The average results of Foundational Literacies from LT Implementation provide information that the average achievement of each Foundational Literacies indicator when referring to the KKTP holistically is still fairly well interpreted. The results above provide an indication that class Va elementary school students at SDN 50 Gedong Tataan still have difficulty in developing the four Foundational Literacies, especially in Reading Literacy and Writing Literacy.

Based on the results above, learning activities in the Learning trajectory (LT) PjBL model are still too complex to be applied in elementary schools. The implementation of project-based learning is in principle based on the concept of constructivism with an emphasis on quite complex scientific performance (Hugerat, 2016; Rohman, 2020; and Violeta, 2011). while according to Jean Piaget (1954) theory of Students in elementary school (SD) are at the level of concrete operational cognitive development who only use inductive reasoning by observing concrete objects. Under these conditions, of course the PjBL model needs to be developed to be more adaptable for use in elementary school students' learning.

The results of the literature study, researchers found that to break down abstract concepts into something more concrete, teachers can make several representations in visual form (Abdurrahman et.al., 2019; Günel & Yesildag-Hasançebi, 2016; and Hansen., and Richland, 2020) or modeling phenomena into audio-visual (Lusiyana et.al., 2020). Furthermore Haglund, Jeppsson and Andersson (2012) found that children's drawings affect their reasoning abilities, children create drawings to find out representations related to ideas, reflections, and judgments. In opinion of Kabatas Memis (2015), knowing and using representations systematically allows students to identify elements such as the introduction, body of text, and conclusion. Besides that, Demirbag and Günel (2014) illustrates that students who learn with multiple representations have higher success in understanding ideas and information presented in written text, argumentation skills and writing skills compared to the control group.

The LT on prototype I which had been tested in the pilot experiment stage to see students' Foundational Literacies abilities was considered less effective, the researchers made adjustments to the LT prototype I. Figure 2 shows the learning trajectory which has undergone revisions on prototype II.

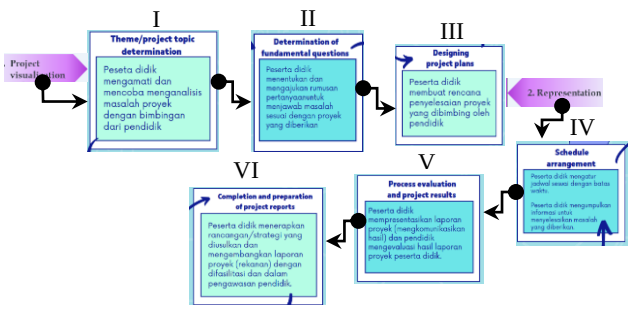

Figure 11. Learning Trajectory Prototype II Model PjBL Oriented Foundational Literacies

Figure 11 learning Trajectory Prototype II from the PjBL model can be explained that before students observe and analyze problems from the information presented by the teacher for project implementation, the teacher visualizes the project to be completed in video form. Students pay close attention to the video visualization displayed by the educator, then students detail and represent contextual phenomena in the video.

Continue with activities II and III. Before carrying out activity IV, students represent the results of the project design that will be completed, the teacher at this stage acts as a facilitator to provide input on the presentation of the representation made by students. Continue with activities IV, V and VI. The subject of implementing prototype II at the teaching experiment stage was carried out in the experimental class and prototype I in the control class at SDN 21 Gedong Tataan. The research subjects at the teaching experiment stage can be presented in Table 12.

Table 12. Research Subjects at the Teaching stage Experiment

Name of School	Grade	Sample size	Dimention of Assessment
SDN 21 Gedong Tataan	Class of Va (Experiment class)	21	Foundational Literacies
	Class of Vb (Control class)	20	

Based on Table 12, the teaching experiment prototype II stage was implemented in class Va with a total of 21 students as the experimental class, while the control class was implemented in class Vb. The results of implementation at the teaching experiment stage can be seen in Figure 12.

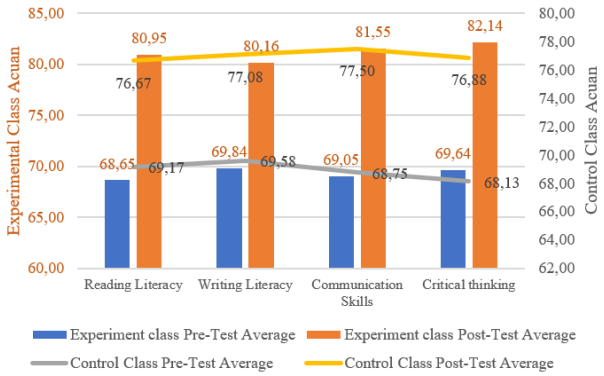

Figure 12. Comparison of Average Foundational Literacies indicators in the Teaching Experiment Stage of the Experimental and Control Classes

The results of the comparison of the average pretest scores in the experimental and control classes shown in Figure 12 provide information that the four Foundational Literacies indicators have homogeneous values, while the comparison of the Foundational Literacies indicators posttest average scores shows that the experimental class is significantly higher than the average score. -posttest average in the control class.

DOI: http://dx.doi.org/10.30998/scope.v8i2.22365

Further testing of the learning Trajectory Prototype II implementation data from the PjBL model is to calculate the percentage of N-gain Score achievement from Foundational Literacies that students in the experimental and control classes have. The results of the N-gain Score percentage calculated using SPSS software can be presented in Table 13.

Tabel 13. Persentage of N-gain Score

Classess	Average of N-Gain Score	Interpretation
Experiment	78,31%	Effective
Control	54,20%	Less Effective

The calculation results presented in table 13 provide information that the average value of the N-Gain Score for the experimental class is 78.31% which is in the effective categorization for building Foundational Literacies in the learning process, while for the control class the value is 54.20% which are categorized as less effective. The findings in this research are relevant to research results (Rohman 2018, Amalia et.al 2023; Rohman et.al 2023; and Pramudiyanti, et.al 2023) which implicitly state that the learning process which is carried out contextually, problem and project oriented can help students to be able to understand ideas and make conclusions based on the information obtained by students in learning. Abdurrahman et al 2019, through the implementation of multiple representations, it can help to develop critical thinking and concretize abstract concepts in the learning process.

CONCLUSION

This research has produced a learning design in the form of a learning trajectory from informal to formal form in Phase C class V elementary school learning with the PjBL model according to the curriculum. This learning trajectory design can be used to teach concepts in Phase C, because in the design developed, a learning trajectory is available along with the materials and media used. Based on the research results, it can be concluded as follows:

1. The learning trajectory produced in this research departs from Local Instructional Theory (LIT) which was compiled by researchers based on expert opinions regarding the implementation of the PjBL model with six stages, namely 1) Theme/project topic determination; 2) Determination of fundamental questions; 3) Designing project plans; 4) Schedule arrangement; 5) Completion and preparation of project reports; 6) Process evaluation and project results. Learning Trajectory. This LIT was then developed into a learning trajectory referring to the principles of the PjBL learning model.
2. The use of concrete media towards semi-concrete models, both in the form of proportional models and non-proportional models in the learning process, has an important impact in building Foundational Literacies and student motivation. From the learning practice in the classroom (teaching experiment stage), the learning trajectory that is prepared gives students the opportunity to reinvent and understand the learning material according to the contextual experiences that the students have.

The use of project example videos used in the learning trajectory in prototype II is very helpful for teachers and students in implementing the project.

ACKNOWLEDGMENT

The researcher would like to thank the parties involved in this research, especially SDN 34 Gedong Tataan, SDN 50 Gedong Tataan, SDN 21 Gedong Tataan, who were willing to collaborate during the research.

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