GROUP WRITING TASK IN CHEMISTRY TO ENHANCE STUDENTS' SCIENTIFIC EXPLANATIONS AND THEIR ATTITUDES TOWARD SCIENCE

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The current practice of teaching science in Indonesian secondary schools is still dominated by the use of a traditional approach, which is didactic and involves mainly chalk-and-talk. This study reports the effect of using group-writing tasks with Year 12 students in a chemistry classroom. Instead of the teacher explaining the concepts and the development of models and theories of the atom, the teacher asked students to work in groups and to create an explanation, a short story or a transcript of a drama on the topic. Each group was assigned to produce a written paper describing the development of models and theories of the atom. The findings revealed that the use of group writing tasks in teaching science can promote students' attitudes toward science and enable students to elaborate their explanations of the concepts. Furthermore, by working cooperatively, students may develop their social skills such as sharing information, negotiating meaning, being dedicated to the task, valuing each other's individual effort, and caring for others.

INTRODUCTION

Teacher-centred approaches have dominated science education for a long time in developing countries such as Indonesia. Thair and Treagust (1997) provide examples in a science classroom at Manado, Indonesia. They noticed that the main characteristics of teacher-centred approach are that the teacher has absolute authority, and students will only speak or act in response to teacher's instruction. Little time is devoted to questioning or discussion. Evidence is that through science education reform via the PKG program some teachers have started to move from a teacher-centred approach to have a more student-centred orientation (Esomar, 1988;

Mertajaya, 1993; Pragoto, 1993; Supriyono, 1991; Thair & Treagust, 1999; Untung, 1993). Yet many teachers still embrace the former due to an overload of the curriculum, driven by the external examinations, focus on prescribed curriculum demands and place less emphasis on teaching concepts at a deeper level. Psychologically both the teacher and students are already comfortable with the transmission mode of teaching. Classroom climates which in the past have shaped students' attitude to be passive, contributed to this condition. This problem has often confronted the first author in his experience of changing his teaching approach to be more student-centred. Many students admit that they prefer the learning process in the old way but passivity can be seen to limit students to a rote-level of understanding. Rarely do students ask and explain which are respectively indicative of a higher level of understanding in learning and evaluation.

In order to promote students' understanding, the literature (Byers & Hersnovics, 1977; Glynn & Muth, 1994; Skemp, 1976; and Untung, 1993) recommends that teachers need to take into consideration an alternate approach that stimulates and accommodates students' interests and creativity so that they become active learners and aware of their own learning. In addition, constructivist views of learning claim that students will experience meaningful learning when their previous knowledge is taken into account (Treagust, Duit, & Fraser, 1996). The writing-to-learn strategy may serve both these purposes in the science lessons (Fellows, 1994; Glynn & Muth, 1994; Rivard, 1994;). This paper reports on a study using group-writing tasks to teach the concepts of theories and models of the atom for Year 12 students at SMU (Sekolah Menengah Umum—a senior high school) Negeri 1 Banjarmasin, Indonesia. Instead of explaining the concepts and the development of models and theories of the atom, the first author asked students to work in groups and to create an explanation, a short story or a transcript of drama on the topic. Each group was assigned to produce a written paper that describes the development of models and theories of the atom.

THEORETICAL UNDERPINNING

The result of research on the levels of students' understanding has implications for learning and teaching practice particularly in science and mathematics classrooms (Byers & Hersnovics, 1977; Buxton, 1978; Skemp,

1976). Considering the fact that students may vary in the rate at which they come to understand, it is suggested that teachers be selective in designing their instruction to enhance students' understanding, starting from a basic level, perhaps from rote or intuitive understanding to more advanced levels, which are described as relational or formal understanding. Relational understanding involves the ability to integrate the concepts into a new situation (Byers & Hersnovics, 1977; Buxton, 1978; Skemp, 1976). Unfortunately, most Indonesian teachers tend to use traditional instruction, for example, the chalk-and-talk method that is likely to constrain their students from gaining a higher level of understanding. Research conducted in Australia by Baird (1990) asserts this condition. The researcher reported that students were disappointed with the teacher's method used in the learning processes and complained that the teachers only emphasise on the lecture method (chalk-and-talk), or they [students] watched a demonstration without any follow-up of serious or meaningful discussion. In addition, Baird (1990) also admitted that this kind of method not only detracted students' motivation to learn science but also led to boredom.

Consequently, this situation may generate students' negative attitude toward science, thus producing a bad impact on their achievement. Similarly, research conducted by Speering and Rennie (1996) in Australia showed that students in secondary science were disappointed with the teaching strategy that was being presented to them because they had only limited interaction with their teacher and mostly did bookwork during the learning process. Furthermore, research into 'Challenge' in learning and teaching science conducted by Baird and Penna (1996) revealed similar features. Although many teachers considered teaching which challenged the students was very important, rarely did many of them provide the challenge. As a result, the students tended to be less positive about science.

In order to avoid this situation in the classrooms, teachers should be aware of their teaching strategy. One of the teaching strategies that may help to resolve the problem is the group-writing task strategy that employs both reading and writing activities.

A number of studies on writing have revealed that writing activity has great influence in learning and suggests that writing might be used to enhance the learning of science content. Rivard (1994) believed that the

importance of the writing process is that it is not only for learning about something or acquiring such knowledge, but also for producing a personal response to something, clarifying ideas, and for constructing knowledge. Furthermore, Resnick (as cited in Rivard, 1994) suggested that writing has a potential role as a cultivator and an enabler of higher order thinking.

Writing can serve as a powerful heuristic for learning new information when it is done for communicative purpose and when the writer [learner] attempts to integrate new information with previous knowledge (Newell, 1986). Writing by its nature may enhance the thinking process. When students engaged in the writing process, he or she tries to organise his or her ideas, refines them, and present them to the reader in order to get the ideas across. In addition, Glynn and Muth (1994) claim that reading and writing activities in the science classroom play important roles in the learning process; while reading, students not only gain confidence and satisfaction in the concept they have learned but also they may overcome misconceptions they held before. They highlighted that through writing activities students can express their knowledge in their own words and writing can connect them to daily occurrences. The writing process allows students to explore concepts or themes so that they will eventually achieve higher levels of understanding of the concepts.

According to Rivard (1994) there are three types of writing activities, namely expository writing, expressive writing, and combination of both. Tasks such as note taking, summarizing, explaining, and analysing are examples of expository group whereas journals and diaries belong to expressive writing. The narrative form, written in the first person, can be used.

Research that focuses on the use of the narrative form in science classrooms reveals significant results. Strube (1996) describes that the narrative form has two meanings; firstly, the teacher presents information (concepts or facts) in narrative format and secondly students construct personal narratives that are based on the information. He also emphasises that the narrative form in teaching science, particularly chemistry, helps students improve both storage and recall information (concepts, facts, etc) from memory. Hardy (1975) suggested that through using the narrative format, the teacher might understand how students order their experiences.

Furthermore, the teacher may also detect students' misconceptions that are evident in the writing narrative.

The advantages of using narratives in teaching science has been reported, for example:

1. It allows information or concepts to be more easily stored and recalled (Finke, 1978)
2. It makes the information or concepts more meaningful by generating the relevance in non-scientific context.
3. It makes the concepts or information more memorable since the attention paid to it as a story element rather than isolated facts or discrete concept.
4. It is more enjoyable by showing it can be used to entertain as well as to explain (Strube, 1996).

Research also suggests that through working collaboratively students can achieve higher-quality reasoning strategies, more meta-cognition, and more new ideas and solutions to the problem than if student work individually. In addition, working collaboratively can also develop students' social skills such as caring for others and responsibility (Johnson, Johnson, & Holubec, 1988). While students are working in cooperative groups, they tend to be more intrinsically motivated, intellectually curious, and caring for others.

SIGNIFICANCE OF THE STUDY

Although the benefits of using narratives in particular and writing to learn in general are clear, unfortunately there is little research in secondary science education that investigates whether writing activities such as narratives can enhance students' learning of specific science concepts (Strube, 1996). Most research on writing in science is conducted with college or university students that may not be applicable for secondary students (Rivard, 1994). In order to bridge this gap, this paper reports the result of the investigation of using group writing task approach in learning concepts of theories and model of atom. The research was conducted in chemistry in a Year 12 class of 29 students at SMU (Sekolah Menengah Umum—a senior high school) Negeri 1 Banjarmasin of Kalimantan Selatan, Indonesia.

The significance of this study is grounded on some assumptions. First, the study may provide an alternative teaching strategy for Indonesian teachers and students. Second, this study may help teachers to fulfil one of the goals of science education in Indonesia (MOEC, 1993) that stated that students should be able to communicate scientific understanding to different audiences for a range of purposes. Students' ability in communicating their science knowledge can be exercised, enhanced, and practised via the use of group writing task in the teaching and learning process.

METHOD

The study was conducted in one chemistry class that consisted of nine boys and 20 girls. The students were grouped into groups of four or five of their own preference. Each group was responsible to produce a paper that described the development of the models and theories of atomic structures. The form of the paper could be explanatory, a short story, or a transcript of a drama that can be exhibited. Each group was given three weeks to generate the paper. After completing the task, students were given a simple questionnaire to determine their responses toward group-writing-task activities. Informal interviews were conducted to confirm students' responses of the questionnaire. Students' explanations of the concepts that were expressed on the paper and on the test/quiz were observed and analysed to investigate whether or not the group writing task approach enhanced students' scientific explanation of the theories and models of atom.

ACTIVITIES SCHEDULE

Week 1 Discussion on students' prior knowledge of the topic. (Students have already studied a basic level of atomic theory in Year 10). An introduction and explanation of the task, followed by negotiation between teacher and students, and students-students on the nature of the task, i.e., how to form a group, how to share resources, and when group members will meet together.

Week 2 Students collected and gathered related information.

Week 3 Students generated the format of the paper. The final paper was discussed and submitted.

A test in essay form was administered to investigate students' understanding of the concepts.

The materials were available in both the school and public libraries that were easily accessible for all students. Students were welcome to discuss their progress or to bring up problems that they might face during the activities. Informal discussions and interviews were conducted during the sessions to explore students' opinions of the task. At the end of the project, they were given a questionnaire. The results of the responses from the questionnaire and the paper generated from the activities as well as students' answers at the test/quiz were analysed to draw conclusions.

RESULTS

All groups chose a transcript of a drama to describe the development of the models and theories of atomic structures; none chose a short story or an explanatory form. Analysing the papers submitted by the groups enabled the impact of the group-writing-task approach on students' learning to be investigated upon. First, the papers produced by the students in a group revealed that they encountered more concepts. Amazingly, they put lots of facts and concepts that they might not have learnt through a traditional approach (chalk-talk), or could not find in textbooks they used in the classroom. The group-writing-task approach potentially allows students to learn the content more deeply.

Second, the papers submitted by the groups provided evidence on students' attitude toward their learning and science. The majority of the students indicated that they felt enlightened through this activity. For example, one group wrote " *...this paper was dedicated to my beloved teacher who has enlightened us...*" Moreover, other groups noted that they were inspired by the work of scientists through their reading activity. They noted how scientists totally devoted their life into science development. They put their appreciation on the acknowledgment: "*This paper is dedicated to all scientists who enlighten our worlds by their efforts.*"

Third, the content organisation of the papers indicated a possible relational understanding of the concepts. In their papers, students provided significant explanations of the background of models or theories of the atom. They argued how such a model and theory of the atom became unacceptable and another theory or model replaced it. During informal interviews, despite students' complaints regarding time and energy consumed in producing the paper, they agreed that they developed a deeper understanding of the atomic concepts. They admitted that through reading the relevant paper or book, followed by discussions with peers, they were aware that they knew the topic beyond memorizing the facts, names, or notions. This claim is confirmed with the analysis of students' answers on the test. Most students in this classroom provided more explanations and went beyond memorization than did the students in another classroom who were taught with traditional teaching strategies. For example, in response to the question: "Why is Rutherford's theory and model of the atom rejected?", the students in the first author's class provided Maxwell's theory to explain how the electrons' energy drop off for an atom to become unstable. On the other hand, the students in other classrooms simply answered that the atom is unstable since its electron lost its energy. In other words, most students in the first author's classroom had worked towards relational understanding rather than a rote-level of understanding (Skemp, 1976). This confirmed that a group writing task strategy could enhance student's scientific explanation.

At the end of the activities, a questionnaire was administered to explore students' attitudes toward group writing task approach. The questionnaire was very simple and was aimed at determining students' responses on three main themes, namely, the usefulness of the group writing task, the nature of group writing task, and the effect of group writing task on their attitudes toward a chemistry [science] classroom. Their responses are shown Table 1.

Table 1
Students' responses to questionnaire on the effects of the group writing task

The activity (group writing task) was:	**Yes responses (N=29)**
Very useful	11
Useful	16
Not Useful	2
Hard / difficult	24
Easy	-
Fair	5
Challenging	29
Boring	2
Increasing my motivation to study science	24
Decreasing my motivation to study science	2
Has no effect on my motivation to study science	3

Analysis of the questionnaire results and follow-up of the interviews with some students indicated that the writing activity allowed students to develop constructive behaviours and revealed positive student attitudes toward science. For example, most students, 82% (24 of 29), stated that their preferences toward science, particularly, chemistry, increased after finishing their paper. None of the students admitted that the task was easy and most of them found that the task was difficult. Moreover, all students admitted that the tasks were challenging. Many of them expressed their frustration in finding the resources, managing the time, dealing with other tasks of other subjects such as physics and mathematics homework. Nevertheless, they agreed that the activities provided them with meaningful experiences. Most students stated that their motivation to study science, particularly chemistry, had increased through the activity. Considering this fact, the *group writing task approach* promotes students' positive attitude toward science.

Despite these positive findings, however, this study also documented two students' who reacted negatively toward the activity. They stated that although the activity may be useful, it was wasting their time. They added that what they needed was how they learnt what would be tested in the final examination.

From the interviews with students, the nature of the task called for the students to work collaboratively. Further investigation revealed that despite difficulty in managing their time while working together, the students were aware that they had developed positive social skills. Most students expressed their positive experiences in working collaboratively, such as sharing information, negotiating meaning, being dedicated to the task, valuing each other's individual effort, and caring for others.

DISCUSSION

Compared to traditional teaching methods, this study shows that the group-writing task strategy has more benefits for both students and the teacher as are shown Table 2.

Table 2
The differences between a traditional method and a group writing task strategy

Typical traditional method	**Group-writing task strategy**
Teacher-centred	Student-centred
One-way communication	Three ways communication (teacher-student-student)
Rote learning, emphasises on memorisation	Relational understanding, constructing
Students are passively receiving information	Student actively constructs knowledge
Teacher's role: source of information	Teacher's roles: facilitator, guide and coach
Individual, competitive	Cooperative, develop students' communication and social skills
Tends to distract students from learning science	Enhance student's attitudes toward science

The results of this study show both the advantages and disadvantages of this teaching method that employs reading and writing activities. However, the study clearly depicts that the advantages of using this teaching strategy outweigh the disadvantages. The lists (see Table 2) depict how a group-writing task strategy gives both teacher and students more benefits than the traditional method does. The advantages of implementing this teaching method can be highlighted from the findings.

First, students' attitudes toward science are more positive, thus increasing their motivation to learn chemistry and science, and these intrinsic conditions become the impetus for the students to experience meaningful learning. In addition, similar to an investigation carried out earlier this study also found that through working in group students also developed constructive behaviours such as sharing information, negotiation of meaning, dedication to task, and valuing each other's individual effort (Nason, Lloyd, & Ginns, 1996).

Second, students can reach a higher level of understanding of the subject or concepts. Students' elaboration in explaining their answers shows their higher level of understanding (Skemp, 1976). This finding asserts that having the students work collaboratively in small groups and providing them reading and writing activities could enhance their construction of knowledge (Nason et. al., 1996). Third, the activities through a group project may generate students' creativity in producing their work. This is in accordance with Agarwal's (1999) suggestion that if the teaching strategy provided a chance for students to express their ideas or thoughts freely, their creativity might emerge. Students' papers generated during the learning processes provided some evidence of students' creativity. For example, the ways in organizing the facts that supported the development of models and theories of atomic structures were varied. Each group had their own interests in choosing facts or evidence when another replaced a theory or a model of the atom. The study also documented various ways they chose to set their narratives. One group arranged their paper in a serious pattern, using many science terminologies; another group came up with a fresh idea by adopting a cartoon theme as their setting without losing the substance.

Despite those advantages, nevertheless the study also considers the disadvantages of this teaching and learning approach. Obviously, time and energy are consumed in conducting the activity. These become constraints for both teacher and the students. The teacher must provide the materials that were needed by the students, monitor the progress, and help the students in addressing the literature. Moreover, some students may fall behind schedule in other subjects because of the activity required by this teaching method.

CONCLUSION AND RECOMMENDATION

If learning for understanding is the main purpose of teaching, then teachers should become critically aware of their teaching strategies. 'Chalk-and-talk' methods that are the preference of most teachers should be replaced, at least in part, by other alternatives. The result of this study asserts that group writing, which utilizes both reading and writing, can help students to experience meaningful learning. The evidence showed that by the end of the study, the students in this Indonesian State School classroom taught by the first author were able to transform the information from the resources such as books, magazines, and other media into a highly integrated and structured form of story, and in-depth knowledge of theories and models of the atom. Moreover, this strategy also increases students' motivation, enhances their attitude toward science, and develops students' constructive behaviours.

The disadvantages of this strategy, namely that it is time-and energy-consuming, should not hamper the teacher from employing it. In fact, the advantages of this strategy outweigh the disadvantages. Teachers should note that the aim of her/his teaching is to help students understand and is not merely to transmit what is already known to them. It is the student who will learn, and it must the teacher who facilitates that learning.

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