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Large-Scale Trial of Question Web Learning in Physics to Enhance Students' Scientific Questioning Skills

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ABSTRACT

Objective: Students' scientific questioning skills are essential in inquiry-oriented physics learning. However, many high school students still hesitate to ask questions and experience difficulty formulating testable scientific questions. This study aimed to examine a large-scale trial of the Question Web Learning model in physics learning to enhance students' scientific questioning skills. **Method:** This study was part of educational design research and employed a one-group pretest-posttest design during the assessment phase. The participants were 93 grade XI science students from 3 public senior high schools in Banda Aceh, Indonesia. Data were collected through classroom observations, a written scientific questioning skills test, field notes, and student response questionnaires. The data were analyzed descriptively using implementation categories, question-quality categories, normalized gain, and response percentages. **Results:** he findings showed that the Question Web Learning model was implemented in good to very good categories across five meetings in the three schools. Students' written test scores increased from the scientific category before learning to the very scientific category after learning, with high normalized gain in all schools. Classroom observations also showed an increase in the number and quality of students' questions, with no non-scientific questions recorded. **Novelty:** This study provides empirical evidence from a large-scale trial that Question Web Learning is a practical and effective for supporting students' scientific questioning skills in high school physics learning.

INTRODUCTION

Scientific questioning is one of the essential competencies in science learning because it connects curiosity, inquiry, reasoning, and evidence-based explanation. In physics classrooms, students do not only need to receive concepts from the teacher, but they also need to ask questions about physical phenomena, identify relationships among variables, and use questions as a starting point for investigation. Questioning is therefore closely related to scientific literacy, critical thinking, and science process skills. Recent studies continue to show that learning environments that provide space for inquiry, discussion, and student-generated questions can support deeper conceptual learning and stronger engagement in science (Dah et al., 2024; Andrian et al., 2025).

However, the ability to ask scientific questions is not automatically developed in ordinary classroom interaction. Many students tend to remain silent when teachers provide opportunities to ask questions. Some students are afraid of being laughed at, some do not know what to ask, and others think that asking questions means they have not understood the lesson. In physics learning, this problem becomes more serious because scientific questions should be clear, focused, related to observable variables, and potentially answerable through investigation. Without explicit learning support, students may produce questions that are too general, too factual, or unrelated to the scientific problem being studied (Wulandari & Hayati, 2022).

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The preliminary findings reported in the doctoral research underlying this article showed that the percentage of students who asked questions in physics learning was still low. Initial studies in several senior high schools found that only around 15% to 30% of students were active in asking questions, and a previous preliminary study reported that students' questioning participation was approximately 20%. These findings indicate that low questioning participation is not merely a temporary classroom problem, but a learning issue that needs to be addressed through a structured pedagogical model. In science learning, students need repeated practice, teacher guidance, and a classroom culture that values questions as part of learning rather than as signs of weakness (Yulaichah, 2024).

Question Web Learning was developed to respond to this problem. The model uses a question web as a learning structure that helps students connect one question with other related questions about a physics concept or phenomenon (Affandi & Nurjannah, 2018). In this model, students do not begin by asking questions orally in front of the class. Instead, they first construct written questions in small groups, organize the questions into a web, discuss the relationships among the questions, and then gradually present or ask the questions in class discussion. This process is expected to reduce students' fear of making mistakes and to help them move from written questions to oral questions. The model also places the teacher as a facilitator who provides initial phenomena, guides the formulation of scientific questions, encourages discussion, and gives appreciation for students' questioning efforts (Salam, et al., 2025).

The logic of Question Web Learning is supported by constructivist and social learning perspectives. Students construct their understanding through interaction with concepts, peers, teachers, and learning tasks. A question web provides a visual and verbal scaffold that allows students to organize their curiosity and transform it into more scientific inquiry. When students work collaboratively, they can compare questions, revise unclear statements, and learn how to connect questions to variables and evidence. This is consistent with the view that inquiry learning should not simply ask students to investigate, but should also provide sufficient support for identifying meaningful questions and interpreting evidence (Dah et al., 2024).

Previous studies have reported positive effects of question-based and inquiry-oriented learning. Nurjannah et al. (2020) found that question webs-based learning improved students' science process skills and scientific questioning skills compared with conventional learning. Similarly, Andrian et al. (2025) reported that a learning intervention integrating problem-based learning, teacher-student questioning, collaborative discussion, and inter-group question-and-answer activities improved students' questioning skills in physics learning. These studies suggest that questioning skills can be developed when the learning process deliberately provides opportunities for students to write, discuss, and express questions.

Nevertheless, a research gap remains in the empirical implementation of Question Web Learning across more than one school. Many learning model studies are carried out in one classroom or one school, so the results are often limited to a specific context. A large-scale trial is important because it provides a broader picture of whether the model can be implemented by teachers and accepted by students in different school settings (Zayrin, et al., 2025). In educational design research, the large-scale trial is also essential for examining the practicality and effectiveness of a prototype before it becomes a final learning model.

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In addition to cognitive performance, questioning also has an affective dimension. Students need to feel that the classroom is safe enough for them to express incomplete ideas. A student who is afraid of being judged may prefer to remain silent even when he or she has a question. For that reason, a learning model for questioning cannot only focus on the product of the question, but should also consider classroom climate, teacher appreciation, peer interaction, and the gradual movement from private thinking to public expression. Question Web Learning was designed with this concern because it allows students to prepare questions collaboratively before they are asked openly (Rambe, Afri, & Narpilla, 2025).

The present article also draws on earlier work on Question Web Learning and teacher mentoring. Evendi et al. (2018) reported that the implementation of question webs-based learning could improve students' scientific asking skills, while Wati et al. (2020) showed that mentoring physics teachers using question web-based learning helped teachers support students' scientific questioning ability. These studies demonstrate that the model is relevant not only for students, but also for teacher practice. The large-scale trial reported in this article extends these earlier findings by examining how the model worked across three high schools after being developed through educational design research.

In educational design research, the value of a learning model is not only judged from statistical improvement. A model should be connected to a real classroom problem, designed on the basis of theory, revised through trials, and assessed in a setting that is close to actual practice (Plomp & Nieveen, 2013). Therefore, this article does not only report the increase in test scores. It also discusses the implementation process, classroom constraints, student participation, and student responses. These aspects are important because a model that improves scores but cannot be implemented by teachers or accepted by students would have limited educational value.

The novelty of this article lies in the focus on the large-scale trial of Question Web Learning in physics learning. The model was not treated as a short activity or a simple worksheet, but as a complete learning model with sequential phases. The large-scale trial also involved three schools, so the findings provide a more realistic picture of the model's practicality. This is particularly important for physics learning in Indonesia, where teachers are expected to encourage students to observe, ask, investigate, reason, and communicate, but students often need structured support before they can participate actively in these processes.

Therefore, this article focuses on the large-scale trial of Question Web Learning in high school physics. The study was conducted in three senior high schools in Banda Aceh and examined the implementation of the model, the development of students' question quantity and quality, students' scientific questioning test results, and students' responses to the learning process. The objective of this article is to describe the practicality and effectiveness of Question Web Learning in improving students' scientific questioning skills in physics learning. The study is guided by the assumption that structured written-question practice, group discussion, and classroom questioning activities can improve students' confidence and ability to formulate scientific questions.

RESEARCH METHOD

This study was conducted as part of educational design research. The overall design research consisted of a preliminary study, prototype development, limited trial,

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revision, and large-scale implementation. This article reports the assessment phase, especially the large-scale trial, because this phase provides evidence of the practicality and potential effectiveness of the model after earlier revisions. The large-scale trial employed a one-group pretest-posttest design. Students were given a pretest before the implementation of Question Web Learning, participated in physics learning using the model, and completed a posttest after the learning sequence.

The research was carried out in three public senior high schools in Banda Aceh, Indonesia: SMA Negeri 3 Banda Aceh, SMA Negeri 4 Banda Aceh, and SMA Negeri 8 Banda Aceh. The participants were grade XI science students. The total number of participants was 93 students, consisting of 32 students from SMA Negeri 3 Banda Aceh, 31 students from SMA Negeri 4 Banda Aceh, and 30 students from SMA Negeri 8 Banda Aceh. These schools were selected because they were responsive to the improvement of physics learning quality and had learning conditions that allowed the model to be implemented. The physics topics taught during the large-scale trial were static and dynamic fluids.

Table 1. Research participants in the large-scale trial

School	Class	Number of students	Meetings	Physics topic
SMA Negeri 3	XI science	32	5	Static and dynamic fluids
SMA Negeri 4	XI science	31	5	Static and dynamic fluids
SMA Negeri 8	XI science	30	5	Static and dynamic fluids
Total	**-**	**93**		**-**

Question Web Learning was implemented in five meetings, excluding the pretest, posttest, and teacher simulation activities. The model consisted of five phases. In the first phase, the teacher identified the problem and explained the learning objectives. In the second phase, the teacher delivered initial information and guided students in constructing a question web. In the third phase, students discussed scientific questions in class. In the fourth phase, the teacher and students conducted reflection and appreciation. In the fifth phase, the teacher evaluated the learning process and outcomes. During the learning process, students were guided to move gradually from written questions in small groups to oral questions in class discussion.

The instruments used in the large-scale trial included an implementation observation sheet, a question quantity and quality observation sheet, a written scientific questioning skills test, field notes on learning constraints, and a student response questionnaire. The implementation observation sheet was used to record the extent to which each phase of the model was carried out. The question quantity and quality observation sheet was used to record students who raised their hands, students who asked questions, and the category of each question. The written scientific questioning skills test consisted of essay items designed to measure students' ability to formulate scientific questions. The student response questionnaire was used to obtain students' responses to the learning model, learning materials, worksheets, teacher guidance, and the possibility of using the model in future physics learning.

Before the large-scale trial, the instruments were reviewed by experts in physics education and educational evaluation to examine content relevance, clarity of indicators, scoring rubrics, and suitability with the objectives of Question Web Learning. The instruments were revised based on expert suggestions and the results of the previous limited trial. In addition, the observers were trained before data collection

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to ensure a shared understanding of the observation indicators, the categories of students' questions, and the scoring procedure. This preparation was conducted to reduce differences in interpretation among observers during classroom observation.

The quality of students' questions was categorized into very scientific, scientific, less scientific, and non-scientific. A very scientific question referred to a question that was clear, relevant to the physics phenomenon, related to variables or concepts, and potentially answerable through investigation or scientific reasoning. A scientific question was relevant to the topic but still required minor clarification in focus or variable relation. A less scientific question was related to the lesson but remained too general, factual, or insufficiently connected to investigation. A non-scientific question was irrelevant to the physics topic or could not be connected to scientific reasoning.

Data analysis was conducted descriptively because the aim of the large-scale trial was to examine the practicality and potential effectiveness of the model in the assessment phase. Implementation data were interpreted using implementation categories and inter-observer agreement. The agreement among observers was examined by comparing the consistency of observers' ratings on the implementation and questioning observation sheets. Students' questions were summarized by meeting and school. Test results were described through pretest and posttest percentages, scientific questioning categories, and normalized gain. The normalized gain was used to describe the increase in students' scientific questioning skills from pretest to posttest. Student responses were analyzed using the percentage of positive responses, while field notes were used to explain implementation constraints and contextual factors that affected the learning process.

RESULTS AND DISCUSSION

Results

The large-scale trial showed that the Question Web Learning model could be implemented consistently in three senior high schools. The implementation of the model was observed through five learning meetings in each school. In general, the learning activities were carried out in good to very good categories. This result indicates that the syntax of Question Web Learning could be followed by the teacher and students in different classroom contexts. The learning process began with identifying problems and presenting learning objectives, continued with information delivery and question web construction, followed by scientific question discussion, reflection and appreciation, and ended with evaluation.

The implementation result is important because the success of a learning model is not only determined by students' achievement scores, but also by whether the model can be applied in real classroom situations. In this study, students were initially unfamiliar with formulating scientific questions because they rarely practised identifying variables, formulating problems, and connecting questions with empirical evidence. However, after repeated learning activities, students became more familiar with writing questions, discussing them in groups, and presenting them during class discussions. This finding is consistent with Dah et al. (2024), who explained that inquiry-based learning can support students' conceptual understanding, motivation, scientific thinking skills, and science-related skills, but still requires teacher support, classroom management, and appropriate interaction during implementation. Therefore,

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the successful implementation of Question Web Learning in this study was closely related to teacher guidance and the structured learning stages provided by the model.

During the implementation, the teacher's role was central in helping students distinguish between general questions and scientific questions. At the beginning of the learning process, some students tended to ask factual or simple questions. Through teacher scaffolding and group discussion, students gradually developed questions that were more connected to variables, phenomena, and possible investigation. This finding supports Wu et al. (2023), who found that student-generated questioning can improve students' cognitive performance when it is supported by a guided pedagogical framework. In the present study, the question web functioned as a pedagogical scaffold that helped students organise their curiosity into more systematic and investigable questions.

The classroom observation showed that students' participation in asking questions increased during the learning process. The number of students who raised their hands and the number of students who asked questions were relatively high across the three schools. At SMA Negeri 3 Banda Aceh, the number of students who raised their hands ranged from 62 to 89, while the number of students who asked questions ranged from 18 to 21. At SMA Negeri 4 Banda Aceh, the number of students who raised their hands ranged from 65 to 86, while the number of students who asked questions ranged from 16 to 20. At SMA Negeri 8 Banda Aceh, the number of students who raised their hands ranged from 55 to 88, while the number of students who asked questions ranged from 15 to 19.

Table 2. Classroom Observation of Students' questioning participation

School	Raised hands frequency iya range	Asked questions range	Very scientific	Scientific	Less scientific	Non-scientific
SMA Negeri 3	62-89	18-21	7-12	3-7	2-7	0
SMA Negeri 4	65-86	16-20	6-11	2-6	2-8	0
SMA Negeri 8	55-88	15-19	4-11	3-5	3-7	0

The data in Table 2 indicate that Question Web Learning encouraged students to participate actively in classroom questioning activities. The relatively high number of students who raised their hands shows that students were willing to be involved in the questioning process. However, the number of students who actually asked questions was lower than the number of students who raised their hands. This condition suggests that students' willingness to ask questions developed earlier than their oral questioning confidence. Therefore, the transition from written questions to oral questions needs continuous practice. This result is in line with Andrian et al. (2025), who reported that students' questioning ability in physics learning improved through learning interventions that included problem-based learning, teacher-student questioning, collaborative group discussion, and inter-group question-and-answer activities. Similar to that study, the present research shows that students' questioning skills can be improved when classroom activities deliberately provide opportunities for students to prepare, discuss, and communicate their questions.

The quality of students' questions also improved during the learning process. In the three schools, students produced questions in the categories of very scientific, scientific, and less scientific, while non-scientific questions did not appear during the observation. This finding indicates that the question web helped students keep their questions

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relevant to physics concepts and learning problems. The presence of less scientific questions is reasonable because students were still learning how to connect questions with variables and possible investigation. Nevertheless, the absence of non-scientific questions shows that the learning model helped students avoid irrelevant or purely speculative questions.

This result is consistent with Nurjannah et al. (2020), who found that question webs-based learning improved students' science process skills and scientific questioning skills compared to conventional learning. The similarity between the previous study and the present study strengthens the argument that question webs are useful not only as a learning activity, but also as a structured tool for developing scientific questioning. The present study extends the previous finding by showing that the model could be implemented in a large-scale trial involving three schools. Thus, Question Web Learning has the potential to be used beyond one classroom or one school context.

The improvement in question quality also supports the findings of Nurramadhani and Permana (2020), who reported that STEM-based project learning in science activities could improve the quality of students' generated questions toward more open and higher-order questions. Although the learning model used in their study was different, both studies show that students' questions become better when the learning environment provides inquiry-based activities and opportunities to generate questions. In the present study, the question web made students' thinking more visible because each group had to write, connect, and discuss their questions before presenting them in class.

Students' scientific questioning skills were also measured using a written test before and after learning. The results showed that students' scores increased in all three schools. At SMA Negeri 3 Banda Aceh, the pretest score was 58.49% and increased to 88.75% in the posttest, with an N-gain of 0.73 in the high category. At SMA Negeri 4 Banda Aceh, the pretest score was 62.20% and increased to 90.86% in the posttest, with an N-gain of 0.76 in the high category. At SMA Negeri 8 Banda Aceh, the pretest score was 59.11% and increased to 89.22% in the posttest, with an N-gain of 0.73 in the high category.

Table 3. Students' scientific questioning test results

School	Pretest (%)	Pretest category	Posttest (%)	Posttest category	N-gain	Gain category
SMA Negeri 3	58.49	Scientific	88.75	Very scientific	0.73	High
SMA Negeri 4	62.20	Scientific	90.86	Very scientific	0.76	High
SMA Negeri 8	59.11	Scientific	89.22	Very scientific	0.73	High

The results in Table 3 show that students' scientific questioning skills improved from the scientific category to the very scientific category after learning through Question Web Learning. The high N-gain values in the three schools indicate that the improvement was not limited to one school. This finding supports Evendi et al. (2018), who reported that the implementation of a question webs-based learning model improved students' scientific asking skills. The present study strengthens that finding because the improvement was found in a large-scale trial involving three schools and 93 students.

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The improvement in written test scores can be explained by the structure of Question Web Learning. Students did not only receive an explanation about scientific questions, but they also practised producing questions repeatedly. They were asked to observe a phenomenon, write questions, discuss the relationship among questions, revise their ideas, and communicate their questions in classroom discussion. This process allowed students to develop a better understanding of what makes a question scientific. Causey and Spencer (2024) also found that explicitly teaching students to generate questions can increase both the quantity and quality of questions. Although their study involved younger learners, the principle is relevant to this research: students need to be taught how to ask questions, not only asked whether they have questions.

The change in students' categories also showed a meaningful improvement. Before the implementation of Question Web Learning, most students were in the scientific and less scientific categories. After the learning process, most students moved to the very scientific category, and no student remained in the less scientific category. At SMA Negeri 3 Banda Aceh, no student was in the very scientific category during the pretest, but 29 students reached this category in the posttest. At SMA Negeri 4 Banda Aceh, the number of students in the very scientific category increased from 1 student to 21 students. At SMA Negeri 8 Banda Aceh, the number increased from 3 students to 28 students.

Table 4. Distribution of Students' Scientific Questioning Categories in Pretest & Posttest

School	Test	Very scientific	Scientific	Less scientific	Non-scientific
SMA Negeri 3	Pretest	0	22	10	0
SMA Negeri 3	Posttest	29	3	0	0
SMA Negeri 4	Pretest	1	25	4	0
SMA Negeri 4	Posttest	21	1	0	0
SMA Negeri 8	Pretest	3	17	10	0
SMA Negeri 8	Posttest	28	2	0	0

The category changes in Table 4 indicate that Question Web Learning helped students formulate questions that were clearer, more focused, and more scientifically oriented. This improvement is important in physics learning because physics concepts often require students to identify relationships among variables. For example, in fluid topics, students need to understand the relationship between depth and pressure, density and buoyancy, or cross-sectional area and fluid velocity. Through question webs, students could connect one question to another and see how a physics phenomenon can be investigated through a sequence of related questions.

The findings also suggest that the question web supported students' science process skills. Scientific questioning is closely related to formulating problems, identifying variables, designing investigations, and interpreting evidence. Therefore, when students improved their ability to formulate scientific questions, they also practised an important part of science process skills. This explanation is supported by Nurjannah et al. (2020), who found that question webs-based learning improved both science process skills and scientific questioning skills. It is also in line with the broader literature on inquiry learning, which emphasises that inquiry activities can strengthen students' scientific and thinking skills when they are accompanied by sufficient guidance and teacher support (Dah et al., 2024).

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Students' responses to the implementation of Question Web Learning were positive. The response questionnaire showed that 93.61% of students stated that the model motivated them to ask questions. A total of 95.16% of students stated that the model made them brave enough to ask questions without fear of being laughed at, and 93.68% stated that they were willing to ask questions even though their questions were not fully correct. Furthermore, 96.84% of students stated that the model trained their way of thinking in developing physics concepts through questions.

Table 5. Selected student responses to Question Web Learning

Statement	Average positive response (%)
The model motivated students to ask questions	93.61
The model made students brave enough to ask without fear of being laughed at	95.16
Students were brave enough to ask even when the question was not fully correct	93.68
The model trained students' thinking in developing physics concepts through questions	96.84
Written questions trained students to ask questions	91.42
The model can be applied in future physics learning	90.28

The positive responses in Table 5 show that Question Web Learning affected not only students' cognitive ability but also their confidence and motivation to ask questions. This finding is important because questioning is not only an intellectual activity, but also a communicative and affective activity. Students may have questions in their minds, but they may not express them if the classroom atmosphere does not feel safe. Through group discussion and written question preparation, Question Web Learning created a gradual process that helped students move from silent thinking to written questioning and then to oral questioning.

This result is supported by Causey and Spencer (2024), who explained that student-generated questions can promote active participation, critical thinking, and deeper learning. The present study shows a similar pattern in high school physics learning. Students became more willing to ask questions because the model gave them time to prepare and discuss their ideas before speaking in front of the class. This also supports Wu et al. (2023), who emphasised that teacher awareness of pedagogical design is important when using student-generated questions to support inquiry learning. In this study, the teacher did not only collect students' questions, but also guided students to improve and discuss them.

The response data also support the practical value of the model. More than 90% of students agreed that the model could be applied in future physics learning. This result indicates that students did not view Question Web Learning as a temporary research activity, but as a learning approach that was meaningful and useful for them. In educational design research, this aspect is important because a learning model should be practical, acceptable, and beneficial in classroom practice. The positive response also suggests that the model can help build a classroom culture where asking questions is considered a normal and valuable part of learning.

Discussion

Compared with previous studies, the present findings show both consistency and extension. The consistency can be seen from the improvement in students' scientific questioning skills, which is similar to the findings of Evendi et al. (2018) and Nurjannah

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et al. (2020). The extension lies in the broader implementation context. While previous studies were commonly conducted in a particular class, school, or topic, the present study involved three senior high schools in a large-scale trial. Therefore, the findings provide broader empirical support for the practicality of Question Web Learning in high school physics learning.

The findings are also relevant to recent research on questioning interventions in physics. Andrian et al. (2025) reported that students' questioning skills improved when they were involved in problem-based learning, collaborative discussion, and inter-group questioning. The present study supports this finding because Question Web Learning also combines problem identification, group work, and classroom discussion. However, the present study contributes a more specific structure through the use of question webs. The question web allowed students to organize questions visually and conceptually, making the questioning process more systematic and easier to discuss.

The results further indicate that teacher scaffolding remains necessary. Although students' questioning skills improved, less scientific questions still appeared during classroom observation. This means that some students still needed help to identify variables, clarify question focus, and connect questions to possible investigation. Therefore, Question Web Learning should not be applied as an independent student task without teacher facilitation. The teacher needs to model how to formulate scientific questions, provide examples, guide group discussion, and give feedback on students' questions.

The absence of non-scientific questions during classroom observation is one of the strengths of the implementation. It indicates that students were able to maintain relevance between their questions and the physics topic being studied. Nevertheless, the existence of less scientific questions shows that the development of scientific questioning skills is gradual. Students need repeated exposure to phenomena, opportunities to revise questions, and feedback from both teachers and peers. This condition is reasonable because scientific questioning requires students to combine conceptual understanding, reasoning, and science process skills.

The use of Question Web Learning also helped the teacher observe students' thinking processes. When students wrote and connected questions in a web, the teacher could identify whether students were still asking about definitions, had begun to ask about relationships among variables, or had been able to formulate investigable questions. This information can be used as formative assessment during physics learning. In this sense, Question Web Learning does not only function as a learning model for students but also as a diagnostic tool for teachers to understand students' conceptual and inquiry development.

In relation to physics learning, the model is relevant because physics requires students to explain phenomena through concepts, variables, and evidence. In fluid mechanics, for example, students may begin with simple curiosity about why an object floats or sinks. Through question webs, this simple question can be developed into related scientific questions about density, buoyant force, pressure, and fluid flow. This process helps students understand that physics concepts are interconnected and can be investigated systematically.

Overall, the large-scale trial indicates that Question Web Learning is practical and shows promising potential for enhancing students' scientific questioning skills in high school physics. The model increased classroom participation, improved the quality of

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students' questions, raised students' written test scores from the scientific category to the very scientific category, and received positive responses from students. These findings support previous research on question webs-based learning, student-generated questioning, and inquiry-based science learning. However, because this study used a one-group pretest-posttest design, the findings should be interpreted as evidence of promising improvement rather than a definitive causal comparison with other learning models.

CONCLUSION

Fundamental Finding : The large-scale trial showed that Question Web Learning was practical and effective for improving students' scientific questioning skills in high school physics. The model could be implemented well to very well across five meetings in three schools. The learning process increased students' participation in asking questions and supported the development of very scientific and scientific questions without producing non-scientific questions during the observations. Students' written scientific questioning test results also improved from the scientific category before learning to the very scientific category after learning, with high normalized gain in all schools. **Implication :** These findings imply that Question Web Learning can be used as an alternative learning model to strengthen inquiry-oriented physics learning. The model helps teachers guide students gradually from written questions to oral questions, while also building students' confidence, reducing their fear of making mistakes, and training them to develop physics concepts through scientific questions. In classroom practice, the question web can also function as a formative tool that helps teachers identify students' conceptual understanding, question focus, and readiness to formulate investigable questions. **Limitation :** This study was limited to a one-group pretest-posttest design and was conducted in three public senior high schools in Banda Aceh. Therefore, the findings have not yet been compared with a control group or tested in broader school contexts with different characteristics. **Future Research :** Future studies are recommended to examine the effectiveness of Question Web Learning using experimental or quasi-experimental designs involving control groups. Further research may also include delayed posttests to examine the long-term retention of students' scientific questioning skills. In addition, future studies can analyze the cognitive level of students' oral and written questions in greater depth, investigate the quality of teacher scaffolding during the questioning process, and examine the implementation of Question Web Learning in different physics topics, school levels, or broader educational contexts.

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