THE TRANSIENT STAGES OF INDUCTIVE AND DEDUCTIVE REASONING

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Introduction

As per van Hiele's (1984) levels of thinking, the second level involves understanding shapes through their properties, while at the third level, definitions come into play, with the idea of reaching a preparation stage where verification is possible. In terms of inference, inductive reasoning and analogy may be possible at the second level, but deductive reasoning is not possible at the third level. However, inference may go back and forth between inductive and deductive reasoning, i.e. between the second and third levels. We clarified this by analyzing what kind of features these levels exhibit using the Toulmin model, based on the reaction of students in teaching experiments.

QUESTIONNAIRE SURVEY

The results of this questionnaire survey on how to grasp the inclusive relation of the rectangle that serves as an entry to verification show that about 61% students correctly concluded that "parallelograms and rhombuses" are in the same group. Of these, about 25% performed at the first level, perceiving this intuitively, while about 20% performed at the second level, figuring this out through shared characteristics, and about 17% exhibited knowledge at the higher second level, where they could logically reach the correct conclusion based on definitions but could not advance as far as the deductive proof stage.

Method

This paper views logical thinking in a form expanded to include reasoning to convince oneself and others more broadly, including induction, inference from analogy, and deduction from the perspective of argumentation, in order to connect geometrical education in elementary and junior high schools more smoothly. On this basis, the paper analyzes the extent to which the capacity for logical thinking has developed in the upper grades of elementary school using utterances by and questionnaire surveys of students in concrete learning scenes and reveals the relationship between the level of thought about shapes and reasoning, and the factors considered important in developing reasoning.

In the methodology, we first conducted a teaching experiment on inclusion relationships in quadrilaterals and analyzed modalities of logical thinking about recognition of shapes using a Toulmin model. Next, based on this, we interpreted the students' modalities for developing logical thinking about shapes from the perspective of reasoning, and captured changes in the students' reasoning concerning shape recognition therein. Finally, integrating this analysis and the above theoretical position, we elaborated the difference between Levels 2 and 3 in relation to the thought level and reasoning about shapes and elucidated the extent to which they can be raised.

Results

There is a transitional stage between inductive and deductive reasoning; the details are shown in Table1 .

	Figure recognition	Inference
2nd level - a	Properties (theoretical)	Reasoning with only one large intension
2nd level - b	Properties (theoretical)	Reasoning with several intensions in parallel
2nd level - c	Properties (theoretical)	Inclusive inference by thinking about the relationship between intensions and extensions
2nd level – d	Properties (theoretical) Definitions	Inferring what is preferred in the intension as a definition
3rd level	Definitions	Deductive reasoning using definitions as a part of verification

Table 1: Second-level refinement in relation to figure recognition and inference

Conclusions

Finally, we examine the key factors behind the rise in thought level and the transition from induction to deduction. First, when considering the validity of reasoning and investigating whether the reasoning process from what was recognized towards a grounded conclusion is valid, the refutation of the derivation of the reasoning can be considered one key factor. Inductive reasoning is the primary method at the stage of recognizing properties in parallel and proceeding with reasoning, and by prioritizing properties from a refutation that an inevitable conclusion cannot be reached, deductive reasoning arises as definitions begin to function and logicality increases with the increasing validity as grounds. In this state of thinking at the transitional stage, induction and deduction are mixed to develop thinking.

Moreover, when one recognizes that one's own thinking was incorrect due to refutation by another, a conflict arises from the inconsistency with one's own thinking, and taking definitions and theorems to be the foundation of thought as agreed matters in an attempt to resolve the conflict organizes, develops, and integrates what was previously in a parallel state. We believe that deductive reasoning as grounds for a conclusion that proves the definitions and theorems as agreed matters becomes possible through tracing this thought process, which enables students to approach the entrance to demonstration.

References

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