DOCUMENT RESUME

ED 408 169	SE 060 252

AUTHOR	Nieswandt, Martina
TITLE	Improving Learning in Chemistry Classes through Original Writing about Chemical Facts.
PUB DATE	Mar 97
NOTE	17p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28, 1997).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Chemistry; Educational Strategies; Foreign Countries; Interdisciplinary Approach; Learning Activities; Relevance (Education); *Science Instruction; Secondary Education; Student Evaluation; *Writing Across the Curriculum
IDENTIFIERS	Germany

ABSTRACT

This paper aims to situate a research project in the context of the literature about writing, describe the goals and methods of the project, and present some empirical results from the initial stages of the project. Students in four schools were divided into an experimental group (N=43) and a control group (N=48). The experimental group received specially designed writing tasks and the control group did the homework orally. Four types of writing tasks were used: (1) description of experimental observations; (2) interpretation of experimental observations; (3) explanation of phenomena; and (4) planning a clarifying experiment in the face of a remaining problem. Students' assessments are analyzed for the appropriate use of chemical facts, topic relevance, and text coherence. It was concluded that the appropriate use of chemical facts and concepts remained low throughout the study and that there were no significant differences between the two groups. Contains 26 references. (DDR)

Improving learning in chemistry classes through original writing about chemical facts.

Dr. Martina Nieswandt
Institute for Science Education (IPN)
at the University of Kiel
Olshausenstr. 62
D-24098 Kiel, Germany

Paper presented at the annual meeting of the
American Educational Research Association (AERA),
Chicago, 24 - 28 March 1997

Objectives

The aim of the paper is to situate our project in the context of the research on writing and to describe the aims and methods of the project. Additionally, we present some empirical results from the initial stages of the project.

Theoretical framework

Language seems to be central for communicating and more importently for understanding scientific phenomena (Stork 1993). Students learn through the use of language by: describing daily life phenomena, finding out the differences and similarities of these phenomena, creating terms for the similarities and deriving rules, and explaining phenomena with the help of abstract theories and concepts.
This could be a plea for systematic class discussion where students thoroughly discuss their ideas and reach common conclusions. But class discussions have shortcomings like all spontaneous oral comments made under the influence of relevant events. Speaking is "full of repetition, unclear (...) (and) also often formally incorrect" (Aebli 1991, p. 157). In contrast, writing is an instrument to complete, to extend and to permanently consolidate the process of knowledge and thinking.
Cognitive science and its emphasis on "epistemic writing" (cf. Bereiter 1980) supports Aeblis' pedagogical common sense. Epistemic writing is a form of processing one's own knowledge. This knowledge is not only a precondition for producing texts, but text production causes the writer to think over his/her ideas once again, bringing them into new context, giving them a new structure, and finally arriving at newly conceived knowledge. In the context of this research strand on writing, our project can be classified as a contribution to the role and impact of writing in cognitive functioning (cf. e.g. Bereiter and Scardamalia 1978, Britton 1975, Bruner 1972, Olson 1977, Vygotsky 1978).
Does writing help students to learn science more meaningfully than traditional class discussion? If it does, how? If it doesn't, why not? The aim of the project is to test whether writing results in more meaningful science learning (Ausubel, Novak and Hanesian 1980), and better long-term recall. More than that, the analysis includes a look into the "black box" to consider the exact ways in which students' writing changes.

Data and Methods

The writing project was carried out in a 9th grade chemistry class at each of four different Gymnasiums (secondary schools). Teachers implemented four units covering a total of 30 lessons. These teaching units are part of a course developed and tested at the Institute for Science Education and used for introductory chemistry classes. This course distinguishes itself by offering a sequence of experiments which takes the daily-life and environmental surroundings into consideration (Stork/Schulz/Johanssen 1993). The first three of these units focus on phenomena which are described and explained on a descriptive-operative level. The final units show examples of evaporation and condensation phenomena where interpretation takes place on the particle level:

1. *A waste product of combustion, which creates problems - carbon dioxide and the green house effect.*
2. *The most important of all oxides: Water - Circulation of water, provision of drinking water, purification of sewage.*
3. *A comparitive view of the coversion of energy during chemical reactions - the "struggle" of oxygen.*
4. *From the level of phenomena to the level of particles - the states of matter and their meaning.*

We divided the classes into two groups, an experimental group (with 43 students) and a control group (with 48 students).

Types and assesment of texts.

The project treatment was as follows: The experimental group received eight specially-designed writing tasks as homework, two per teaching unit, while the control group did the homework orally. The written products from the experimental group were collected and returned to students with comments on grammar and on their expression of chemistry concepts. This iterative procedure allowed students to use writing to explain chemical phenomena and to receive feedback on their writing and understanding of chemistry concepts.

Students were asked to complete four different types of writing tasks. Each successive type represents an increase in intellectual demands.

1. ***Description*** *of experimental observations including relevant circumstances of natural and technical phenomena.*
2. ***Interpretation*** *of experimental observations based on pre-theoretical, concrete observed regularities.*
3. ***Explanation*** *(interpretation) of phenomena with the help of abstract theories and concepts (concept of energy, the particle model).*
4. ***Planning*** *a clarifying experiment in the face of the remaining problem.*

The written texts were analyzed for 1) the appropriate use of chemical facts and concepts. We developed models listing elements of an appropriate answer for each task. Students' answers were then compared to these models. The written texts were also analyzed for 2) topic relevance (i.e., adhering to the task; McCutchen 1986), and 3) "text coherence" (van Dijk/Kintsch 1983) or the logical structure of the text.

"Text coherence" includes two different categories, the "logical structure of the text" and "cohesion connections". The analysis of the "logical structure of the text" works with the assumption that every main clause correlates with the previous main clause. In the text, these structural correlations are realized through different content correlations or "functional sentence roles" (Cooper/Matsuhashi 1983; Eigler et al 1990). We classify a main clause as "superordinate" if in this main clause the content of a previous main clause is summarized or generalized. A main clause is considered "subordinate" to a previous main clause if the content of the previous main clause is explained by using examples, definitions or characteristics. We assess a main clause as "coordinate" to the previous clause if new information is added on the same level of abstract or if a contrast is formulated. With this analysis, we are able to make statements on the linking-up of the text and on high complexity of thoughts or on the linearity of the text showing a train of thoughts.

The category "cohesion" is defined "as the set of possibilities that exist in the language for making the text hang together" (Halliday/Hasan 1976, p. 18). We differentiate between the following cohesions: Pronouns, adverbs, comparatives, conjunctions, lexemes and phrases. The amount of the most used cohesions points out the structure of the text and the complexity of knowledge (McCutchen 1986).

Types and assesment of tests.

The following test design was developed in order to find out whether independently written observations and interpretations of chemical facts lead the students of the experimental group to meaningful learning and whether a long-term consolidation of the lesson materials takes place.

	Pre-Test	Interim Test 1	Interim Test 2	Interim Test 3	Interim Test 4	Post-Test	Final Test
Understanding of language	X					X	
Thinking tied to visual conceptions	X					X	
Knowledge of Chemistry	X	X	X	X	X	X	X

Table 1: Types of tests and their contents

The tests were designed to assess both meaningful learning and long-term consolidation of the lesson materials. The study started with a pretest which focused on the general ability of language and on the current knowledge of chemistry. To assess the students' language faculties and the ability to think in visual terms we took parts of the Cognitive Abilities Test (CAT) (Thorndike/Hagen 1971) which was translated and modified for Germany.

At the end of every teaching unit all students took a test (interim test). Directly after the last test of the final unit the students wrote a post-test which covered all four units including a second language test. At the end of the school year - two months after the post-test - the students took a final exam in order to test their retention of the chemistry lessons given during the whole school year. It is important to note that these tests were in traditional short answer format. The tests required, on the one hand, the recall of learned knowledge and on the other hand, the synthesis of knowledge: the reorganization of knowledge and application of learned knowledge to new situations or problems.

All tests were graded for their chemical appropriateness. Together with a prime example of the solution the tests were then given back to the students.

For our investigation, the tests were analysed under professional points of view. As we did for the texts we developed models listing elements of an appropriate answer for each task of the tests. Students' answers were then compared to these models.

With these tests we are able to check the following hypothesized effects within the experimental group:

1. *During the whole measuring period the amount of the recall of learned knowledge should increase and*
2. *Writing should lead to a deeper understanding of chemical connections which make it easier to reorganize available knowledge and to apply this knowledge to new situations or problems.*

Results[1]

The analysis of the *texts* from the experimental group shows that the appropriate use of chemical facts and concepts was relative low throughout the study. In five of the eight tasks students' answers contained on average only 37% of elements of the model answers. In two of the tasks they scored 50% and in one 70%. However, the texts rated highly on topic relevance. The analysis of text coherence showed no change in complexity of thoughts over the course of the study. The written interpretation of experimental observations based on pre-theoretical, concrete observed regularities of as well as the explanation of phenomena with the help of abstract theories and concepts (e.g., the concept of energy, the particle model) remained difficult for the students. Students improved on average in their ability to describe experimental observations. For example, in task number one the average score was 50% and in task number two it was 70%. There was no corresponding increase in students' ability to interpret and explain phenomena.

Overall, the *test* results showed no significant differences between the experimental and the control group (see diagram 1). However, their were important exceptions.

[1] For more detailed results see Nieswandt 1997.

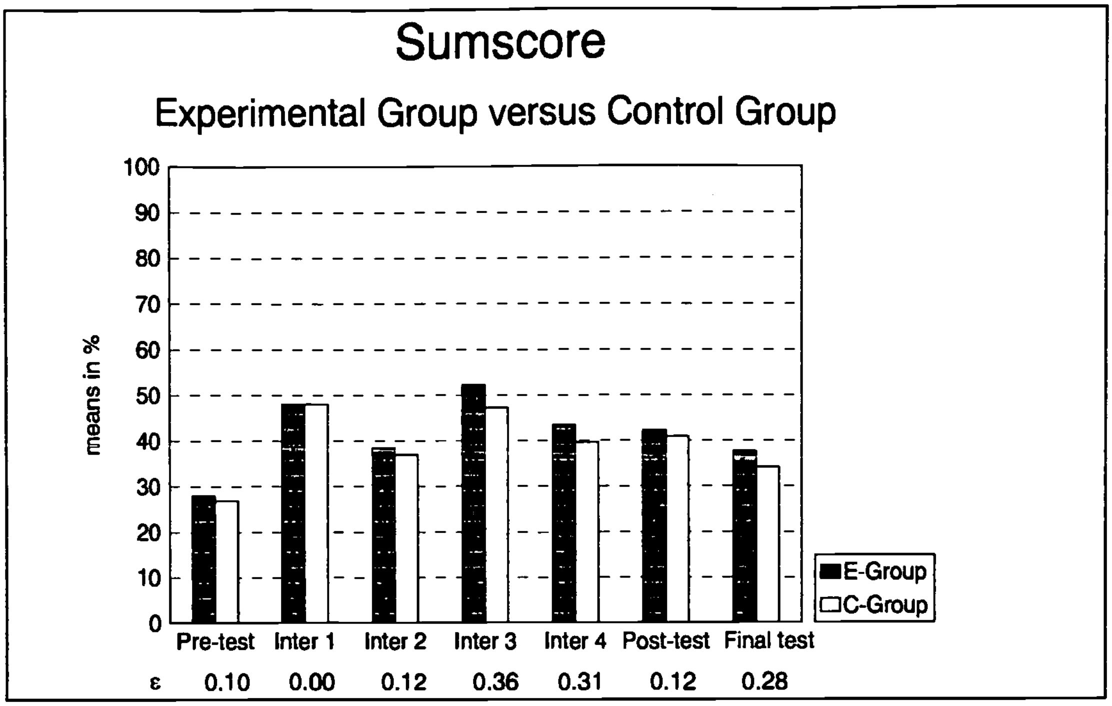

Diagram 1[2]

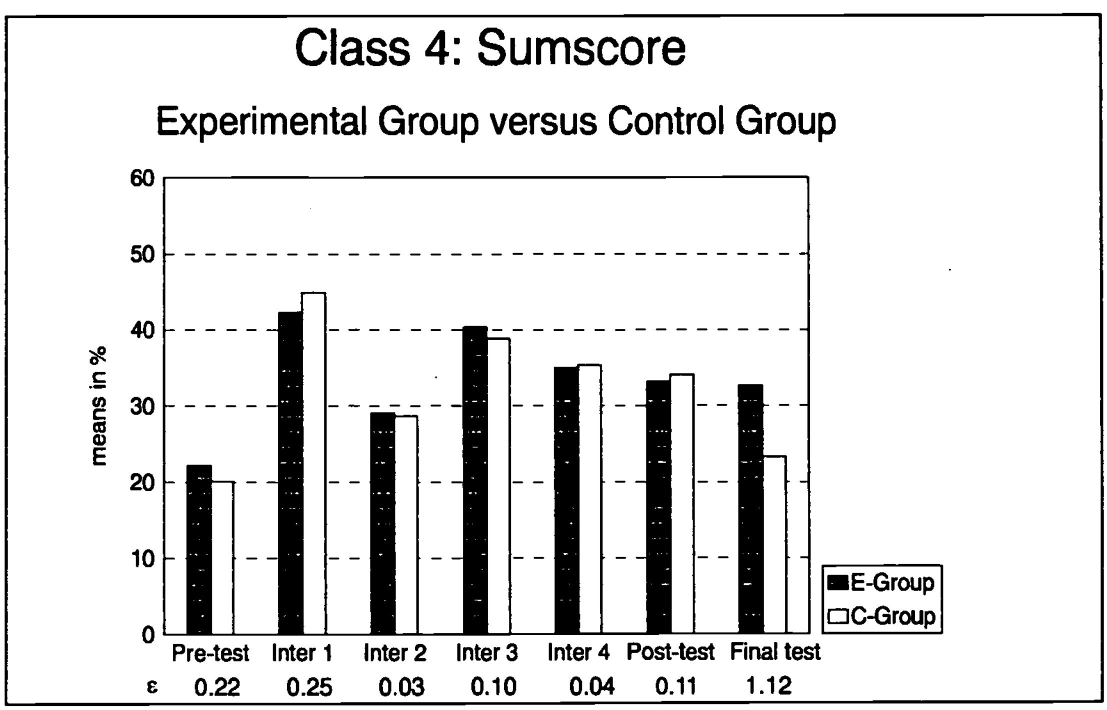

Diagram 2

---

[2] The differences betweeen the means of each group are often not significant but a look at the standard deviation (SD) showed differences between the experimental group and the control group as well as between girls and boys. We can say there is a significant difference when the difference of SD (this is the difference between mean 1 and mean 2 divide by SD of the whole group) is at least .30. We call this a small effect. Differences from .50 are called medium effects and differences from .80 are seen as strong effects. This categorization of effects follows Cohen (1969, p. 22 ff). With n = 69 scores at ε = .30 are significant; with n = 25 scores at ε = .50 and with n = 10 scores at ε = .80 are significant. These statements are valid at β= 0.2, this is similar to a power of 0.8.

More detailed analysis suggests that in one of the four classes the students of the experimental group scored significantly higher in the final test than the students of the control group (32% vs. 23%, $p < .01$, $n = 20$; $\varepsilon = 1.12$; see diagram 2).

The analysis of the three different task requirements (recall of knowledge, reorganization of knowledge and the application of learned knowledge) show that the experimental group of class 4 had a higher ability of recall of chemical knowledge at the end of the school year than the students of the control group of the same class (see diagram 3). The students of the experimental group also have a better long-term recall than they colleagues in the control group. But we have not found that the students of the experimental group have had a deeper understanding of chemistry. The tests' results of the experimental group were no higher than the control group on the ability to reorganize knowledge nor on the application of learned knowledge to new situations or problems.

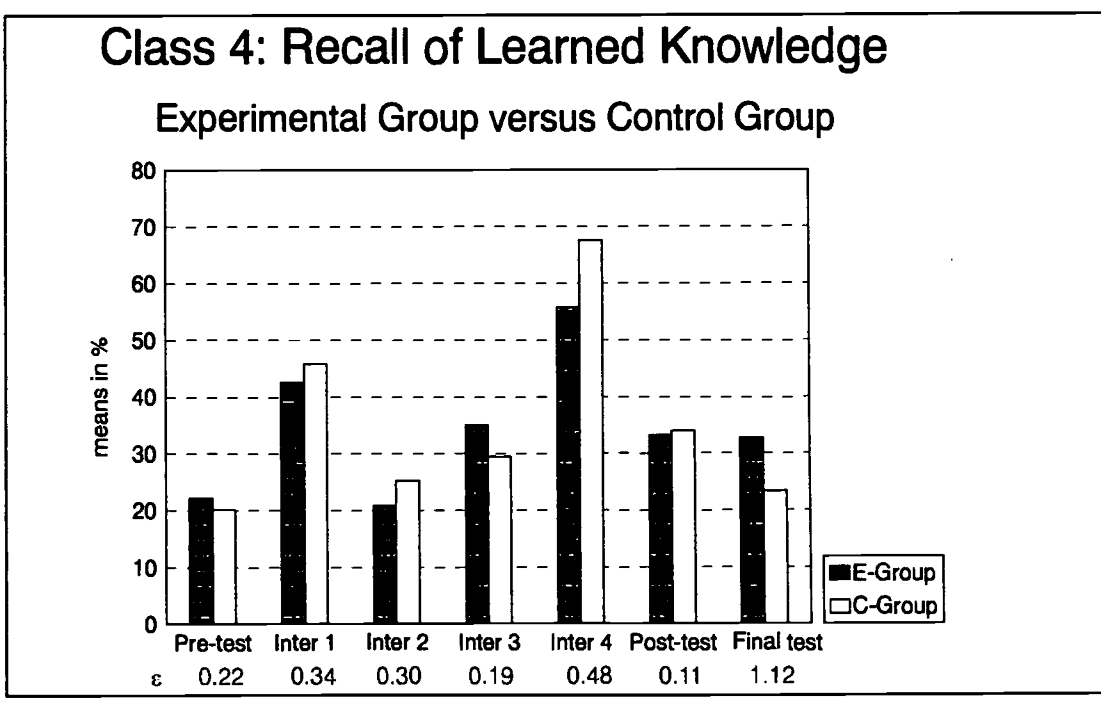

Diagram 3

In particular, the comparison of the two groups of girls in class 4 showed that the girls of the experimental group have strikingly higher scores at the end of the school year than the girls of the control group (see diagram 4).

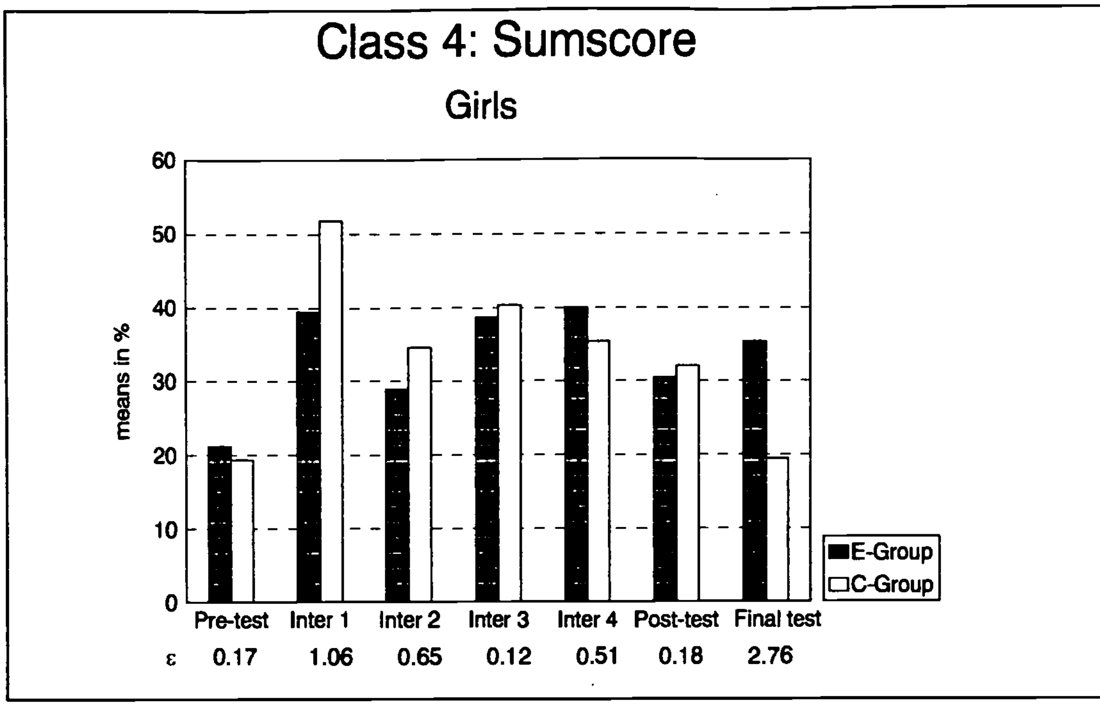

Diagram 4

Because of the small number of students in class 4 we made some more qualitative analysis of the students of the experimental group in this class.

A view of the girls' test results (see table 2) show that only two of the four girls have scored higher in most of the interim tests and also in the final test (No. 70 and 73) than the average score of the whole girls group. One girl also had good results in the final test (No. 68) but not in the other tests except for interim test 4. In the group of the boys only two boys have scored high in all test (No. 71 and No. 74).

No.	Gender	Pre-test	Interim test 1	Interim test 2	Interim test 3	Interim test 4	Post-test	Final test
68	female	21	26	17	24	40	29	37
70	female	40	47	36	44	29	29	43
72	female	6	50	28	39	47	30	25
73	female	13	29	42	52	44	34	37
65	male	15	41	26	56	37	27	-
66	male	13	38	13	29	24	25	25
69	male	17	29	11	29	18	29	29
71	male	40	59	61	51	36	44	35
74	male	23	50	33	52	52	44	35
75	male	30	50	31	33	23	41	28
All girls		21.13	39.41	28.86	38.67	39.94	30.48	35.38
All boys		22.96	44.61	29.17	41.78	31.61	34.93	30.38

Table 2: Sumscore of the girls and boys of the experimental group in class 4

A look at the single tasks of the tests (see table 3) indicates that the students No. 70, 71, 73 and 74 have high results in the tasks which required recall of learned knowledge and that the students No. 71, 73 and 74 also have high results in the tasks which required the synthesis of knowledge: the reorganization of knowledge and application of learned knowledge to new situations or problems.

	E-Gr. Cl. 4	All girls Cl. 4	All boys Cl.4	No. 70 f	No. 71 m	No. 73 f	No. 74 m
Pre-test	22	21	23		40		
Interim test 1							
Recall	43	43	42	50	57	32	43
Reorganization	35	20	47	20	60	40	80
Application	73	40	100	100	100	0	100
Sumscore	42	39	45	47	59	29	50
Interim test 2							
Recall	21	18	23	29	63	23	6
Reorganization	26	23	29	31	69	53	47
Application	83	98	69	100	83	100	100
Sumscore	29	29	29	36	61	42	33
Interim test 3							
Recall	35	43	28	77	54	46	69
Reorganization	38	37	39	29	46	54	29
Application	44	38	49	44	53	53	65
Sumscore	40	39	42	44	51	52	52
Interim test 4							
Recall	56	79	40	71	71	86	64
Reorganization	16	19	14	8	8	23	30
Application	71	68	73	55	85	70	100
Sumscore	35	40	32	29	36	44	52
Post-test	33	30	35	29	44	34	44
Final test	33	35	30	43	35	37	35

Table 3: Means of the test results of all tests

Legend: E-Gr.: Experimental group Cl.: Class
f: female m: male

Are these results an effect of writing?

In order to find an answer of this question we looked at first at the results of the appropriate use of chemical facts and concepts in all eight written tasks. The written tasks belong to different typs of texts: Description of experimental observations, interpretation of experimental observations, explanation of phenomena with the help of abstract theories and concepts (concept of energy and the particle modle), and planning a clarifying experiment. As you see in table 4, a single written task can include more than one of these types of texts. For example the written task 1 includes the description and the interpretation of an experimental observation.

	E-group (means)	Number			
		70 girl	71 boy	73 girl	74 boy
WT 1					
Description	4.26	4	4	4	4
Interpretation	3.37	6	7	4	3
Sumscore	7.63	10	11	8	7
WT 2					
Description	9.00	7	8	4	9
Sketch	7.86	9	9	6	6
Sumscore	16.85	16	17	10	15
WT 3					
Interpretation	6.96	8	9	10	12
WT 4					
Interpretation 1	1.52	1	3	1	1
Interpretation 2	4.59	4	5	7	5
WT 5					
Explanation	18.22	6	15	20	17
WT 6					
Planing	3.22	3	6	6	3
Sketch	6.63	3	5	6	4
Carrying out	5.26	2	8	2	3
Expectation	4.93	2	12	3	2
Reason	5.11	0	3	6	6
Sumscore	25.15	10	34	23	18
WT 7					
Explanation 1	7.30	3	11	11	4
Explanation 2	5.11	3	7	7	2
WT 8					
Description	9.93	9	8	10	0
Interpretation	8.89	15	9	14	0
Explanation	5.37	6	11	7	0
Sumscore	24.19	30	28	31	0

Table 4: Appropriate use of chemical facts and concepts

Legend: WT: Writing task
E-group: Experimental group

What kind of results did the four selected students have in each of these four text types?

None of the four students have higher than the average scores of the experimental group in describing experimental observations. The results in the written task 1 and 8 are like the average of the experimental group (see table 4) and in the written task 2 it is worse than the experimental group.

In the second typ of text, the interpretation of experimental observations, all four students have scored higher in the written task 3 than the experimental group. These results are similar in the written task 1 except for the student No. 74 who has an average result in this written task. The results of the written task 4 show that the girl No. 70 scores lower than the average results in both parts of this written task while the students No. 73 and 74 score lower only in the first part. In the other part they are better. The boy No. 71 has better results in both parts.

Students had to explain phenomena with the help of abstract theories and concepts in the written task 5, 7 and 8. Only the girl No. 73 did this very well in all of these three written tasks. The student No 71 who had good results in the first two types of tests has lower scores only in the written task No. 5. In the other written tasks he scored higher than the average of the experimental group. The girl No. 70 has only good results in the last written task and the boy No. 74 scores low on all written tasks.

The good results of the boy No. 71 were also seen in the last text type, the planning of a clarifying experiment. He is the only one who had better results than the experimental group. The other three students score lower than the average of the experimental group.

Cluster analysis of the variables of the written tasks which give information of the topic relevance and the text coherence show that the boy No. 71 was in six written tasks in the highest cluster. In the other two written tasks he was in the middle cluster. These cluster analysis reveals that the other students are either in the middle or in the lower cluster. Only once or twice they are in the highest cluster.

The results of the analysis of tests and texts show the differences between the four students. While the girl No. 70 has good results in the appropriate use of chemical facts and concepts only in these written tasks which required the interpretation of experimental observations, the male student No. 71 has scored high in all types of texts except of the description of experimental observations. Because the analysis of topic relevance and text coherence indicates only an average writing ability, it is difficult to explain the good test results of the girl No. 70 as an effect of writing. We find similar results for the students No. 73 and 74. But all of them scored high in the final test. Therefore we may say for these three students at least, writing results in a better long term-recall.

We find much better and clearer effects by analysing the boy's No.71 tests and texts. His good appropriate use of chemical facts and concepts and his appropriate use of language are also been seen in his good test results. At the end of the school year, this boy has a deeper understanding of the chemical connections as well as good long-term memory capability. His results indicates at least that writing about chemical facts supports a long-term consolidation.

Summary and final reflections

The analysis of the tests of the all students who participated in this study does not indicate that the students of the experimental group have higher test results than the students of the control group except of one class. The students of the experimental group in class 4 scored significantly higher in the final test than the students of the control group. This result indicates that writing may support a long-term consolidation of the lessons materials.

What are the reasons of these results?

The analysis of the written tasks have shown that both the appropriate use of chemical facts and concepts during the eight written tasks is low, and also the language abilities do not meet our expectations. Comments of some students like "What, I have to write in chemistry?", "Do we have a chemistry lesson or a German lesson?" or "Do not make me crazy, woman!" refer to the low motivation of the students to do their written homework carefully. At the same time these comments can be interpreted as difficulty experienced during writing. This impression is strengthen by the fact that some written homeworks were copied from other students or incomplete or the students did them only after repeated demands.

Original writing of a factual text needs at first a thoughtfull structure of the own knowledge and then the formulation of a reasonable sequenze of statements. This is much more ambitious than the oral speech. In an oral speech one statement can be described and corrected more often by a broaden paraphrasing, new examples and proof correction of mistakes. The students should *not learn* basic writing skills in the chemistry lesson; they should *apply* them and *develop further*. But the majority of students were not able to transfer the abilities and skills of the

German class into the school subject chemistry. The high number of spelling, grammar and punctuation errors indicate this as well as the low ability of the students to write for a special target group. The lag of professional science knowledge also makes writing more difficult. Original writing of complex facts - like explanation of the three states of matter with the help of the particle model - requires that the students have understood the content in their mind thus far and that they can elaborate appropriate words and sentences. But when knowledge is incomplete (and the results of the analysis of the appropriate use of chemical facts and concepts indicate this), then problems already appear during structuring the thoughts, which continue in the written products as the language analysis makes clear.

Although the experimental/control group desing of the study made it inpossible to practice and teach writing in the class, we did not do completely without it. After the students of the experimental group have written their homeworks they received a modle of an appropriate answer of this task. In addition they got their own writing back after we have corrected mistakes of spelling, grammar and punctuation and gave alternatives of phrases.

The short time periode of the study may be another reason for the modest results we see. The entire procedure was finished within half a school year. In face of the students' problems with writing this periode of time was not enough. During planing this study, we decided not to broaden this periode because we were concerned about the variability of the students' motivation. The lose of motivation of the few students during the study underscores these concerns.

Because of the results of the written products should we give up writing of chemical facts in chemistry classes?

The results of class 4 indicate that writing may support the long-term consolidation. But the analysis of the four students' individual learning process shows clearly only one case where writing about chemical facts was done seriously and where both a long-term consolidation, and a deeper understanding of chemical connections was achieved. These are preliminary results. More analysis of individual students in the other three classes will follow.

The number of succesful cases are small at the moment, but we find some signs which suggest there is a positive effect of writing on meaningfull learning. Research in science education should note that writing can be an instrument to promote science learning. When developing curricula and teaching materials, regular written work on scientific contents should be considered in order to increase students' abilities and understanding of science.

References

Aebli, H.: *Zwölf Grundformen des Lehrens*. Klett-Cotta, Stuttgart **1991**.

Ausubel, D. P./**Novak**, J. D./**Hanesian**, H.: *Psychologie des Unterrichts*. Beltz, Weinheim and Basel **1980**.

Bereiter, C.: *Development in writing*. In: Gregg, L. W./Steinberg, E. R. (Eds.): *Cognitive Processes in Writing*. Lawrence Erlbaum, Hillsdale, NJ **1980**, pp. 1-64.

Bereiter, C./**Scardamalia**, M.:*The psychology of written composition*. Erlbaum, Hillsdale, NJ **1978**.

Britton, J.: *The development of writing abilities*. Macmillan Education, London **1975**.

Bruner, J. S.: *The Relevance of Education*. Penguin, Harmondsworth **1972**.

Cohen, J.: *Statistical Power Analysis for the Behavioral Sciences*, New York/London **1969**.

Connolly, P./**Vilardi**, T. (Eds.): *Writing to Learn Mathematics and Science*, New York/London, 1990.

Cooper, Ch. R./**Matsuhashi**, A.: *A theory of the writing process*. In: Martlew, M. (Ed.): The psychology of written language. Development and educational perspectives. Chichester: Wiley **1983**, pp. 3-39.

Dijk, T. A. van/**Kintsch**, W.: *Strategies of discourse comprehension*. Academic Press, New York **1983**.

Eigler, G./**Jechle**, Th./**Merziger**, G./**Winter**, A.: *Wissen und Textproduzieren*. Gunter Narr, Tübingen **1990**.

Flower, L. S./**Hayes**, J. R.: Problem-Solving Strategies and the writing process, in: *College English*, 39, **1977**, No. 4, S. 449-461.

Halliday, M.A.K./**Hasan**, R.: Cohesion in English, London **1976**.

Hayes, J. R./**Flower**, L. S.: Identifying the organization of writing processes. In: Gregg, L.W./Steinberg, E.R. (Eds.): *Cognitive processes in writing*, **1980**, pp. 3-30.

Hillocks, G.: *Research on Written Composition: New directions for teaching*. ERIC Clearinghouse on Reading and Communication Skills, Urbana, IL **1986**.

***The IEA Study of Written Composition I**: The International Writing Tasks and Scoring Scales*. Edited by T. P. Gorman, A. C. Purves, R. E. Degenhart, Pergamon Press, Oxford, New York etc. **1988**.

***The IEA Study of Written Composition II**: Education and Performance in Fourteen Countries*. Edited by A. C. Purves, Pergamon Press, Oxford, New York etc. **1992**.

Mc Cutchen, D.: Domain knowledge and linguistic knowledge in the development of written ability. In: *Journal of Memory and Language*, 25, **1986**, pp. 431-444.

Nieswandt, M.: Schreiben als Mittel zum verstehenden Lernen und zur Konsolidierung des Gelernten im Chemieanfangsunterricht des Gymnasiums, forthcoming Kiel **1997**.

Nieswandt, **M./Stork**, H.: Writing in junior chemistry classes. An instrument of learning science meaningfully? Paper presented at the annual meeting of the National Association for Research on Science Teaching (NARST), San Francisco **1995**.

Olson, D. R.: From utterance to text: The bias of language in speech and writing. In: *Harvard Educ. Rev.,* 48, **1977**, No. 3, pp. 257-281.

Pearce, D. L./**Davison**, D. M.: Teacher use of writing in the junior high mathematics classroom. In: *School Science and Mathematics,* 88, **1988**, No. 1, pp. 6-15.

Stork, H.: Sprache im naturwissenschaftlichen Unterricht. In: Duit, R./Gräber, W. (Ed.): *Kognitive Entwicklung und Lernen der Naturwissenschaften*, Kiel **1993**, pp. 63-84.

Stork, H./**Schulz**, P./**Johanssen**, R.: Auf dem Weg in die Chemie. Einführender Unterricht in der Sekundarstufe I. In: *IPN Blätter* **1993**, No. 8, pp. 1 and 3.

Thorndike, R.L./**Hagen**, E.: *Cognitive Abilities Test*. Examiners's Manual. Multi-Level Edition (Form 1 - Levels A-H/Grades 3-12), Boston **1971**.

Vygotsky, L. S.: *Mind in society: The development of higher pychological processes*. Harvard University Press, Cambridge, MA. **1978**.

AREA 1997

SE010252

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: IMPROVING LEARNING IN CHEMESTRY CLASSES THROUGH ORIGINAL WRITING ABOUT CHEMICAL FACTS

Author(s): MARTINA NIESWANDT

Corporate Source:

Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following options and sign the release below.

[X] Check here	Sample sticker to be affixed to document	Sample sticker to be affixed to document	[ ] or here
Permitting microfiche (4"x 6" film), paper copy, electronic, and optical media reproduction	"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY ______ Sample ______ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."	"PERMISSION TO REPRODUCE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY ______ Sample ______ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."	Permitting reproduction in other than paper copy.
	Level 1	Level 2	

Sign Here, Please

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Signature: Dr. M. Nieswandt	Position: RESEARCHER
Printed Name: DR. NIESWANDT	Organization:
Address: INSTITUTE FOR SCIENCE EDUCATION (IPN) OLSHAUSENSTR. 62, D-24098 KIEL GERMANY	Telephone Number: +49 (431) 880-3169
	Date:

OVER

CUA

THE CATHOLIC UNIVERSITY OF AMERICA
Department of Education, O'Boyle Hall
Washington, DC 20064
202 319-5120

February 21, 1997

Dear AERA Presenter,

Congratulations on being a presenter at AERA[1]. The ERIC Clearinghouse on Assessment and Evaluation invites you to contribute to the ERIC database by providing us with a printed copy of your presentation.

Abstracts of papers accepted by ERIC appear in *Resources in Education (RIE)* and are announced to over 5,000 organizations. The inclusion of your work makes it readily available to other researchers, provides a permanent archive, and enhances the quality of *RIE*. Abstracts of your contribution will be accessible through the printed and electronic versions of *RIE*. The paper will be available through the microfiche collections that are housed at libraries around the world and through the ERIC Document Reproduction Service.

We are gathering all the papers from the AERA Conference. We will route your paper to the appropriate clearinghouse. You will be notified if your paper meets ERIC's criteria for inclusion in *RIE*: contribution to education, timeliness, relevance, methodology, effectiveness of presentation, and reproduction quality. You can track our processing of your paper at http://ericae2.educ.cua.edu.

Please sign the Reproduction Release Form on the back of this letter and include it with **two** copies of your paper. The Release Form gives ERIC permission to make and distribute copies of your paper. It does not preclude you from publishing your work. You can drop off the copies of your paper and Reproduction Release Form at the **ERIC booth (523)** or mail to our attention at the address below. Please feel free to copy the form for future or additional submissions.

Mail to:
AERA 1997/ERIC Acquisitions
The Catholic University of America
O'Boyle Hall, Room 210
Washington, DC 20064

This year ERIC/AE is making a **Searchable Conference Program** available on the AERA web page (http://aera.net). Check it out!

Sincerely,

Lawrence M. Rudner, Ph.D.
Director, ERIC/AE

---

[1]If you are an AERA chair or discussant, please save this form for future use.