

Formation of Forward – Reverse Actions to Motivate the Conservation Ability in Children 5-6 Years of Age

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ABSTRACT

The content of the article refers to the experiment of which the theories of both Piaget and Galperin are combined to form forward and reverse actions, thereby developing the conservation ability in 5-to-6-year-old children. The experimental results revealed the strong correlation in forward direction between the forward – reverse actions and conservation ability of children; forming forward – reverse actions in children 5-6 years old using Galperin's intellectual action stages, in comparison with the performance in normal conditions (control), has significantly increased the number of children achieving these actions, leading to the significant improvement of conservation ability of children engaged in the experiment. Thus, the organization and training for children 5-6 years old to perform the forward and reverse actions following the intellectual action stages listed in Galperin's theory has accelerated the speed and degree of forming some of the children's conservation categories, which will be both higher than the normal limits as determined by Piaget et al. at which any child gain initially the abilities.

Keywords

Conservation ability; Reversibility; Reverse actions; Intellectual operations; Formation of intellectual actions

Literature Review

Piaget's theory about conservation in the intellectual structure of children

J. Piaget was called "Giant in the nursery school" (Elkind, 1972). He was the first psychologist who examined and explained in detail the cognitive and intellectual development of children from birth to young adulthood (14-15 years), including the findings of conservation ability. Using a lot of open and suggestive observations and multiple-choice tasks, Piaget et al. formulated a "scheme" of intellectual structures of children across ages: Sensorimotor stage, from 0 months to 18 months; (2) Symbolic development and pre-conceptual stage, from 1.6 - 2 years old to about 4 years old; (3) preoperational stage, from 4 to 7 - 8 years old; (4) Concrete operational stage, 7-8 years to 11-12 years old and (5) Formal operational stage, 11-12 years or older (Piaget,

1950; Piaget and Inhelder, 1969). In fact, between the stages, there are factors as the conditions of transitions. Conservation is the ability to realize that something, an object or event, can have the same properties even if it appears differently; Conservation is a necessary condition for the transition from preoperational stage to concrete operational stage (Piaget, 1950). According to Piaget, the conservation of material, quantity and length of objects is attained at ages 7-8 while conservation of weight and mass is attained at ages 9-10 and 11-12, respectively. Particularly, conservation of volume cannot be attained at ages 11-12 in many cases. The reason why children 5-6 years of age are incapable of conserving is that the reversibility appears not at this age. Piaget et al. further revealed that reversibility was characteristic of conservation ability (Piaget, 1950; 1969; Piaget, & Inhelder,

1969). Piaget's theory further posited that children's conservation ability developed naturally in a pre-defined order, was present not until a certain age but consistent with the neural maturation and lessons gained through experiences and less reliant on external education. The experiments were repeated by various authors to confirm the solid views of Piaget on children's conservation (Halford and Boyle, 1985; Ginsburg & Opper, 1988). Piaget's theory exerted a great influence on cognitive and intellectual psychology (Hergenhahn, 2000; Ribaupierre, 2015) and laid the foundation for early childhood education and research (Nutbrown, 2006). However, besides the recognized great scientific achievements, a lot of viewpoints of Piaget are still under debate, critique and supplement. Numerous empirical studies provided the findings that children from different cultures gained different performances in multiple-choice tasks (Brainerd, 2003; Huntsinger et al., 2011). The studies by Hughes (1978) disclosed that 5-year-old children realized others' perspectives. H. Gardner (1983) asserted that there was a lot of good evidence that children could remember numbers and classify with certainty from age of three. Following Siegler's (1991) study, children can improve themselves in such conservation tasks, but show the moderate performance or underperformance in other tasks. In addition, some of the studies criticized Piaget's guiding and questioning techniques which deemed to have the adverse influences on children's concentration and attention on conservation tasks (Rose & Blank, 1974; Donalson, 1978). Thus, in addition to widely acknowledging Piaget's arguments on nature of conservation and its role in development of intellectual operations, it is also necessary to further identify the time when these operations appear in children and the external influences on the same (Lourenço, 2016).

P.Ia. Galperin's theory about the stages of intellectual action formation

In 1959, P.Ia. Galperin, a Russian Psychologist, published his work titled "Development of studies on the formation of intellectual actions", which clarified the stages of formation of intellectual actions in children, from external actions to mental actions (Galperin, 1959). Galperin did not adopt the age-based approach, but relied on function and mechanism of intellectual actions in the process of outside-in transformation of an action into a mental operation. Galperin argued that using such approach is to solve the nature of the mental inclusion of intellectual actions (Galperin, 1966). Galperin further stated that a complete and full intellectual action, formed outside-in, must experience 5 stages: (1) stage of drawing up the outline of the orienting basis of the action; (2) stage of the formation of the action in the material (or materialized) form; (3) stage of the formation of the action as an external speech (speaking loudly); (4) stage of the formation of the action in the external speech to oneself; (5) Stage of the formation of the action in the inner and shortened speech (Galperin, 1959). Talyzina (2002) argued that the formation and development of intellectual operation using the outside-in approach to actions was more flexible, mobile, and less dependent on age factors, opening up the possibility of early formation of intellectual operations in children beyond their ages. Galperin himself confirmed this argument (Galperin and Talyzina, 1979). Today, Galperin's theory is widely accepted in practice (Podolxky, 2017). The findings from Galperin's theory have been manipulated effectively by various teachers (Aidarova, 1968; Sokina, 1968; Calmina, 1968; Duong Dieu Hoa, 1995; Phan Trong Ngo, 2005; Ho Ngoc Dai, 2010; Pockrebuseva, 2017; Iliasov, Kostrova, 2017).

Potential combination of the arguments of both J. Piaget and P.Ia. Galperin for the formation of forward - reverse actions within conservation of children

J. Piaget's approach to the intellectual action is different from that of P.Ia. Galperin. The former focused on the external observations of intellectual generation of children, i.e, vertically and age-based, thereby, establishing "maps" and "coordinates" of appearance of intellectual

structures from birth to young adulthood. The latter approached the active organization to form intellectual actions, horizontally and outside-in, then, established the process of intellectual action formation in children at certain time-points. However, the potential combination, if practicable, of different viewpoints of both J. Piaget and Galperin, can proactively accelerate the formation of intellectual actions in children. Piaget's arguments provide the basis for age-based formation of intellectual operations while those of Galperin, emphasizing the process of intellectual action formation, act as the basis for proactively organizing the formation of intellectual operations in children. This study aims to apply such combination in the formation of forward – reverse actions to develop the conservation of children 5-6 years old.

Methods

Basis and hypothesis of the experiment “combining the theories of J. Piaget and P.Ia. Galperin for the formation of forward – reverse actions in children 5 to 6 years old”. J. Piaget's theory reflected that the determinant of conservation is *reversibility*, i.e., ability to reverse in operation. So, to develop the conservation ability, it is necessary to form the ability to reverse, i.e. **formation of forward – reverse actions in conservation**. In terms of origin, to attain the reversibility, children must perform the forward and reverse actions with objects (such as pouring water from cup A to cup B which is shaped differently from cup A and vice versa). When the actions are included as a part of the experience of children, to a certain extent, they are **structured** into a whole, separable and reversible; then, the children have the ability to conserve characterized by reversibility (Piaget, 1950; Piaget and Inhelder, 1969). According to Piaget's theory, structuring into a whole does not take place at the time when the two forward and reverse actions are external, but mentally, in mind.

In other hand, the theory of Galperin has “formulated” a strict process consisting of stages of intellectual action formation in children, from the physical actions to mental operations. It is a one-way and outside-in process. Thus, Piaget discovered the inevitability of reverse actions in conservation, suggested structuring of these actions in the minds of children to generate the reversibility in conservation while Galperin identified the process of transforming from the physical actions to mental operations, which provide the grounds to proactively form the forward actions in the formation of intellectual operations. However, neither Piaget nor Galperin actively combined externally such forward and reverse actions into a whole and established the process of combining those in the outside-in transition. As a result, a research hypothesis is stated as follows: *is it possible to actively organize the combination of forward and reverse actions in a whole for children 5-6 years old according to a reasonable process; thereby, accelerating the formation of conservation to reach the higher speed and level and more stable status?* The present study aims to organize an experiment to examine the hypothesis above.

Organization of experiment

To form forward – reverse actions in children 5 to 6 years old in the direction of combining two forward and reverse actions into conservative actions, based on Galperin's process of intellectual action, *thereby, accelerating the formation of conservation to reach the higher speed and level and more stable status*. Guiding and organizing for children 5 to 6 years old to implement and practice the forward - reverse actions during performing multiple-choice conservation tasks, according to the stages of intellectual action formation defined in Galperin's theory. Each action is guided in 5 times; then, the results of tasks are reviewed.

Experimental, observed and independent variables in the experiment

Experimental variables were the forward - reverse actions in the tasks of children's conservation following the process defined by Galperin. The observed variables were the conservation categories included in the **tasks**: conservation of quantity, material, length and mass of the objects. These are common in the preoperational stage, which were emphasized in Piaget's theory. The independent variables included the sex and geographical areas of the children engaged in the experiment.

(Multiple-choice) Tasks in experiment and post-experiment measurement

The tasks used in the investigation, which assessed the degree of forward – reverse actions and the degree of conservation by subjects before and during the experiment were those used in the studies of Piaget et al. in the past, specifically, conservation of the number of flowers, water amount in cups of different shapes, length of ruler and weight of cakes.

The **results of the tasks** performed by the experimental and control groups were measured at 30th day after the actual experiment using the same categories of tasks but with other types of items. Specifically, conservation of number, material using cups, length and weight involved circles of candies, small pebbles, meandering lines of wool and clay clumps, respectively.

Criteria and scales of conservation ability in the tasks

Two experimental variables were observed and defined: (i) Forward – reverse actions formed in conservation tasks were divided into 3 levels based on 3 criteria: Level 1: Proficient, stable and flexible; Level 2: Relatively proficient, stable, but not really flexible upon transition to

other task; Level 3: non-proficient, unstable and inflexible. (ii) Conservation ability demonstrated through the tasks were divided into 3 levels based on 3 criteria: Level 1: real and reliable conservation by which children could correctly answer the conservation-associated questions, explain and protect their answers without any clues or help of experimenters. Level 2: existing but unsure conservation ability by which children could give and explain the correct answers of the conservation-associated questions, but did not admit or hesitate over the same when experimenters asked otherwise or re-asked, or could answer correctly with clues or help of experimenters. Level 3: Inability of conservation by which children gave incorrect answers, did not admit the conservation, even when clues were given by the experimenters, or gave the randomly correct answers without explanation. To examine the difference between the experimental and control groups, the measurement results of the forward – reverse actions and the results of conservation tasks **were** assigned to the 3-level scale scores: Level 1 of 3 points, Level 2 of 2 points and Level 3 of 1 point.

Experimental results were analyzed according to the percentage of attaining the levels by subjects and the mean scores of the tasks.

Sample subjects in the input investigation (first-round investigation)

The sample subjects in the tasks were 560 children 5.0 to 6.0 years old in kindergartens in two urban and rural areas of the provinces/cities: Hanoi, Hai Duong, Son La and Thanh Hoa. The groups of sample subjects were structured according to demographic characteristics: Sex: Female: 284 (50.7%) and Male: 276 (49.3%); geographical areas: Urban: 247 (44.1%), rural: 313 (55.9%). The characteristics of sex and geographical areas of the groups were consistent with the demographic characteristics of the investigated localities. The investigation results on

the degree of forward – reverse actions and results of conservation tasks performed by 560 children 5.0 to 6.0 years old are described in Table 1 below.

Table 1. Investigation results on performing forward – reverse actions in the conservation tasks by subjects engaged in the investigation

Group of subject		Results of forward – reverse actions and conservation tasks (amount/percentage)				
		Forward – reverse action	Conservation of the number of flowers	Conservation of water amount in cups	Conservation of length of ruler	Conservation of weight of cakes
Total	Level 1	47(8.4%)	116 (20.7%)	48 (8.6%)	61 (10.9%)	17 (3.0%)
samples	Level 2	127 (22.7%)	139 (24.8%)	81 (14.5%)	94 (16.8%)	31 (5.5%)
N= 560	Level 3	386 (68.9%)	305 (54.5%)	431 (76.9%)	405 (72.3%)	512 (91.5%)

There were 116 out of 560 (20.7%) subjects giving the correct answers (level 1) of “conservation of number” tasks. 61 (10.9%) and 48 (8.6%) subjects gave the correct answers of “length of ruler” and “water amount in cups of different shapes”, respectively. Only 17/560 (3.0%), accounting for the least part, gave the correct answers to “weight of cakes” task. On the contrary, the number of subjects giving the incorrect answers for all tasks accounts for high percentage. Investigation results showed that under normal conditions, most children 5-6 years old were incapable of conserving, especially conservation of length and mass. This was consistent with the judgment of Piaget et al. (1950; 1969).

Regarding the forward – reverse actions in conservation tasks, the results of tasks showed that 47/560 (8.4%), 127/560 (22.7%), 386/560 (68.9%, a significant part) children could perform these actions at the “proficient” level (level 1), level 2 and “unperformed” level, respectively. Thus, like the ability of conversation, the ability of forward – reverse actions of children 5 to 6 years old was

very limited. The mean scores of forward – reverse actions were strongly correlated with the mean scores of tasks ($R = 0.793$).

Establishment of experimental and control groups

The subjects divided into experimental and control groups were selected among 560 children 5-6 years old investigated in the first round according to the criteria: inability to perform the forward – reverse actions in tasks; giving incorrect answers, or giving correct answers with uncertainty in conservation tasks (at levels 3 and 2 for forward – reverse actions and conservation). 224 children were selected, then, divided into 2 groups: experimental group of 112 subjects and control group of 112 subjects. The experimental and control groups had equivalent mean scores of forward – reverse actions and first-round conservation tasks, and gender and geographical areas of the subjects.

Results

Experimental results of forward – reverse actions in the process of implementing conservative actions of children 5-6 years old

Experimental variables were forward – reverse actions in the conservation tasks performed by children engaged in the experiment. The investigation results of forward – reverse actions which children attained after 05 times of practicing according to the experimenters' instructions are described in Table 2.

Table 2: Mean score and percentage of achieving forward and reverse actions in tasks by involved children

Subject						Level 1		Level 2		Level 3	
	Mean	Median	Std	Min	Max	Q't	%	Q't	%	Q't	%
						y		y		y	
Control (n=112)	1.31	1.00	0.62	1.00	3.00	9	8.8	17	15.2	86	76.8
Experimental (n=112)	2.34	2.50	0.74	1.00	3.00	56	50.0	38	33.9	18	16.1

The mean score of the actions performed by children belonging to the experimental group was 2.34 points/3 points. 56 (50%) out of 112 children reached level 1; 38/112 (33.9%) reached level 2; only 18/112 (16.1%) had underperformance of the forward – reverse actions in conservation tasks. In addition, 9 out of 112 (8.8%) reached level 1; 17 out of 112 (15.2%) reached level 2 and up to 86 out of 112 children (76.8%) could not perform the combination of these two forward – reverse actions in the tasks.

Testing the mean score of forward – reverse actions of both the experimental and control groups

Paired samples T-test was used to identify the differences in the mean scores of forward – reverse actions between the experimental and control groups, obtained in tasks. See results in Table 3.

Table 3: Results of testing the differences in the mean scores of forward – reverse actions between the experimental and control groups

Group of subject	Mean	SD	Difference				
			Mean	SE	95%CI	P	
Experimental group	2.34	0.62	1.03	0.93	1.20	0.85	0.000
Control group	1.31	0.74					

The testing results showed the statistically significant difference in the mean scores of forward – reverse actions between the experimental and control groups (Mean = 1.03).

Testing the mean scores of forward – reverse actions of subjects in term of sex and

geographical areas of experimental and control groups.

In term of sex and geographical areas, is there any difference between the two groups above during the experimentation as well as under normal conditions? The testing results are shown in Table 4.

Table 4: Results of testing the mean scores of forward – reverse actions of subjects in term of sex and geographical areas of experimental and control groups

Group of subject			N	Mean	SD	Difference				
						Mean	SE	95%CI	P	
Experimental	Sex	Male	54	2.35	0.10	0.02	0.14	0.26	0.30	0.701
		Female	58	2.33	0.10					
	Geographical area	Rural	59	2.31	0.10	-0.07	0.14	-0.35	0.21	0.439
		Area	53	2.38	0.098					
Control	Sex	Male	55	1.29	0.081	-0.04	0.12	-0.27	0.19	0.509
		Female	57	1.33	0.084					
	Geographical area	Rural	59	1.31	0.077	-0.02	0.12	-0.25	0.22	0.672
		Area	53	1.32	0.088					

The tested value of both experimental and control groups was $P > 0.05$. It showed no significant difference in forward – reverse actions of children 5-6 years old in term of sex and geographical areas of experimental and control groups.

Results of conversation tasks of experimental and control groups

Table 5: Mean scores of the conservation tasks performed by the experimental and control groups

No.	Task item	Mean	SD	min	Max	Median
Experimental group	Conversation of number	1.91	0.86	1	3	2.00
	Conversation of material	1.65	0.80	1	3	1.00
	Conversation of length	1.72	0.82	1	3	1.00
	Conversation of mass	1.60	0.77	1	3	1.00
	TOTAL	1.72	0.66	1	3	1.50
Control group	Conversation of number	1.79	0.85	1	3	2.00
	Conversation of material	1.37	0.66	1	3	1.00
	Conversation of length	1.46	0.71	1	3	1.00
	Conversation of mass	1.24	0.57	1	3	1.00
	TOTAL	1.46	0.63	1	3	1.25

Generally, the mean score of the conservation tasks of the experimental group was higher than that of the control group (Mean and median of the experimental group were 1.72 and 1.50, respectively, which were both higher than those of

The important problem posed in this study is how the forward – reverse actions have impact on conservation of children aged 5-6 years. Table 5 describes the mean scores of the conservation tasks performed by the experimental and control groups.

control group, 1.46 and 1.25, respectively). The mean scores of most tasks performed by the children belonging to the experimental group were also higher than those of the control group. It is confirmed by the testing results in Table 6.

Table 6: Testing the difference in mean scores between tasks of experimental and control groups

No.	Task	Group of subject	Mean	SD	Difference				
					Mean	SE	95%CI	P	
1	Conversation of number	Experimental	1.91	0.86	0.12	0.11	-0.31	0.34	0.31
		Control	1.79	0.85					
2	Conversation of material	Experimental	1.65	0.80	0.29	0.09	0.10	0.47	0.002
		Control	1.37	0.66					
3	Conversation of length	Experimental	1.72	0.82	0.27	0.10	0.07	0.47	0.009

		Control	1.46	0.71					
4	Conversation of mass	Experimental	1.60	0.77	0.36	0.09	0.18	0.54	0.000
		Control	1.24	0.57					
5	CHUNG	Experimental	1.72	0.66	0.26	0.08	0.09	0.42	0.002
		Control	1.46	0.63					

Paired samples T-test: Sig. (2-tailed) was used to show that the difference in the mean scores of the “Conversation of number of candies in circle” task between the experimental and control group is not statistically significant ($P= 0.31 > 0.05$). The mean scores of other tasks performed by the experimental group were statistically significantly higher than those of the control group ($p < 0.05$) of which the most distinct difference was present in “Conversation of mass of clay clumps” task followed by “conversation of number of gravels in cups” task. On the basis thereof, it can be asserted that children 5-6 years old of the experimental

group are more capable of conserving than those of the control group.

Correlation in forward – reverse actions of children 5-6 years old between the experimental and control groups

To clarify the impacts of forward – reverse actions on conversation ability, it is required to make clear the degree of correlation between the mean scores of forward – reverse actions and mean scores of tasks performed by the experimental and control groups. The testing results are described in Table 7.

Table 7: Correlation between the mean scores of forward – reverse actions and those of conversation tasks performed by the experimental and control groups

Group of subject	Task	R	R ²	B	SE of B	p
Experimental group	Conversation of number	0.674	0.455	0.932	0.097	0.000
	Conversation of material	0.939	0.882	1.003	0.035	0.000
	Conversation of length	0.827	0.684	0.952	0.062	0.000
	Conversation of mass	0.831	0.691	0.774	0.049	0.000
	TOTAL	0.893	0.797	0.915	0.044	0.000
Control group	Conversation of number	0.673	0.453	0.776	0.081	0.000
	Conversation of material	0.594	0.353	0.642	0.083	0.000
	Conversation of length	0.645	0.416	0.712	0.08	0.000
	Conversation of mass	0.687	0.472	0.708	0.071	0.000
	TOTAL	0.698	0.536	0.609	0.051	0.000

There was the moderate to strong correlation between the mean scores of forward – reverse actions and those of conversation tasks performed by the experimental and control groups, of which the *correlation* between the mean scores of forward – reverse actions and those of tasks performed by subjects of the experimental group was *strong forward* while such correlation in the

control group was *moderate forward*. Thus, it was concluded that the correlation between the degree of forward – reverse actions and degree of conversation shown by children 5-6 years old was present. The correlation was stronger if forward – reverse actions were formed actively and developed in children. This was shown in the linear regression model between mean scores of

forward – reverse actions and those of tasks. See Table 8.

Table 8: Linear regression model between mean scores of forward – reverse actions and those of conversation tasks of children 5- 6 years old.

No.	Factor	B	SE	95%CI of B		p
				Lower Bound	Upper Bound	
Experimental	Forward – reverse R=0,893; R ² =0,797; R ² _{adjust} = 0,791; F = 141,338; P _{anova} < 0,001; B ₀ = 0,608	0.916	0.044	0.828	0.941	0.000
Control	Forward – reverse R=0,799; R ² =0,639; R ² _{adjust} = 0,629; F = 63,757; P _{anova} < 0,001; B ₀ = 0,396	0.712	0.051	0.61	0.814	0.000

The factors included to build the regression model for mean scores of conservation tasks were sex and geographical areas of children and scores of forward – reverse actions in conversation operations. However, only mean score of forward – reverse action was regressively correlated with mean score of task. In experimental conditions and normal conditions (with control group), the model explained 79.1 % and 62.9% of the variability of the mean scores of conservation tasks, respectively. For both experimental and control groups, the model forecasted the impacts of the mean scores of forward – reverse actions on the mean scores of tasks. However, the regression model between mean scores of forward – reverse actions and the mean scores of tasks of the experimental group (B= 0.916 [95% CI 0.828 – 0.941] were higher than that of the control group (B= 0.712 [95% CI 0.61 – 0.814]. It was demonstrated that the conservation could be present earlier than ages 5-6 if forward – reverse actions were actively formed and developed according to the proper process.

Conclusion

Psychologically, Piaget figured out various contributory findings in term of children’s intellectual development, including conservation ability and reverse actions to form children’s reversibility in conservation. Piaget’s arguments about forward – reverse actions in conservation, combined with Galperin’s argument

about the process of intellectual action formation in children, have provided the basis for proactively forming forward – reverse actions, thereby accelerating the speed and level of development of conservation ability in children.

The experimental results in the direction of combining the above points of J. Piaget and P. Ia. Galperin for forming forward – reverse actions in children 5-6 years old showed that the correlation between forward – reverse actions and conservation in children was strong forward. At the same time, the formation of forward – reverse actions in children 5-6 years old using Galperin’s intellectual action process significantly increased the number of children achieving this action compared to that in normal conditions (control group); as a result, the conservation ability of experimented children was also significantly increased. Thus, the organization and practice of performing forward – reverse actions for children 5-6 years old following the intellectual action process defined in Galperin’s theory has accelerated the speed and degree of forming some of the children’s conservation categories, which will be both higher than the normal limits as determined by Piaget et al. at which any child gain initially the abilities.

However, the limitation of this study is that the forward – reverse actions have not been separated from the conservation actions but directed and practiced according to the separate processes, thereby, determining more clearly the impacts of forward – reverse actions on

conservation operation in particular and intellectual operation in general in children 5-6 years old.

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