

子どもの社会科学的事象に関する理解 —社会科教育・心理学的研究の展望

A review of social studies education to encourage the understanding
of scientific concepts

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邦文要約

学習者は日常生活のなかで知識を獲得し、それらの知識を結びつけて素朴概念を構築している。これまで様々な領域における素朴概念や年齢にともなう変化が明らかにされてきた。一方で、教授・学習や教科教育の分野では、学習者に科学的概念を獲得させるための介入が提案されてきた。本稿では、科学的概念の獲得や理解を目的とした介入に関する研究を概観し整理する。そして社会科教育への提案を目的とし、介入研究に残された課題を考察する。

1 Introduction

Learners acquire knowledge from various everyday experiences and combine this knowledge to build naive theories. The development of these naive theories in children and the conceptual changes (restructuring of knowledge) have been clarified in biology, physics, astronomy, and other natural science areas (Carey, 1985¹⁾; Clement, 1982²⁾; Vosniadou & Brewer, 1992³⁾). In science education, several teaching and learning intervention methods have been proposed to encourage learners to change their conceptual views and acquire more scientific concepts. However, in social science, studies the psychological approaches used to develop children's naive theories and

encourage conceptual changes have been insufficient. Although lesson preparation and curriculum developments have been proposed to deepen children's understanding of social studies education, few studies have empirically examined their effectiveness. In this paper, practical social studies education research is reviewed and conceptual development and concept change in social studies education development examined from cognitive, intervention, and learning and instruction perspectives.

2 Practical research in social studies education

The purpose of social studies education is to deepen learners' understanding of social scientific phenomena. In this section, previous research on geography education is examined. In recent years, developing problem solving skills in children has been difficult to achieve in lecture style classes based on textbooks and developing an understanding of scientific concepts has been difficult to achieve in activity based classes (Nagata, 2004⁴⁾). Therefore, it is necessary to develop social studies education materials that encourage learner understanding of social science events and ensure that the scientific concepts are actively developed.

Yoshida (2001)⁵⁾ claimed that to nurture a “geographical viewpoint and way of thinking,” the conceptual structures related to these geographical viewpoints need to be properly organized through an analysis of descriptions and a structuring of the learning content to ensure learning guidance and guarantee class improvement.

In addition, Kotani (2005)⁶⁾ claimed that children needed to be trained to understand the basic social science concepts, so that these can be used to analyze actual social scientific events, and suggested that teaching materials should be linked to a child’s own experiences. With this concept in mind, therefore, teaching plans for junior high school social studies materials should lower the abstraction level to accord with the students’ experiences.

Many international education research studies have examined ways to encourage learners to understand social scientific phenomenon in geography education curriculum by analyzing textbook contents; how they are used to develop problem solving skills, and the methods learners use to explore the content through teacher questioning. However, as few studies have analyzed different types of developed content and most have only suggested possible methods that could be used (Yamaguchi, 2002)⁷⁾, the effects have not been clarified or the developments illuminated.

Another major problem in social studies education is that existing learner knowledge is not taken into account when teaching or developing content. Seki (2003)⁸⁾ pointed out that as children were limited to acquiring fragmentary knowledge, they were not learning to develop an understanding of the meaning of the events between the events they were learning. Therefore, a unit was developed that incorpo-

rated a webbing method to link the learners’ existing knowledge and experiences to social science concepts. The webbing method involves rearranging ideas so learners can acquire and accommodate new knowledge with their already existing knowledge. Through an analysis of the diagrams drawn by the learners, it was possible to assess learner awareness of the new information and the effect of the teaching method; therefore, this approach was novel research for the social sciences field.

Learner and unit developments based on existing learner knowledge are uncommon in most social studies education, unlike in science education, which is specifically designed to build on existing learner knowledge. In the following section, we examine science education practices, with a specific focus on practical research that takes prior learner knowledge into account.

3 Practical science education research

In some science education practices, focus is placed on solving a problem based on a contradiction of current learner knowledge of the scientific knowledge system. That is, by disproving certain cases, the learners’ simple concepts are reimagined as scientific concepts. However, it has been found that learners can have misconceptions about the exercise that can be difficult to modify (Hikita & Matsumoto, 1999⁹⁾; Kato, 2006¹⁰⁾). Consequently, shifting the learners’ existing conceptual knowledge to encompass scientific concepts has been an important issue in science research studies (Kai & Morimoto, 2008¹¹⁾).

Uematsu (2008)¹²⁾ reconstructed the misconceptions by resurrecting everyday life after class even though the misconceptions had been corrected by the teachers and textbook content

in school lessons, and found that some rebounding occurred because the learners were basing their knowledge on past experiences; that is, even though the learners were aware of their own errors and even when the misconceptions were corrected, they continued to make the same errors or have the same misconceptions. This is because it seemed that an erroneous concept was more correct when it came into contact with information based on experience. Therefore, to ensure the revision of the mistaken learner concepts, a teaching strategy was needed that prevented such rebounding but that considered both the learner's past experience and the scientific information they need to remember. Experimental college student groups were established that read teaching materials that had both types of information; that is, scientific information, and information on the validity of past experiences and the misconceptions. A control group was established and only given teaching materials with the scientific information. Tests were conducted before and after to assess the students' judgments regarding plants photosynthesis and on the potato nutrition production process (pretest, post-test 1). After post-test 1, information was given to prompt the recall of past photosynthesis experiences and the same test as the pre / post 1 (post-test 2) was conducted. The purpose of the teaching materials for the experimental group was to limit the validity of their past experiences and misunderstandings. In the true / false judgment test, the analysis was limited to those who had less misclassified reactions than in the pretest, from which it was found that the number of people who rebounded was smaller in the experimental group than in the control group. In the description test, many learners in the control

group rebounded, from which it was inferred that the learner had not rebounded because they had learned the relative relationship between past experience and scientific information using this teaching strategy. However, it may be possible that the subjects simply reproduced the contents of the teaching material from the task content and description examples. Further, it was not clear how the subjects had related the scientific information to their own experiences.

In many science education studies, it was found that the learner's naive concepts had formed independently of the scientific concept, so the learner's knowledge had to be restructured by the learners themselves; that is, it was necessary for the learners to recognize their erroneous naive scientific concepts when presented with the correct scientific concepts (e.g., Hikita & Matsumoto, 1999; Shimizu & Yamaura, 2006¹³⁾).

On the other hand, some science education research has tried to examine this phenomenon in relation to the daily events already known to the learner (e.g., Masuda, 2006¹⁴⁾; Masuda & Morimoto, 2000¹⁵⁾). Masuda (2006) found that it was difficult for learners in an elementary school science unit on "current and its use" to understand scientific concepts through experimentation as they were required to infer the scientific analogy using their existing knowledge. Because a current is invisible in its natural state, the learners needed to infer this knowledge using water flow. This experiment was recreated with junior high school students using a water current model and a current circuit to examine the strategies learners employed to make the scientific analogy. When asked to express current and voltage using the model, some students compared the current

and voltage to the circulation system and some examined each element separately; that is, as the former focused on the existence of the power supply in addition to the current and the voltage, they did not only analogize the characteristics of each element but also the relationship between the elements to draw the model, and were able to scientifically interpret the current circuit from the water current model. After conducting communication activities to support the modeling, the latter students were asked to pay attention to the relationships between the voltage, current, resistance, conducting wire, and power supply elements so that they could scientifically interpret the relationships. Interviews were held in which the students who had initially examined each element separately explained their models and the point at which the communication activities made them understand. While this type of intervention study has rarely been conducted in science education, it was still not clear which factors in the communication activities had caused these changes.

Masuda (2006) examined how learners' existing knowledge and everyday experiences could be used to encourage the acquisition of accurate scientific concepts, which was in contrast to Uematsu (2008) who sought to harness the existing erroneous learner knowledge and daily experiences to confront the learners with the accurate scientific concepts.

4 Understanding scientific phenomenon from a cognitive development viewpoint

Understanding about society generally leads to the acquisition of concepts on social phenomena such as the economy, politics, law, history, and so on. Psychologically, thinking about the mechanisms behind society, psychological ac-

tivities, and psychological processes can assist in understanding a social scientific event. Understanding natural science, therefore, is a psychological process that requires an objective understanding of the mechanisms of nature. However, since Furth (1980)¹⁶⁾ pioneered developmental psychology, insufficient attention has been given to the understanding of social science events by children. In the following we introduce studies focused on children's knowledge of social science events.

Fujimura (2002)¹⁷⁾ and Ishibashi (2017)¹⁸⁾ examined cognitive development related to social science events. Fujimura (2002) examined the understanding of the economic reasons for price differences between perishable food, processed food, and industrial products using individual interviews with elementary school 4th, 5th, and 6th graders. It was found that supply quantity and utilization value explanations were expressed by less 4th graders than 5th graders and discussions on cost, profits, and sales were expressed by less 5th graders than 6th graders. The children also focused on the factors they felt were more important than fresh foods, industrial products, or the target characteristics. Using supplemental questions about the cause-and-effect relationships, the factors that influenced the product price were extracted.

Ishibashi (2017) examined children's thinking about geography as evidenced by their causal explanations of industrial locations. A sample of 25 third graders and 26 fifth graders were asked to individually discuss three problems related to the geographical location of dairy industries, arable industries, and food services industries. The children were asked why a certain industry had developed in a particular location, and were also asked follow-up ques-

tions to clarify their explanations, pursue the causal relationships, and focus on different conditions. An analysis of the children's explanations revealed that as children got older they focused more on social and economic conditions, and less on "pre-natural" and human conditions. Even the third graders were able to explain the natural causes for the growth of dairy and arable industries, and the fifth graders were able to provide the social causes for the food service industries. Follow-up questions gave the children the opportunity to focus on different geographical conditions. This was particularly true for the fifth graders, who focused on at least one geographical condition before they were asked the follow-up questions. In addition, by analyzing the children's answers in detail and focusing on the answers before and after the follow-up questions, useful information regarding social studies education was extracted, especially in terms of the children's prior knowledge.

Some cognitive development studies have attempted interventions to promote conceptual change and conceptual understanding in learners.

To clarify the mechanisms behind such concept changes, Clement (2008)¹⁹⁾ also used a contradiction strategy (as discussed above), an analogous teaching method, and conventional intervention methods to assess the understanding of scientific concepts, with the belief that a learner's intuition and thoughts are important when proposing intervention methods.

Focused on the learner's explanations, a process was modeled to change the erroneous concepts into scientific concepts. Instead of dismissing the learners' ideas before giving the scientific concepts, the concepts were based on these ideas and the possibilities for change

identified, which was a different approach from traditional intervention approaches.

Cognitive development intervention studies have attempted to examine how learners' concepts change when presented with conflicting information. However, as discussed, it is not necessary to assume that the simple learner concepts are incorrect; rather, they contain an active aspect that can support the understanding of the actual scientific concepts and can promote conceptual change so as to acquire more accurate scientific concepts. Therefore, when attempting to promote concept change, the activation of existing knowledge can assist in acquiring the scientific concepts. Because social science events are more routine than natural science or mathematical domain events, it is conceivable that children have some existing knowledge. Therefore, it is suggested that children's existing knowledge be harnessed when seeking to get them to acquire knowledge and understand concepts.

5 Learning and instruction intervention studies

In contrast to research on cognitive development, teaching and learning studies have tended to see the simple concept as a misconception, with a naive concept being the one consistently used to explain events in the living world. Further, these misconceptions are generally seen as being "false" in the face of accepted scientific concepts (Tanaka, 2008²⁰⁾). Tanaka (2008) claimed that erroneous concepts and simple concepts should not be encouraged, and the retention and rebound of misconceptions and naive concepts should be prevented as much as possible. In learning and instruction research, to encourage the acquisition and

understanding of scientific concepts, intervention methods have focused on showing the learner why they were wrong and making them aware of the correct knowledge (e.g., Fushimi & Iwasaki, 1990²¹⁾, Shindo, 1995²²⁾). However, it has been shown these methods have had little success; consequently, new methods have been proposed (e.g., Magara, 1990²³⁾, Takagaki, 2001²⁴⁾).

Magara (1990) claimed that the knowledge acquired by children from everyday life was not erroneously planned or systematically learned. School education seeks to redress the learners' erroneous knowledge rather than developing teaching activities based on the existence of such knowledge. Therefore, from the education and learning perspective, intervention first clarifies the correct knowledge to reduce any inconsistencies between the correct knowledge (rule) and the learner's erroneous knowledge (existing knowledge). Further, it gives an explanation for the learners' erroneous knowledge so as to rearrange this knowledge to deal with, for example, the concept of living things.

A series of experiments were conducted with Japanese university students. In the learning session, the control group was given an explanation about a variety of tulips and the experimental group was given an explanation that seed plants are seeded in general as well as being given the explanation about planting tulips. In the first experiment's post-test conducted one week after the learning session, knowledge about the tulip referred to in the learning session and a hyacinth that had not been referred to in the learning session (normally bulbs can be planted) were tested. More students from the experimental group answered correctly than those in the control

group. However, no differences were observed for the potato planting procedure. In the second experiment, a post-test test was held immediately after the learning session, in which it was found that the experimental group had more correct answers about the tulips than the control group. In both experiments, more participants in the experimental group found the explanation text interesting than in the control group. Because there were fewer cognitive conflicts (Hatano & Inagaki, 2006²⁵⁾) through the added explanations, the incorrect knowledge was easily identified and the correct explanation promoted. In addition, it was shown that it was more effective to solve learner questions based on the facts than by correcting the incorrect knowledge. However, as a generalization to other plant types was not tested and the thinking change process from before and after the intervention was not sufficiently considered, it is difficult to say whether this teaching method was effective.

Magara (1996) was dealing with understanding in the natural science; however, Takagaki (2001) explored a similar dilemma in mathematics.

Takagaki (2001) examined whether the "preconception" learners obtained from their day-to-day experiences was strong enough to be transformed into a scientific concept using conventional school education methods. To transform the preconception into a scientific concept, it was necessary to eliminate the cognitive conflicts by extending the experiences and existing everyday knowledge. Takagaki (2001) examined a 5th grade elementary lesson about "height" from a diagrammatic figure, the concept of which had not been previously learned. Using mathematical case examples displayed through

“graphical representation,” the preconception of height was related to the mathematical height concept and the measurement of height. Therefore, the teaching method sought to relate the preconception of height to the concept of mathematical height. The results showed that there was a successful transformation of the preconception of height. However, the teaching method was only in one direction and the children were unable to discuss this transformation during the teaching session. Therefore, because the thought processes of the children were not considered, the increase in correct answers from the pre- and post-test may have been because the teaching contents were being repeated (without understanding). In addition to presenting scientific concepts as problematic and as problems not yet seen, there have been many attempts to design interventions to reduce the contradictions between learner misconceptions, naive concepts, and scientific concepts. Teaching and learning studies such Takagaki (2001) have found that when learners understand the contradictions between facts and their own ideas, this understanding acts as a type of intervention (Uematsu, 2008) as it suggests that the learner has deliberately repositioned the information.

6 Research on understanding scientific events

In this section, the research outlined in the previous sections is organized from four viewpoints; handling learner knowledge, the intervention method, thinking process examinations, and interventions (Table 1). Future research topics are also considered from two viewpoints; (1) acquired through intervention, (2) examination of intervention method.

(1) Obtained by intervention

The studies outlined in this paper examined the understanding of scientific phenomena and the interventions needed to acquire the scientific concepts. However, it depends on the research field as to what science concept is acquired and how the learner's concepts have changed.

Learning and instruction intervention studies (Magara, 1990; Takagaki, 2001) consider that for factual knowledge to be reproduced and answered correctly, learners need to be taught the acquisition of scientific concepts.

For cognitive development, Carey (1985) stated that all children have naive theory knowledge which is causally related; therefore, children's understanding was researched from “its causal framework.” When there were conceptual changes, there was a “causal explanation” as to whether they were scientifically correct, which led to a step by step understanding of the scientific concepts (Furth, 1980). Clement (2008) claimed that the explanatory model for the learner corresponded to the core part of the theory, and that a large change in the explanation model was the most important part of the concept change.

In view of the above, there has been insufficient focus on whether the misconception was corrected and whether conceptual change was achieved. In teaching and learning research that has examined conceptual change, there has been little focus on whether the learners had captured the process or causal cause of the scientific events. Social studies education research has tended to focus on the acquisition of factual knowledge and the revival of real knowledge in a description.

Therefore, in social studies education, when seeking to promote concept change and understanding, cognitive development, causal

Table 1 Research subjects concerning the understanding of scientific events

Field of study (Previous re- search)	a How to handle learner' knowledge	b Interventions	c Consideration of the thinking process	d What was acquired
Social studies Yoshida, 2001; Kotani, 2005 etc.	not considered	References general problem solving pro- cess and overseas geography education curriculum	not considered	not considered
Science education Kato, 2006; Uematsu, 2008 etc.	<ul style="list-style-type: none"> Scientifically in- correct What is modified 	<ul style="list-style-type: none"> Present discrepancies between learner's simple concepts and scientific concept cause cognitive conflict Make learners aware of their naive concepts 	Partial utterance case in class, note description of some learners	Factual knowledge, teaching knowledge
Masuda, 2006 etc.	Based on acquiring scientific concepts	<ul style="list-style-type: none"> Let learners think about new events based on the knowledge of the previous course analogy 		Scientific concept
Cognitive de- velopment Clement, 2008; etc.	Based on acquiring scientific concepts	Developing an active aspect regarding ex- isting knowledge	Focus on the association of knowledge for each learner	Scientific con- cept
Learning and instruction Magara, 1990 etc.	<ul style="list-style-type: none"> What is wrong with scientific concepts What is modified 	<ul style="list-style-type: none"> Presenting the dis- crepancies between the learner's simple concepts and the scientific concept cause cognitive conflict Making learners aware of their naive concepts 	not considered	Factual knowledge, teaching knowledge

explanations, and the knowledge the learner is drawing from need to be considered when examining how the change occurs for the learners to understand the scientific concepts.

(2) Investigation of intervention methods

As mentioned in the previous section, in learning, and instruction research, a learner's naive concept is regarded as a misconception. On the other hand, in cognitive development, the active aspect of the learner's simple concept has been considered to be the learners' existing knowledge and can be effectively used to promote the understanding of scientific concepts. Fujimura (2002) found that children who had not learned an economics construct were able to offer an economically appropriate causal explanation using existing knowledge from daily experience and other subjects. Therefore, it is suggested that the children's existing knowledge can be the basis for understanding scientific concepts. However, such attempts have rarely been seen in social studies education.

In science education, as it is important to pique learners' interest in science by dealing with common everyday phenomena (e.g., Masuda & Morimoto, 2000), the same could also be emphasized in social studies education. However, the effectiveness of dealing with everyday phenomena is not limited; to promote conceptual change and conceptual understanding, using daily events to activate the learners' existing knowledge could be effective in promoting the understanding of scientific concepts. Masuda (2006) found that these two types of knowledge were related to each other and that students did not individually have knowledge of the scientific concept, but some were able to understand the concept more deeply than

others. In examining communication between students and students and students and teachers, the teacher asked questions about the causal relationships between elements and elements to promote the association between the two types of knowledge.

Cognitive development rather than just learning and instruction viewpoints could also be incorporated into social studies education research to promote conceptual understanding and conceptual change, which could lead to new teaching practices. As a concrete proposal here, focusing on the active aspects of the learner's simple concepts could encourage learners to pursue causality (Fujimura, 2002; Ishibashi, 2017); that is, by promoting existing knowledge and highlighting the association between that knowledge and the social sciences could promote conceptual changes and conceptual understanding, which could encourage a reconstruction of the learner's framework of knowledge.

In this paper, social studies education research was examined from two viewpoints through an examination of practical research into learning in science education, teaching and learning interventions, and conceptual understanding and conceptual development in cognitive development. Through an examination of these different disciplines, an intervention method was devised to promote conceptual change and conceptual understanding based on the active aspects of the learner's naive concepts, and also considered the thought processes of the learner in the interventions, all of which provide development directions for future social studies education research.

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