



TSG TSG 5.10: Methods and methodologies in mathematics education research

EXAMINATION OF THE FORMATION PROCESS OF LEARNERS' DEVELOPING WAY IN MATHEMATICS

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The purpose of this study was to obtain suggestions for a framework to capture the formation Process of Learners' Developing Way.

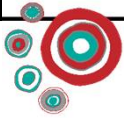
Developmental knowledge (hereafter DK) is "Three situations for the Developmental approach (hereafter 3DA)" and "Knowledge based on Developing way (hereafter KD)" and constructed four stages: "Experience," "Understanding," "Trial," and "Independence" (👉 slide 2).

A framework to capture the formation PLD

(PLD : The Process of Learners' Developing Way)

Stages	Developmental knowledge(DK)				Features	Noticing	Aspects of the learner
	Three Situations for the Developmental approach (3SD)						
	Discovery Development		Structural Development				
a*		b*		c*	d*	e*	
Independence	IV . Integration				↑ Intrinsic, Conceptual ↓ Extrinsic, Procedural	Unconscious	Continue 3SD autonomously and creatively by making full use of DK on self.
Trial <small>👉 slide 4</small>	III . Identification		II *			Take note of the Usefulness	Based on the utility of DK obtained from the past efforts, we will continue 3SD using DK.
Understanding	II . Introjection		I *				They start to take note of the Usefulness of DK through their activities.
Experience <small>👉 slide 3</small>	I . External regulation					Extrinsic, Procedural	Unaware, Don't accept

I~IV : The Regulatory styles (Ryan & Deci, 2000)



*Knowledge based on Developing way : a. Focus on numbers, quantity, and shapes, b. Analysis of numbers, quantity, and shapes, c. Problem-solving and ensuring clarity, conciseness, and precision, d. Generalizing, e. Engaging with New Development, valuing

* Regulatory styles : I .External regulation, II .Introjection, III .Identification, IV .Integration

Characteristics of the Experience Stage

Three Situations for the Developmental approach (3SD) by a university student

Introduction

Q. Create two two-digit integers using two numbers from 1 to 9 and subtract the smaller number from the larger number.

ex. 1 and 9

$$\begin{array}{|c|c|} \hline 9 & 1 \\ \hline \end{array} - \begin{array}{|c|c|} \hline 1 & 9 \\ \hline \end{array} = 72$$

Discovery Development

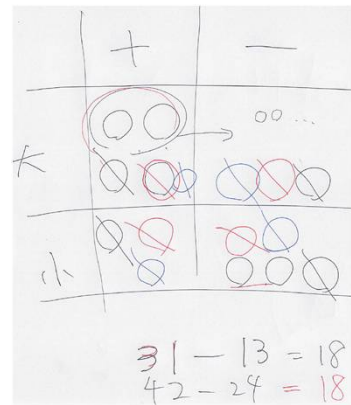
S : I want to calculate with other numbers.

$$\begin{array}{l} 21 - 12 = 9 \quad 76 - 67 = 9 \\ 98 - 89 = 9 \quad 9 \times \downarrow \\ \text{偶} 42 - 24 = 18 \\ \text{奇} 75 - 57 = 18 \\ 52 - 25 = 27 \quad 9 \times 2 \\ 96 - 69 = 27 \quad 9 \times 3 \end{array}$$

Try various things to find regularity.

Structural Development

S : I have nothing more to think about!
T : What did you do when you found regularity?



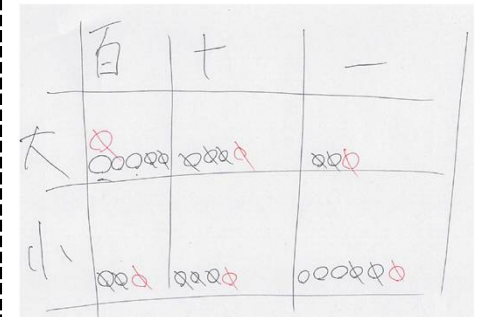
$9 \times (2 \text{ 桁の数の差})$
 $= (\text{答え})$

$$\begin{array}{l} 31 - 13 = 18 \\ 42 - 24 = 18 \end{array}$$

Presenting a way to elucidate the Structure and Express it in relational formulas.

New Development

S : I have nothing more to think about!
T : How about changing the number of digits?



Calculate diversely, but do not express in relational formulas.

External regulatory status

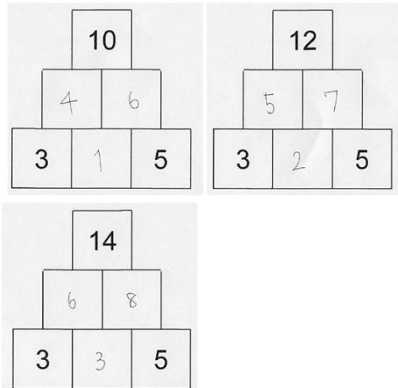


Characteristics of the Trial Stage

Three Situations for the Developmental approach (3SD) by a university student

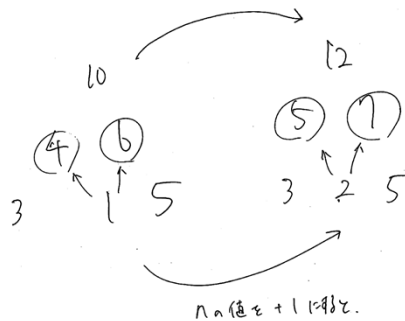
Introduction

Q. Add the adjacent numbers and fill in the box above.



Discovery Development

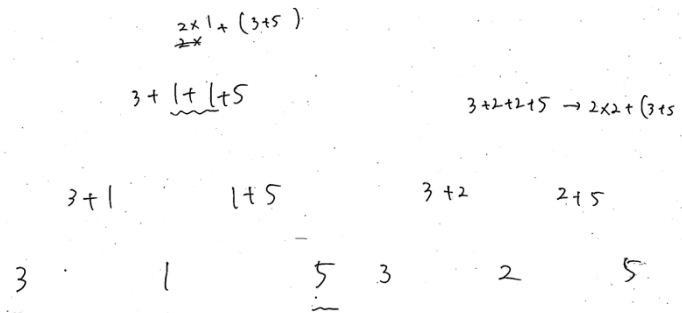
S : What should I focus on to solve it?



Examine in order.

Structural Development

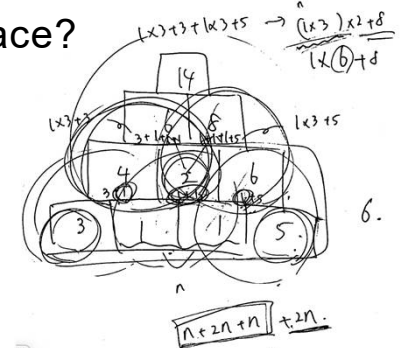
S : It seems to be a regularity.
S : I have not been able to generalize well, so let's do that first.



Clarification of structure, awareness of expression through relationships

New Development

S : Isn't there a similar place?



S : If I had worked alone, I might not have gotten this far.

3SD unfolds smoothly. Teachers affect ?

From Introductory Status to External Regulatory Status



References

Banchi, H. & Bell, R. (2008). The many levels of inquiry. *Science and Children*, 46(2), pp.26-29.
Ryan, R. M. & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1), pp.54-67.