

## A Research of the Influences of Verbal Guidance On Chemical technique

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**Abstract** This research based on the test of 142 high school students, adopted post evaluation in the control group design, and chose the neutralization titration as a task of the experiment to explore the influences of Verbal guidance on the formation of experiment operation ability. The result shows that Verbal guidance can promote the formation of chemical technique, especially in automated skills.

**Keywords** Chemical Education Research, Manipulative, High school/Introductory Chemistry

Many researches on cognitive athletic psychology have shown that characterization of speech can promote the explicitness degree of athletic skills (1-4). For instance, Shea's study has shown that during the learning period of athletic skills, coaches or gym teachers can help the athletes or students to maintain their athletic skills and keep the accuracy of explicitness through proper Verbal information (1). The experimental researches by Chen Min and Zhou Tianbao (1998) show that applying Verbal drilling to physical education (i.e., making the students repeat aloud the name of the motion during the training) can help to improve the motor skill and maintain the results (2).

In Vygotsky's viewpoint on the influence of speech on personal behavior (in terms of both recognition and motor), one's adjustment of behavior is, in a high degree, a process of speech, which is continuously developing from social speech to internal speech. Individual behaviors are initially adjusted by speech from others, and are then adjusted by the speech instructed by the learners themselves, and at last, they are automatically adjusted by the internal speech transferred from the self-instructed speech. External adjustment from others, self-adjustment and automatic adjustment, consist the 3-stage skill acquisition theory of Vygotsky. Utilizing this theory, Shen and Xin (1998) designed the teaching experiment, which are very effective for improving the teachers' ability of teaching supervision (5). Though Vygotsky's theory is mainly about the intellectual skills acquisition (6), since the study of chemical technique contains the study of rules (operation procedure, methods), i.e., the study of intelligent skills, we still believe it is instructive to the study of chemical technique. It is clear from the chemical education literature that some sort of mental preparation combined with physical practice can benefit students' laboratory skills. (?)

Inspired by the aforesaid researches, we believe that Verbal instructions (including Verbal guidance from others, self-instruction of the learners and internal Verbal guidance) is also helpful for the forming of operation skills of chemical experiments as delicate motion skills. However, we still need to make clear if Verbal guidance is effective for the forming of operation skills of chemical experiments.

The purpose of the study is to design instructive experiments according to the assumption that Verbal guidance is helpful to the forming of chemical technique, neutralization titration as the task of experimental operation, study the influence of Verbal guidance on chemical technique, and to provide psychological basis for the teaching quality of chemical technique of students.

The basic assumption of the study is: applying Verbal guidance to the study of chemical technique (i.e., first make the students operate corresponding experiments under instruction of teachers while learning the procedure, methods and precautions of experiments, and then repeat the aforesaid knowledge aloud while operating corresponding experiments independently, and at last ask the students to repeat the aforesaid knowledge silently while operating corresponding experiments independently) can stimulate the students to transfer external Verbal guidance into internal Verbal guidance, i.e., forming the internal instructing procedure of operations, so as to improve the accuracy of experimental operations and the effect of automatization.

## 2 Methods of research

### 2.1 Testees

142 students from three classes of grade 2005 (High school grade 1) from of Panxi high school, age 15-16, the testees have learned theoretical knowledge about neutralization titration while have not observed and operated neutralization titration experiments.

### 2.2 Test design

The 142 students are divided in 2 groups according to odd and even student numbers (numbered randomly when the students are enrolled), and randomly define the experimental group (Verbal guidance group) and the control group (non-Verbal guidance group), adopting post-test of the experimental group and the control group.

### 2 Test materials

This study is reviewed from two aspects: correctness of experimental operations of the testees and the time required to complete the experiment.

Experiment review task: titer the NaOH solution with unknown concentration by HCl solution. Chemicals, instruments etc. for the experiments shall be prepared in advance.

See table 1 for details about review items, standard operation procedure and rules of grading.

Timers for the experiments adopt stopwatches used for track events.

Table 1, Record card for chemical technique review

Laboratory Practice and standard of grade	Lost score	Time spent
1. Washing conical beaker	Washing method(2 score) Washing times and water volume every time(2 score)	
2. Washing burette	Solution volume used to wash burette every time (2 score)	

	Washing times (2 score)
	Washing method (2 score)
3. Acid added to acid burette	Add to acid solution (2 score) Exhaust bubble (3 score) Adjust liquid level under zero scale (3 score) Read scale of liquid level (3 score)
4. Base added to base burette	Add to base solution (2 score) Exhaust bubble (3 score) Adjust liquid level under zero scale (3 score) Read scale of liquid level (3 score)
5. measuring 20ml NaOH solution	Add to NaOH solution (3 score) Whether position of glass beading is moved (3 score) Read scale of liquid level (3 score) add to phenolphthalein and shake up (3 score)
6. titration	Put a white paper under conical beaker (1 score) Titration (3 score) Sway conical beaker (3 score) titration before end-point (3 score) observe end-point (3 score) Read scale of liquid level (3 score)
total	

#### 2. 4 Testers

To control the testers' prejudice during the experiments, we've taken the four measures as follows: Do not notify the testers of the purpose of the study; ask the testers to be sure of the purpose, operation procedure, methods and precautions etc. of the neutralization titration; before the test, organize the testers to carry out detailed analysis on the review items and grading standards of the test, e.g., "bottle shaking" operation in "titration" can be segmented into: correct and skillful operation, 3 scores; basically correct operation, 2 scores; partially wrong operation, 1 score; completely wrong operation, 0 score.; organize the testers to carry out simulating tests on 2 "testees" based on the aforesaid 3 steps to unify the measurement.

#### 2. 5 Testing procedure

To make the students participate in the tests earnestly so as to get genuine conditions of the test, tasks and test review record cards are handed over to the testees 2 days in advance, and the students are notified that: "the result of this test will be counted in the total grades of the semester by 10%." To eliminate the learning effect of the non-Verbal guidance group from the Verbal guidance group and the mutual learning between the students, the test will be completed in 6 hours; the non-Verbal guidance group was tested before the non-Verbal guidance group; during the test, the students that have been tested should be isolated. 5 testers (chemistry teachers of high schools) should test 10 tested each time. The testers' task is to: observe the process of the experimental operation of the testees, record the results of observation item by item according to the experiment

review record card, and at the same time record the total time to complete the experiment. Before the test, the same teacher should first explain to the testees the operation procedure, methods and precautions of the neutralization titration while demonstration, then the testees shall practice for 3 times before finally participating in the test. In the specific operation, the experimental group (the Verbal guidance group): in the first practice, the testees operate corresponding experiments under the testers' Verbal guidance while learning the procedure, methods and precautions of experiments and other knowledge of recognition, in the 2nd practice, they are asked to repeat aloud the above knowledge while operating corresponding experiments, and finally, they are asked to repeat silently the above knowledge while operating corresponding experiments. The time is 30 minutes. Control group: the testees practice for 3 times within the same time. Finally, the tested data are coordinated and analyzed with social science statistical software package SSPS10.0.

### 3 Results and discussion

#### 3.1 Results

See Table 2 for the results of the testees' correctness of experimental operations.

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	n	M	SD	t
Control group	56	55.75	2.62	-2.621*
Experiment group	56	56.82	1.57	

\*  $P < 0.01$

The results have shown that: in term of correctness of operation, Verbal guidance group is better than non-Verbal guidance group. The distance between the two groups is very distinct.

See table 3 for the time required for the testees to complete the experiment

Table 3: the time required for the testees to complete the experiment

	n	M	SD	t
Control group	56	9.530	1.766	3.991**
Experiment group	56	8.218	1.714	

\*\*  $P < 0.001$  (time unit: Minute)

The results have shown that: the time required for the Verbal guidance group to complete the experiment is less than that of the non-Verbal guidance group, the distance between the two groups is very distinct.

#### 3.2 Discussion

In term of correctness of experimental operations, the Verbal guidance group got higher results than the non-Verbal guidance group, and the distance between the two groups is very distinct. This indicates that Verbal guidance can improve the correctness of the learners operations. Then why Verbal guidance can improve the correctness of the learners operations?

It is considered that during the study of chemical technique, providing Verbal guidance for the procedure, methods and precautions of experiments. Recognition psychology deems that characterization is the means of information to appear and record in human brains. There are two kinds of characterizations of declarative knowledge, characterization of proposition and characterization of representation. Proposition representation means a kind of network system constructed by the certain concepts kept in long-term memory according to a certain relationship, it has the features as follows: recognition function: it is represented by the of mental association of

knowledge; layer characteristic: it is represented by the organization and construction function of the upper layer to the lower layer: Insufficient recognition function: it is represented by that the known knowledge of related objects can be used for thinking and reasoning of the objects to make up the missed value. Therefore, proposition representation system can acquire various useful information relating to the proposition representation by activation and diffusion.

In term of the time required to complete the experiment, the Verbal guidance group spent less time than the control group, and the difference between the two groups were extremely distinct. This shows that: during the study of chemical technique, Verbal guidance can improve the automatization degree of the learners' operation motions and reduce the time required to complete the experiments. This has been observed during the process of the test, the operation of the Verbal guidance group was obviously easier, faster and more consistent than that of the non-Verbal guidance group, many testees of the non-Verbal guidance group operated in awkward and inconsistent motions, some even appeared not to know what to do next and needed the help of the experiment review record card or operations of others as clue of further operations.

Why the Verbal guidance group spent less time than the control group? We think that on the basis that the operation motions are basically correct, the time required to complete the same experiment is related to the automatization degree of the operator's motions, the higher degree, the less time, whereas more time will be needed. While the automatization degree of motions is related to the forming of the internal instructive procedure in human brain to instruct the motions. In the viewpoint of recognition psychology, the mental mechanism of skilled operation motions is the internal instructive procedure formed in human brain that instructs operation motions (Shao Ruizhen, 1997)(8), which adopts production system characterization. In J.R. Anderson's viewpoint, the learning of operation skills is divided into 2 stages: stage 1 is the illustrative stage, i.e., recognition of related operation skills, mainly the learning of declarative knowledge; the second stage is the procedure stage, i.e., autoimmunization stage of operation motions, the process in which that procedure knowledge—internal instructive procedure is formed. The process in which the operation transfers from declarative knowledge instruction to the procedure knowledge instruction is called the knowledge editing. During the learning of chemical technique, making the students provide the operations with Verbal guidance while practicing can both strengthen the proposition representation of illustrative knowledge of related operation motions and accelerate the process of knowledge editing.

In the first practice of the Verbal guidance group, through Verbal guidance of the procedure, methods and precautions of experiments, the teachers can, instruct the learners to pay attention to the proper order of experimental operations, mark the external clues from the beginning of each subsidiary motion and correct operations and at the same time carry out proposition representation and characterization of representation to preliminarily form the instructive procedure of experimental operation motions. In the 2<sup>nd</sup> practice, the students repeat aloud the instructive procedure of the motion during the training. The speech in this practice scene have the functions of coordination and consolidation for the instructive procedure of the motion formed preliminarily,

making them more clearly kept in the learners' mind; at the same time, the vocal self-speech again stimulates the senses participating in the operation, this "self-strengthening" makes the learners further connect and strengthen the semantic, scenic and neural and muscular motility information acquired. In the 3<sup>rd</sup> practice, the students repeat silently the instructive procedure of the motion during the training, which is beneficial to the transfer of operation motions from vocal self-speech adjustment to internal speech adjustment and can promote the forming of the internal instructive procedure of the operation motions so as to realize the automation of operation motions. Therefore, as the automatization degree of the Verbal guidance group was improved, it is natural that they spent less time than the non-Verbal guidance group to complete the experiment. Though the non-Verbal guidance group had also 3 practices, since they were lack of clear and systematic Verbal guidance with from outside to inside, many learners have either fail to form complete instructive procedure of operation motions (requiring external clues like the experiment review record card or the operation of other to transfer one motion to another) or fail to form the internal instructive procedure of the operation motions (many motions can only be done after a long time of recalling), then it is natural that then spent more time than the Verbal guidance group to complete the experiment.

#### 4 Results and suggestions

- 4.1 This study has proven the assumption that during the study of chemical technique, Verbal guidance can promote the forming of operation skills, i.e., improve the correctness and automatization of experimental operations.
- 4.2 This study can provide experimental supports to Vygotsky's 3-stage theory of skill acquisition in term of the validity of operations in chemical experiments.
- 4.3 In teaching chemical experiments, purposeful Verbal guidance can be utilized to improve the efficiency for the teaching of chemical technique.
- 4.4 The influence of Verbal guidance on the operation skills of learners of different levels and on the learners' maintenance of these skills still needs further study so as to provide more detailed and accurate data for improving the efficiency for the teaching of chemical technique.

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