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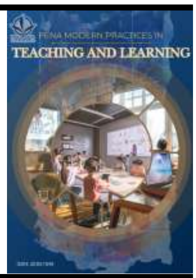

The Effects of the Chain Link Method on the Enhancement of Problem-Solving Skills among Secondary School Students

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ABSTRACT

This study aims to evaluate the effects of the Chain Link method on enhancing problem-solving skills among secondary school students using a quantitative research design. The Chain Link method was applied as a structured learning strategy that enables students to connect concepts in a sequential and progressive manner. This approach is intended to help learners form clearer cognitive links between key ideas, problem-solving steps, and the underlying principles of the subject matter. This suggests that students interpret and internalise new information differently, resulting in diverse levels of conceptual understanding and problem-solving abilities. By guiding students to organise information systematically, the Chain Link method supports deeper conceptual understanding and promotes more efficient learning. A total of 130 respondents participated in this study, consisting of 87 teachers and 43 secondary school students, selected through the distribution of a Google Form. The research instrument was a Likert-scale questionnaire measuring three constructs which are students' ability to connect concepts, their perceptions of the Chain Link method, and the level of improvement in problem-solving skills. These constructs were chosen to provide a comprehensive assessment of both cognitive and affective learning outcomes. Data were analysed using IBM SPSS Statistics, and descriptive analyses were conducted to determine the method's overall effectiveness. Minimum, maximum, mean, and standard deviation values were calculated for each questionnaire section. The mean scores for Section B, Section C, and Section D were 4.19, 4.24, and 4.21 respectively, indicating consistently high levels of agreement across all constructs. The findings show that the Chain Link method significantly enhances students' ability to connect learning concepts and improves the organisation of their problem-solving processes. Students expressed highly positive perceptions of the method, describing it as engaging, easy to follow, and effective in sustaining motivation. Teachers also recognised its potential to strengthen instructional clarity and learning outcomes. Overall, the results confirm that the Chain Link method is an effective instructional strategy for improving problem-solving skills among secondary school students, offering strong potential for wider adoption in classroom settings.

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1. Introduction

Problem-solving is widely acknowledged as an essential skill for secondary school students in the 21st century, Ramdzan *et al*., [1] stated that the methods of implementing 21st Century Learning (PAK-21) are indeed effective and Meng *et al*., [2] to engage in creative and applied thinking. This shows how important it is to use teaching methods that get students involved in building their own knowledge. Instead of just memorizing facts, these methods should encourage students to think about circumstances, draw connections between ideas, and use what they know in real-life scenarios. Educational systems globally prioritize not only content knowledge but also the capacity to analyze situations, formulate alternatives, and employ logical methodologies to achieve viable solutions [3]. This focus shows that there is a rising need for students to use higher order thinking skills, which are necessary for dealing with real-world problems effectively. Students who can solve problems in a structured way are better prepared for college, the workplace, and making decisions in real life. Nonetheless, numerous adolescents continue to face challenges in organizing multi-step processes, applying knowledge to novel contexts, and maintaining the cognitive strategies essential for complex problem-solving [4]. This challenge frequently arises from insufficient exposure to instructional methodologies that explicitly assist learners in integrating individual stages into cohesive sequences, leading to fragmented comprehension and diminished capacity to transfer problem-solving skills across various contexts. These gaps necessitate instructional strategies that decompose intricate tasks into manageable sequences while simultaneously fostering students' ability to integrate steps into a cohesive whole. The emphasize the importance of diverse teaching strategies to meet the varied needs and learning styles of students [5]. As a result, teaching methods like the chain link method offer an organized way to study that helps students gradually acquire the material by leading them through a series of steps while also encouraging a full understanding. This way, students with different cognitive skills and learning styles may all benefit. In addition, it can improve student achievement [6], through the use of diverse classroom activities [7]. This method gets students involved, which helps them grasp things better and do better in school by giving them a variety of learning experiences.

The chain link or chaining approach in teaching meets this need by purposefully structuring learning as a series of connected steps. The Chain Link method provides a structured, step-by-step approach to logical thinking [8]. The chain link approach helps students improve their problem-solving skills by breaking down difficult activities into phases that are connected in a logical way. This helps them learn how to connect ideas in a methodical way. In educational literature, chaining can take different forms depending on the target skill. Forward chaining teaches the first step and proceeds sequentially, backward chaining begins with the final step so that learners quickly experience success, and narrative or word-chain techniques create meaningful sequences that enhance memory and transfer of learning [9]. These chaining approaches give systematic advice that helps people learn by breaking things down into smaller, more manageable steps. This way, learners can gradually improve their skills and remember what they've learned better. The primary pedagogical benefit of chaining lies in its scaffolding effect. It diminishes cognitive load by segmenting individual actions and subsequently reassembling them into a coherent sequence, enabling students to practice both the discrete components and the integrated entirety [9,10]. By dividing hard activities into smaller, more manageable pieces, chaining helps students focus on each step one at a time while progressively putting them all together. This helps them learn and master skills and makes learning easier.

Chaining has a well-established history in language acquisition and behaviorally based skill training. However, its particular impact on secondary-level problem-solving has yet to be unified in a singular, contemporary body of research. Research on chaining in vocabulary instruction and writing indicates significant improvements in retention and production when steps are clearly linked for learners [9-10]. While chaining has proven effective in language and skill acquisition, its application in secondary-level problem-solving remains underexplored. Studies in vocabulary and writing demonstrate that clearly sequenced steps enhance learners' retention and performance, suggesting potential benefits for problem-solving tasks. Research on classroom questioning and question-chain patterns suggests that sequential questioning by teachers fosters deeper reasoning and idea integration skills that are closely associated with problem-solving [11]. These varied results indicate that a chain link approach, meticulously tailored to problem-solving tasks, may enhance students' procedural comprehension and strategic adaptability. So, when the chainlink approach is used with certain problem-solving tasks, students may better understand each phase of the process and use solutions more successfully.

The chaining is consistent with cognitive load theory and information processing models. It divides a complicated task into smaller, linked parts, which makes it easier for working memory to handle and allows for the proceduralizing of routines [3]. At the same time, chaining helps metacognitive growth because students have to keep track of how they move from one step to the next and think about how well each link in the chain worked. Chaining has been effectively employed in applied classroom studies within mathematics and STEM project settings to assist students in navigating multistage problems and to facilitate reflection on problem-solving strategies [4]. Likewise Santos-Trigo [12] highlighted the importance of problem solving and reflection. Similar to study Ramdzan *et al.*, [1] that utilized concept mapping and study RSIS [13] that applied mind mapping, both approaches seek to organize learning concepts systematically, thus enabling students to better comprehend the relationships between ideas in a clearer and more meaningful way. This theoretical and empirical foundation establishes the expectation that a chain link method and crafted to instruct explicit step sequences, deliver clear linking cues, and promote reflection that will enhance the speed, accuracy, and transferability of secondary students' problem-solving abilities.

There isn't a lot of research that directly looks at chain-based interventions and problem-solving outcomes at the secondary level, but what there is looks promising. For instance, the research, [9, 10] on structured sequential activities (like chain writing and word chains) shows that they can lead to measurable improvements in the quality and completeness of tasks, which are indirect measures of the kinds of procedural control needed for problem solving. Research on teacher questioning chains demonstrates that structured sequences of prompts can guide students through progressively intricate reasoning steps, thereby facilitating the solution process [11]. In other words, evidence from related fields indicates that chaining may be effective in developing both the mechanics (understanding the necessary steps) and the cognition (comprehending the rationale and timing for those steps) of problem-solving in adolescents.

Based on this theoretical justification and initial empirical evidence, the current study seeks to evaluate the impact of an intentionally crafted Chain Link Method on the problem-solving abilities of secondary school students. This study employs an adaptation of chaining principles to multi-step academic problems: learning tasks are deconstructed into distinct sub-steps, each link is explicitly taught and practiced, and students are directed to establish and assess connections between links, enabling them to apply sequences flexibly to novel problems. This study looks at both performance improvement and changes in students' strategic behaviors to find out if chaining leads to not only short-term gains but also more transfer of problem-solving strategies across contexts, which is an important goal for educational practice.

This study enhances the educational literature by evaluating a practical classroom method based on cognitive theory and corroborated by related empirical research [3,4] If it works, the Chain Link

Method could give teachers a clear, evidence-based way to teach students how to solve complex problems. This would help students go from trying to solve problems in a piecemeal way to doing it in a thoughtful, repeatable way that works for more than one lesson or topic. The approach has been shown to enhance students' interest in descriptive writing [14], while traditional methods are reported to attract less student interest [15], which is consistent with the objectives of 21st Century Learning (PAK-21).

A survey design incorporates a systematic and well-planned technique for processing acquired data to obtain the information needed to meet the study objectives. [16] Introducing students with problem framing, problem solving, and reflection demands logical, analytical, and flexible thinking and develops critical thinking (higher-order thinking skills) to enhance problem-solving abilities through a range of instructional activities [17]. So, this study aims to determine the extent to which the chain link method assists students in connecting learning concepts during problem-solving, to identify students' levels of perception toward the use of the chain link method in the teaching and learning process, and to assess the effectiveness of the chain link method in enhancing students' logical and higher-order thinking skills (HOTS).

Teaching practices that remain oriented toward conventional approaches and focus on the isolated delivery of procedures have been found to be less effective in supporting the development of integrated conceptual understanding, thereby limiting the cultivation of higher order thinking skills (HOTS) among students. In this regard, the Chain Link method is introduced as a structured learning strategy that emphasizes the sequential and progressive linking of ideas to assist students in developing more systematic thinking. Nevertheless, the extent to which this method is effective in helping students connect learning concepts in problem solving, students' perceptions of its use in the teaching and learning process, and its impact on the enhancement of logical and critical thinking have yet to be empirically established through systematic research. This discussion covers numerous major components, including research design, research techniques, study participants, research instruments, data collection procedures, and data analysis procedures [18].

2. Methodology

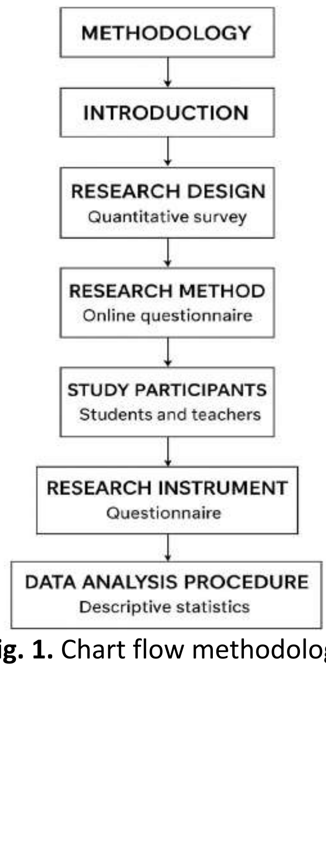

Fig. 1. Chart flow methodology

2.1 Introduction

Figure 1 shows chart flow of methodology that refers to the most appropriate methods used to conduct a study and to determine effective procedures for addressing the research problems, thereby helping the researcher achieve the objectives of the study. Based on Figure 1, the discussion covers several key components, including research design, research methods, study participants, research instruments, data collection procedures, and data analysis procedures [17,18].

2.2 Research Design

This study employs a quantitative research design using a survey approach. The survey design was selected as it is suitable for collecting comprehensive data from a large sample within a short period through an online questionnaire. The survey method is also widely used in educational research to objectively evaluate students' perceptions, mastery levels, and learning experiences. A survey design involves a systematic and well-planned procedure for processing collected data to obtain the information needed to achieve the research objectives [16]. This procedure enables researchers to obtain a quantitative overview of the variables under investigation through the use of standardized instruments such as questionnaires.

Therefore, this research design aligns with the purpose of the study, which is to identify the effects of using the Chain Link Method on secondary school students' problem-solving skills based on the perception data gathered.

2.3 Research Method

This study was conducted using a fully quantitative research method, whereby data were collected solely through an online questionnaire distributed via Google Forms. This method involves the collection of numerical data, followed by descriptive statistical analysis and basic inferential interpretation. Data were obtained only once through a single set of questionnaires that measured students' perceptions of the use of the Chain Link Method and their level of problem-solving skills.

2.4 Study Participants

The participants of this study consisted of two groups: secondary school students aged 13 to 18, and secondary school teachers aged 19 to 52. Participants were selected using purposive sampling, in which individuals were chosen based on their relevance and suitability to the objectives of the study. The selection criteria were as follows:

i) Students (13–18 years old)

The study involved students who were currently participating in teaching and learning (T&L) sessions at a secondary school. These students had prior exposure to examples or activities that incorporated problem-solving in specific subjects. Participation in the study was voluntary, with students willingly agreeing to complete the questionnaire. This ensured that the data collected reflected the perceptions and experiences of students who were actively engaged in the learning process and had some familiarity with problem-solving tasks.

ii) Teachers (19–35 years old, MySTEP teachers, and teachers aged 38, 42, and 52)

The study involved teachers currently teaching at a secondary school in fields related to teaching and learning (T&L). These teachers had prior experience implementing problem-solving activities during their instructions. Participation was voluntary, with all respondents agreeing and being available to complete the research questionnaire. This ensured that the data reflected the perspectives of educators who actively engage in problem-solving tasks within their teaching practice. This study collected data from both groups to obtain a more comprehensive understanding of the implementation of the Chain Link Method within the context of teaching and learning.

2.5 Research Instrument

The research instrument used in this study was a Google Form questionnaire specifically designed based on the objectives of the study. The questionnaire consisted of four main sections, covering demographic information, understanding of the Chain Link Method, students' perceptions, and their level of problem-solving skills.

2.5.1 Section A: Respondent demographics

This section included items related to gender, age, and respondent status whether the individual was a student or a teacher as well as the location of their school and their ethnicity. In addition, participants were asked about their basic understanding and initial exposure to the Chain Link concept. Collecting this demographic information was important to ensure that the study could interpret the findings accurately based on participant characteristics and identify any potential differences across groups.

2.5.2 Section B: Students' understanding of the Chain Link Method

This section consisted of Likert-scale items ranging from 1 to 5, allowing respondents to indicate their level of agreement or understanding with each statement provided. The items were constructed to measure how effectively the Chain Link Method supports students in connecting various learning concepts when solving problems. Furthermore, this section evaluated students' comprehension of the structure of the method, the steps involved in linking concepts, and the overall clarity of the chain-linking process within teaching and learning. The data collected from this section offered insights into how well students grasped the method and its application in academic settings.

2.5.3 Section C: Students' perceptions of the use of the Chain Link Method in PdP

This section focused on students' perceptions regarding the use of the Chain Link Method in the teaching and learning process. Likert-scale items (1–5) were used to measure students' views on the effectiveness, ease of use, readiness, and acceptance of the method. In addition, this section explored students' learning experiences, motivation, and interest when engaging with the Chain Link Method. The findings from this section provide insight into how well students respond to the method and how it influences their engagement and participation in learning activities.

2.5.4 Section D: Effectiveness of the Chain Link Method on problem-solving skills and Higher-Order Thinking Skills (HOTS)

This section evaluates how effective the Chain Link Method is in improving students' problem-solving skills and Higher-Order Thinking Skills (HOTS). Likert-scale items (1–5) were used to assess students' logical reasoning, critical thinking, and analytical abilities. It also measured their confidence in solving problems, strategies used, clarity of conceptual connections, and ability to analyse and evaluate information. The results highlight the method's impact on developing students' higher-order thinking skills and enhancing their problem-solving capabilities in a structured way.

2.6 Data Collection Procedure

The data collection procedure was conducted entirely online through the distribution of Google Forms.

2.6.1 Questionnaire
2.6.1.1 Instrument preparation

The questionnaire was constructed using Google Forms and reviewed to ensure appropriate language use and clarity for student comprehension.

2.6.1.2 Distribution of the questionnaire

The questionnaire link was distributed online to students who met the study's criteria. Distribution was carried out through school platforms or communication applications such as WhatsApp and Facebook.

2.6.1.3 Participant consent

The introduction section of the form explained the purpose of the study, data confidentiality, and voluntary participation.

2.6.1.4 Data collection

All submitted responses were automatically recorded in Excel and SSPS for further analysis. No interviews, observations, or pre–post tests were conducted in this study.

2.7 Data Analysis Procedure

The data collected in this study were analysed using descriptive statistics and basic statistical methods with the aid of software such as SPSS. The analysis process included calculating frequencies and percentages for demographic data, as well as determining the mean and standard deviation for Likert-scale items. Descriptive analysis was then used to interpret students' perceptions of the Chain Link Method and their levels of problem-solving skills. The findings were presented in a clear and systematic manner through tables, graphs, and narrative explanations to provide a comprehensive understanding of the results.

3. Results and Discussion

This section presents the results of the questionnaire analysis conducted on the respondents to address the research objectives. The data were systematically analyzed, beginning with the respondents' demographic information, followed by the examination of each research element using percentage statistics, mean scores, and frequency distributions.

3.1 Section A: Respondent Demographics

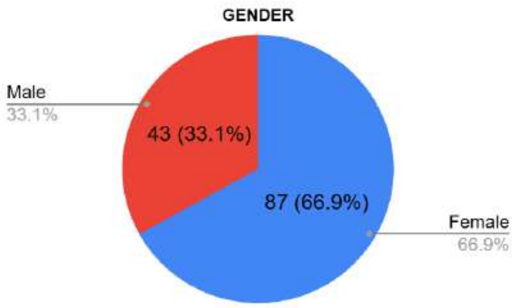

Fig. 2 Distribution of respondents by gender

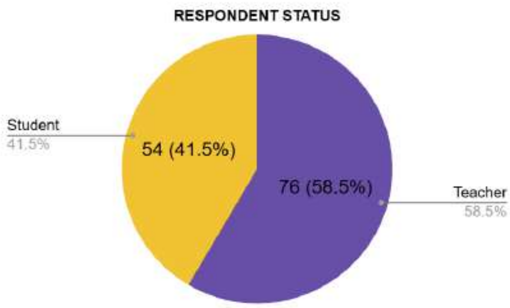

Fig. 3 Distribution of respondents by status

Figure 2 illustrates the distribution of respondents by gender with a total of 130 respondents. The findings indicate that most of respondents were female, totalling 87 individuals (66.9%), while male respondents accounted for 43 individuals (33.1%) of the overall sample.

Figure 3 depicts the types of respondents involved. The largest group comprised teachers, representing 76 individuals (58.75%), followed by students with 54 individuals (41.5%). The dominance of the teacher category suggests that most feedback was obtained from educators, thereby highlighting that teachers' perspectives were more prominent in the research findings compared to those of students.

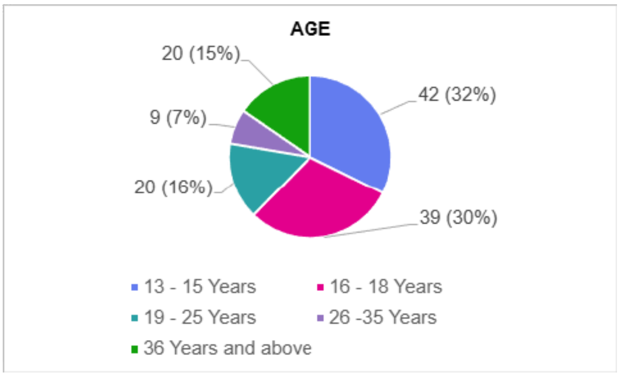

Fig. 4. The age distribution of the respondents

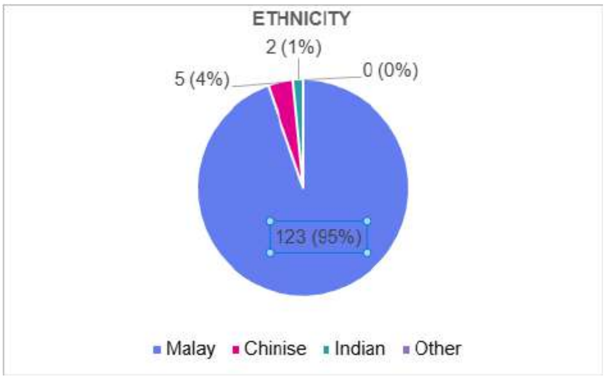

Fig. 5. The ethnic distribution of the respondents

Regarding to Figure 4 which is respondents' age, the majority were adolescents aged between 13 and 18 years. The 13–15 age group recorded the highest number with 42 respondents (32%), closely followed by the 16–18 age group with 39 respondents (30%). Additionally, 20 respondents (16%) were aged 19–25 years, while 9 respondents (7%) fell within the 26–35 age group. Moreover, 20 respondents (15%) were 36 years and above. These data clearly indicate that more than half of the respondents were adolescents, highlighting that the study predominantly attracted the attention of younger age groups.

Based on Figure 5, in terms of ethnicity, the study was dominated by Malay respondents, accounting for 123 individuals (95%), followed by Chinese respondents with 5 individuals (4%) and Indian respondents with 2 individuals (1%), while no respondents were from other ethnic groups. This composition demonstrates a very high level of participation from the Malay community, whereas involvement from other ethnic groups was relatively low.

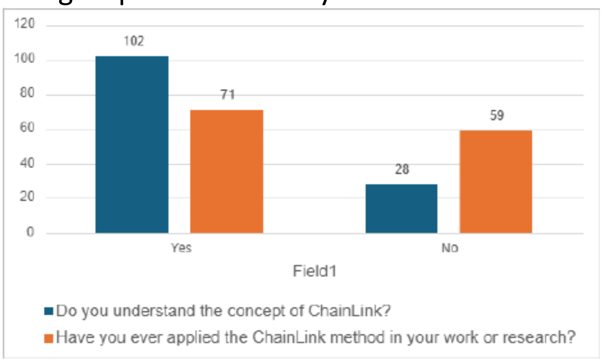

Fig. 6. Respondents' understanding of the Chain Link concept and their applied the Chain Link method in work or research

From Figure 6, the respondents' level of understanding of Chain Link is presented, where the majority 120 respondents reported that they understood the meaning of Chain Link. This indicates a high level of awareness and knowledge regarding the use of Chain Link in learning activities among the respondents. Meanwhile, 28 respondents stated that they did not understand the meaning of Chain Link, suggesting that a small group remains less exposed to related information. A total of 71 respondents reported that they had used Chain Link before, indicating that nearly half of the respondents not only understood the concept but had also applied it in practice. However, 59 respondents stated that they had never used Chain Link.

3.2 Section B: Determing the extent to which the Chain Link Method can assist students in connecting learning concepts to solve problems

Table 1
Summary of descriptive statistics for section B

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
1.Before the implementation of the Chain Link method, the level of problem-solving skills was low and students were unable to relate the topic.	130	2	5	3.91	0.802
2.After using the Chain Link method, students were more able to explain the steps of problem-solving in a logical and structured manner.	130	2	5	4.28	0.747
3.The Chain Link method helps students understand how one concept is connected to another within a topic.	130	2	5	4.30	0.700
4.I can see the relationship between the steps in problem-solving more clearly after using the Chain Link method.	130	2	5	4.21	0.754
5.Through the Chain Link method, it becomes easier to link prior knowledge with new knowledge when solving problems.	130	2	5	4.25	0.727
6.I am able to understand the relationship between theory and practice through the use of the Chain Link method.	130	1	5	4.17	0.779
7.I find it easier to explain the concepts to my peers when using the Chain Link method.	130	2	5	4.19	0.716
8.The Chain Link method helps in remembering important concepts more effectively.	130	2	5	4.22	0.718
Valid N (listwise)			130		

Table 2
Total of descriptive statistics for section B

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
MeanB	130	2.00	5.00	4.1904	0.62939
Valid N (listwise)			130		

Table 1 presents the descriptive statistical analysis for Section B, which aimed to measure students' level of understanding after using this method as a guide in problem-solving. The descriptive statistical analysis indicates that all items achieved high mean scores, ranging from 3.91 to 4.30, reflecting a strong level of agreement on the effectiveness of the Chain Link method in helping students connect learning concepts for problem-solving purposes. Item 3 obtained the highest mean score (4.30) with a standard deviation of 0.700, emphasizing that this method significantly reinforces students' understanding of the relationships between concepts. This finding aligns with several studies highlighting the importance of visualizing concept relationships, such as concept mapping [13,14] which is improves student achievement by helping them see the organization and interconnections among STEM concepts. These results are consistent with previous research indicating that concept-based learning methods, such as mind mapping [1], enhance deep understanding and reduce cognitive load because information is presented visually and in a structured manner. This outcome aligns with the principles of the Chain Link Method, which also emphasizes the systematic linking of ideas to facilitate students' comprehension and retention of both concepts and complex knowledge. Furthermore, this approach promotes critical thinking and simplifies the process of information organization, enabling students to move beyond rote memorization and meaningfully connect new concepts with prior knowledge. Consequently, students develop deeper and more effective understanding, especially in relation to higher-order thinking skills.

Based on Table 1, Item 1 recorded the lowest mean score of 3.91 with a standard deviation of 0.802. This mean value indicates a moderate level of agreement among respondents for this item, suggesting that their agreement is not yet strong. The moderate standard deviation also reflects some variation in opinions among respondents, possibly due to limited clarity or insufficient exposure to the use of the Chain Link method in actual learning contexts. Therefore, Item 1 can be interpreted not merely as a rejection of the Chain Link concept, but rather as an indication that students require more exposure, practice, and understanding of how the method works in order to accurately assess its effectiveness.

Overall, as on table 2, the Chain Link method demonstrated an overall mean of approximately 4.1904, indicating a high level of acceptance and perceived effectiveness among students. The standard deviation of 0.62939 reflects moderate variability, suggesting that most students share similar views, although slight differences in the level of agreement are present.

3.3 Section C: Students' Perception Level Regarding the Use of the Chain Link Method in the Teaching and Learning Process

Table 3
Summary of descriptive statistics for section C

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1.The Chain Link method helps increase students' active engagement in the learning process	130	2	5	4.28	0.729
2. Chain Link makes it easier for students to remember and apply concepts.	130	2	5	4.37	0.695
3.I understand how the Chain Link method is used in learning.	130	2	5	4.19	0.808
4.I am able to use the Chain Link method to understand learning topics better.	130	2	5	4.19	0.716
5.The Chain Link method helps students focus more during lessons.	130	2	5	4.26	0.742
6.Chain Link makes learning easier to understand compared to traditional methods.	130	2	5	4.30	0.678
7.I believe the Chain Link method is suitable to be used for all subjects.	130	1	5	3.98	0.980
8.The Chain Link method makes problem-solving activities more interesting and enjoyable.	130	2	5	4.33	0.698

Valid N (listwise)	130

1

Table 4
Total of descriptive statistics for section C

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
MeanC	130	2.00	5.00	4.2394	0.63472
Valid N (listwise)			130		

The analysis of Section C as in Table 3 that indicates all items received high mean scores, ranging from 3.98 to 4.37, reflecting students' positive perceptions of the effectiveness of the Chain Link method in enhancing understanding and learning. The highest mean score of 4.37, with a standard deviation of 0.695 for Item 2, suggests that the method effectively helps students comprehend and retain concepts. Respondents generally strongly agreed, and their responses were consistent. This demonstrates that the implementation of 21st Century Learning (PAK-21) improves understanding and knowledge that can be applied in practice [1].

Item 7, which had the lowest mean score of 3.98 and a standard deviation of 0.980, indicates that respondents still agreed with the item but were less confident compared to items with higher means. While respondents accepted the Chain Link method, it may be more suitable for certain subjects, reflecting the limitations of applying a single teaching method universally. Therefore, teaching strategies should be diverse and adapted according to the nature of the subject, the students' level, and the learning objectives. A flexible approach, such as the Chain Link method, has the potential to be more effective when combined with other methods tailored to the teaching context. This is due to the differences in students' learning needs and learning styles. Furthermore, Meng *et al.*, and [2] Kridis [9] demonstrates that mixed teaching strategies can enhance students' "ambidextrous innovation," fostering both creative and practical thinking skills. In addition, the use of models such as the flipped classroom, Noh *et al.*, [6] that non-traditional methods can improve student achievement in science subjects, indicating that a combination or variation of methods can have a positive cross-disciplinary impact. These findings affirm that the Chain Link method is one of the activities aligned with 21st Century Learning (PAK-21).

In modern learning, activities aligned with PAK-21 have shown positive developments in student learning. This indicates that traditional teaching approaches are less effective in engaging students, as learning involves passive information reception. Item 6, a mean score of 4.30, indicates strong agreement that the Chain Link method helps students understand learning more easily compared to traditional methods such as lectures and linear notes. This approach can enhance students' interest in descriptive writing [13,14]. In contrast, traditional methods are less effective in engaging students, as they involve passive reception of information [15,16]. The low standard deviation (0.678) further indicates that students' opinions were consistent, with most respondents selecting "agree" or "strongly agree." These results suggest that the visualization of concept networks in the Chain Link method facilitates students in connecting ideas and enhances deep understanding. For additional data, see Table 3.

On table 2, data analysis on students' perceptions of the use of the Chain Link method in teaching and learning shows a mean score of 4.2394, with a standard deviation of 0.63472. These results indicate that most respondents have a positive and consistent perception of the Chain Link method. Academically, this suggests that the Chain Link method is not only well-received by students but also has the potential to enhance engagement and conceptual understanding during learning sessions, which teachers can apply in classroom activities. Therefore, this method can be considered an effective pedagogical strategy in the educational context.

3.4 Section D: The effectiveness of the Chain Link Method in enhancing logical and critical thinking through Higher-Oder Thinking Skills (HOTS)

Table 5
Summary of descriptive statistics for section D

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
1.The Chain Link method is suitable to be applied in topics that require higher-order thinking skills.	130	2	5	4.16	0.786
2.The use of the Chain Link method shows higher improvement compared to groups taught using traditional methods.	130	2	5	4.15	0.769
3.The Chain Link method helps me think more logically when solving problems.	130	1	5	4.25	0.737
4.I am more certain about identifying the root cause of a problem when using the Chain Link method.	130	1	5	4.24	0.786
5.The Chain Link method helps me think of various strategies to solve problems.	130	1	5	4.24	0.766
6.I think more carefully before making decisions when using the Chain Link method.	130	1	5	4.20	0.791
7.I feel my higher-order thinking skills (HOTS) increase after using the Chain Link method in learning.	130	1	5	4.21	0.764
8.Students can answer more challenging questions after using the Chain Link method.	130	2	5	4.24	0.691
Valid N (listwise)			130		

Table 6
Total of descriptive statistics for section D

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
MeanD	130	1.75	5.00	4.2096	0.65114
Valid N (listwise)			130		

Next from Table 3.4, the highest mean in the analysis of Section D, which is 4.25, while the standard deviation is 0.737, indicates a high level of agreement for item 3, which states that *the Chain Link method helps to think more logically when solving problems*. This means that, on average, respondents agree or strongly agree that the Chain Link method helps them think more logically when solving problems. In mathematics education, familiarizing students with problem framing, problem solving, and reflection requires logical, analytical, and flexible thinking [15] and stimulates critical thinking (higher-order thinking skills) to enhance problem-solving abilities through a variety of classroom activities [10,11]. The Chain Link method provides a structured, step-by-step approach to logical thinking [6,7] in problem solving because it offers structure, improves the clarity of the flow of ideas, and is supported by a high mean value and low standard deviation as evidence of its effectiveness. This demonstrates that the Chain Link method positively influences learning by developing competitive students who can generate new ideas in problem solving, and whose thinking becomes more open and mature when dealing with problems.

After the implementation of the Chain Link method, students demonstrated an improved ability to explain problem-solving steps more clearly, logically, and systematically, as this method emphasizes clear connections between each step of the solution process. This approach helps students understand the sequence of the solution process progressively, thereby reducing confusion and increasing focus on a systematic flow of thinking. When students are able to see the relationship between one step and the next, they find it easier to explain the reasons and methods used, while also encouraging critical thinking and reducing the tendency to guess answers without following proper procedures. The research findings support these observations, as Item 2 recorded the lowest mean value compared to other items at 4.15; however, it still falls within the high category on the 1–5 scale, indicating a positive level of agreement among respondents, albeit slightly lower than that of traditional methods. The moderate standard deviation (0.769) further indicates consistency in respondents' views regarding the effectiveness of this method.

Overall, as on table 2, the mean score for Section D was 4.2096 with a standard deviation of 0.65114, thereby reinforcing the finding that the Chain Link method is effective in supporting higher-order thinking skills (HOTS) and assisting students in developing systematic, organized, and well-reasoned thinking.

4. Conclusions

The objective of this study was to see how the Chain Link Method could help high school students improve their problem-solving skills. The overall results strongly support the research goals. The 130 people who answered the survey, which included 87 teachers and 43 students, all agreed on all of the constructs measured. Descriptive statistics show that the average scores for students' ability to connect ideas (Section B) is 4.19, for how they feel about the method (Section C) is 4.24, and for how well it helps them develop logical and critical thinking skills (Section D) is 4.21. These scores show that the people who answered found the method very helpful. The low to moderate standard deviations suggests that the responses were stable and consistent across the sample. The results show that the Chain Link Method does help students connect learning concepts, which was the goal of Objective 1. The items in Section B that got the most points show that students are better at recognizing and connecting relationships between ideas when they are led through a series of structured steps. This fits with what theory say: that linking with scaffolding makes things easier on the brain and helps people understand concepts better. The analysis of Objective 2, which looked at how students felt about using the Chain Link Method in teaching and learning, shows that students think the method is interesting, easy to follow, and helpful for understanding better. The high mean scores in Section C show that the method increases motivation and helps organize information better than traditional linear instructional methods. Some people said that the method might work better for some subjects, but overall, people were still positive and consistent in their acceptance. Objective 3 was to find out how well the Chain Link Method worked to improve higher order thinking skills (KBAT) and problem-solving skills. The results show that logical reasoning, analytical ability, and confidence in problem-solving all got better. Section D shows that the people who answered agreed that the method helps them think more clearly and logically about complicated problems. In short, the results show that the Chain Link Method is a useful and effective way to teach that can help students understand concepts better, get more involved in learning, and think more deeply. The results not only meet all the research goals, but they also show that the method could be used more widely in secondary schools. Its structured, step-by-step method gives teachers and students clear cognitive scaffolding that helps them work through difficult learning tasks. As a result, the Chain Link Method can be seen as a useful teaching tool for helping students get better at solving problems and getting more out of their learning in the classroom.

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