Primary: Jurnal Pendidikan Guru Sekolah Dasar
journal homepage: https://primary.ejournal.unri.ac.id/
contents lists available at SINTA and DOAJ

Vol. 14 No. 3 (2025): June
http://dx.doi.org/10.33578/jpfkip.v14i3.p328-333

The level of conceptual change in science learning progress based on local wisdom among prospective elementary school teachers

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Article info

Keywords
Level of conceptual change, local wisdom

Abstract

This study aims to evaluate the conceptual change of prospective elementary school teachers after participating in science learning based on local wisdom using Conceptual Change Texts. The research employed a descriptive quantitative method involving 30 Primary School Teacher Education students from Universitas Kristen Indonesia Toraja enrolled in the Basic Science Concepts course. The level of conceptual change was identified through a four-tier diagnostic test and assessments in the Student Worksheet, following established guidelines for determining levels of conceptual change. The results showed that approximately 12.97% of students were at the level of Initial Scientific Conception (ISC), 6.98% at the Static (S) level, 77.18% at the Reconstruction (R) level, 4.01% at the Construction (C) level, and none at the Disorientation (D) level. This study demonstrates that science learning based on local wisdom, using conceptual change texts, effectively minimises misconceptions and leads students to achieve conceptual change at the construction and reconstruction levels.

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DOI: http://dx.doi.org/10.33578/jpfkip.v14i3.p328-333
Received 11 April 2025; Received in revised form 28 May 2025; Accepted 03 June 2025
Available online 29 June 2025
e-ISSN 2598-5949 | p-ISSN 2303-1514

1. Introduction

Misconceptions need to be addressed because they can impact teachers' future understanding and teaching practices. Misconceptions tend to resist new concepts, making remedial teaching activities essential. One effective remedial teaching method is the use of text, particularly Conceptual Change Text (CCT). CCT is a type of text designed explicitly for remedial instruction, aiming to overcome students' misconceptions (Dole, 2000). It is purposefully designed to fulfil four essential conditions and align with the six stages of the conceptual change model. As a text, CCT

can be constructed using various genres, such as discussion texts, procedural texts, and explanatory texts (Ahopelto et al., 2011; Aleknavičiūtė et al., 2023).

There are four important conditions required for conceptual change: Learners must feel dissatisfied with their current conceptions, the new conception must be intelligible, the new conception must be plausible and logically acceptable, and the new conception must offer perceived usefulness (Strößner, 2022; Thagard, 1990).

Stepans developed the Conceptual Change Model (CCM) based on a constructivist approach, which consists of six process stages (Stepans, 2005). The first stage is eliciting learners' conceptions of a particular event or physical phenomenon, the second is revealing the level of confidence students have in their conceptions, the third stage confronts students' beliefs through observation of real phenomena, the fourth stage provides scientific explanations to help learners accommodate new scientific conceptions, the fifth stage reinforces and extends the new conception, and the sixth stage encourages learners to explore new ideas aligned with the accommodated conception.

Other researchers have also utilised CCT in areas such as physics, where CCTs have been refined to address misconceptions about abstract and microscopic phenomena (Naeem Sarwar et al., 2024). These texts are further supported by science learning grounded in local wisdom. Beyond learning progression, another aspect that can indicate conceptual development is the level of conceptual change, which describes the transformation of learners' conceptions from before to after instruction (Krajcik & Shin, 2023). These levels are classified into several categories (Sinatra & Mason, 2013): 1) initial scientific conception (ISC): the learner has a scientifically accurate conception from the beginning to the end. 2) static: the learner holds onto the same misconception or lack of knowledge before and after learning. 3) disorientation: the learner's conception changes for the worse (e.g., from correct to incorrect or uncertain). 4) revision (reconstruction): The learner moves from a misconception to a scientifically accurate conception. 5) Construction: The learner shifts from a lack of knowledge to a scientifically accurate conception. 6) Initial scientific conception is a level of conceptual change in which students demonstrate possession of scientifically accurate conceptions both in the initial and final responses.

This study was conducted to explore the level of conceptual change experienced by prospective elementary school teachers during science learning based on local wisdom, specifically regarding the concept of neutral objects.

2. Method

This study used a descriptive quantitative method to collect, process, and analyse data in order to draw meaningful conclusions (Creswell & Creswell, 2017). The research was conducted with students from the Primary School Teacher Education Study Program at Universitas Kristen Indonesia Toraja. The research followed several stages, beginning with a review of the Semester Learning Plan for the Basic Science Concepts course. The goal of this stage was to identify potential misconceptions related to various science topics taught in the curriculum. The selected topic and concept for instruction was electricity, with a narrowed focus on static electricity, particularly the concept of neutral objects. This focus aimed to direct the study toward a specific and relevant concept aligned with the research objectives.

Next, the Four Tier Test instrument was designed. This stage involved creating a diagnostic instrument specifically designed to identify students' misconceptions. The Four Tier Test consists of four levels or tiers, each requiring a different type of student response to assess their understanding of the neutral object concept. The following stage was expert validation. Once the Four Tier Test was designed, it was validated by an expert, such as a lecturer in Basic Science Concepts, to ensure the

[e-**ISSN 2598-5949** | p-**ISSN 2303-1514**]

instrument's validity and accuracy for research purposes. After validation, the test was implemented with the students at Universitas Kristen Indonesia Toraja who had previously studied the topic of neutral objects in the context of static electricity. The instrument was administered to a random sample of 30 students.

Using a descriptive quantitative approach and the Four Tier Test, the study aimed to gather and analyse data regarding students' misconceptions about the concept of neutral objects. The analysis was used to understand the levels of conceptual change that occurred during science learning, informed by local wisdom and knowledge. Several possible initial conceptual states could be revealed in Parts I and II of the test: Scientific Conception (SC), Lack of Conception (LC), and Misconception (MC). These conceptual states may shift after students participate in learning activities. The type of conceptual change from the initial state (Part I) to the final state (delayed test) is referred to as the level of conceptual change. The levels of conceptual change that may occur among the students include: Initial Scientific Conception (ISC), Construction (C), Reconstruction (R), Static (S), and Disorientation (D) (Abrahamson et al., 2015).

3. Results

The results of identifying the level of conceptual change in pre-service teachers through local wisdom-based learning can be seen in the following table:

Table 1. Identification of Conceptual Change Levels in Pre-Service Teachers through Local Wisdom-Based Learning

Level of Conceptual Change	Students	Total	Percentage
Initial Scientific Conception (ISC)	1,5,7,24	4	12,97%
Static (S)	8,10	2	6,9 %
Reconstruction (R)	2,4,6,9,11,12,13, 14,15,16,17,18, 19,20,21,22,23, 25,26,27,28,29,30	23	77,18%
Construction (C)	3	1	4,01%
Disorientation (D)		0	0%

Table 1 above shows the percentage of pre-service elementary school teachers at each level of conceptual change that occurred. Of all the research subjects tested during the remedial teaching phase, 12.97% were at the level of Initial Scientific Conception (ISC), 6.98% at the Static (S) level, 77.18% at the Reconstruction (R) level, 4.01% at the Construction (C) level, and 0% at the Disorientation (D) level. The conceptual progress of pre-service elementary teachers in understanding static electricity material was significant. Of all students who had misconceptions during the initial test, 65.42% were effectively accommodated and progressed to understanding the concepts. For the topic of electricity as a whole, the understanding rate reached 71.28%. For all materials, the figure reached 71.12%, indicating that the effectiveness of learning assisted by Conceptual Change Text (CCT) is relatively high in shifting pre-service teachers from misconceptions to scientific conceptions and from a lack of conceptual understanding to having a scientific understanding.

An indication of this effectiveness is shown by the number of students with consistent Initial Scientific Conception (ISC), those who experienced construction and reconstruction, as well as those who remained static without any change. It is evident that, across all test materials, 12.97%

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of students maintained consistent scientific understanding from the pre-test to the post-test, while 4.01% experienced construction and 77.18% experienced reconstruction. Meanwhile, 6.98% of students remained static and retained their misconceptions. The progress varied across subtopics. The highest rate of conceptual construction occurred in the electric circuit subtopic (35.0%), followed by static electricity (28.89%). The highest conceptual reconstruction occurred in static electricity (25.56%) and electric circuits (20.83%).

In general, this local wisdom-based science learning approach increased the number of students with scientific concepts from approximately 23% in the pre-test to over 81% in the post-test. Conversely, it reduced the number of students with misconceptions from approximately 37%–47% in the pre-test to around 6%–11% in the post-test, demonstrating that the learning tools were effective in increasing the number of students who understood scientific concepts and reducing the number of students with misconceptions. The effectiveness of this instructional approach is also evident through an analysis of progress in conceptual understanding from the pre-test to the post-test.

4. Discussion

The research findings indicate that the use of Conceptual Change Text (CCT) in local wisdom-based learning effectively transforms the misconceptions of elementary pre-service teachers into a scientific understanding. This is evident from the dominance of the reconstruction category at 77.18%, indicating that the majority of students experienced a shift in their conceptions from initially incorrect to scientifically accurate after the learning process. This finding aligns with Chi et al. (1994), who stated that conceptual change occurs when learners recognise a discrepancy between their initial conceptions and scientific phenomena and are willing to adopt new, more explanatory conceptual alternatives.

Furthermore, 12.97% of students already held scientific conceptions from Initial Scientific Conception (ISC) and remained consistent through the final test. This indicates that a portion of students had a strong conceptual understanding even before the instructional intervention. Meanwhile, only 6.98% of students remained at the static level, meaning they retained their misconceptions despite being exposed to CCT-based instruction. This suggests that, although the approach is practical, not all students immediately undergo conceptual change, as noted by Pintrich et al. (1993), who observed that conceptual change is a complex process influenced by various factors, including motivation, prior knowledge, and individual learning strategies.

Interestingly, 0% of students were at the disorientation level, indicating that no student experienced total confusion regarding the taught concepts. This reflects that the materials and instructional approach used were explicit and did not create ambiguity that could hinder understanding. Additionally, the most significant progress was made in the subtopics of electric circuits and static electricity, which demonstrated dominant levels of reconstruction and construction, respectively. This demonstrates that contextual content close to students' daily lives is more easily internalised, as emphasised by Garzón-Díaz (2021), who stated that integrating local context into science learning can enhance the relevance and engagement of learners.

Therefore, this approach increased the percentage of students with scientific concepts from approximately 23% in the pre-test to around 81% or more in the post-test, and reduced the percentage of misconceptions from around 37% to 6% or less. This effectiveness is further supported by Perdana et al. (2018), whose study showed that the use of conceptual change texts can significantly reduce misconceptions and improve students' conceptual understanding in science learning.

[e-**ISSN 2598-5949** | p-**ISSN 2303-1514**]

Thus, it can be concluded that the use of conceptual change text integrated with Toraja local wisdom in science learning not only corrects misconceptions but also strengthens the overall scientific understanding of pre-service teachers. This approach supports the development of contextual and meaningful education that aligns with local characteristics and the needs of learners in the region.

5. Conclusion and Implications

The study shows that There are five levels of conceptual change observed among elementary pre-service teachers, namely: Initial Scientific Conception (ISC) at approximately 12.97%; Static (S) at around 6.98%; Reconstruction (R) at approximately 77.18%; Construction (C) at about 4.01%; and Disorientation (D) at 0%. This study indicates that the use of Conceptual Change Text (CCT) demonstrates a high level of effectiveness (greater than 81.19%) in achieving both construction and reconstruction levels, while also being highly effective in minimising misconceptions in science learning.

6. Limitation

This study is limited by its small sample size and focus on a single topic, which may reduce generalizability. It used only quantitative data and one diagnostic tool, without exploring long-term retention or students' deeper reasoning processes.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

Ethical Declaration

All participants provided informed consent prior to participating in the study. They were made aware of the study's purpose, procedures, and their right to withdraw at any time without penalty.

Acknowledgement

The authors gratefully acknowledge Universitas Kristen Indonesia Toraja (UKI Toraja) for providing financial support for both the research and its publication. Their contribution played a vital role in the successful completion of this study.

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