WRITING IN THE SCIENCE CURRICULUM

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There are a plethora of opportunities for pupils to write across the curriculum. Each academic discipline may well provide chances for pupils to develop skill in writing, science being no exception. The science teacher needs to develop pupil knowledge in science as well as using the contents in written work. Learning to write and writing to learn are related to each other.

Thus, for example, while pupils are reading scientific knowledge, they may also summarize their findings in writing. The written work may be proof read and saved for future review purposes. Which are salient writing activities for pupils in ongoing science lessons and units of study?

Writing in Ongoing Lessons and Units of Study

Problem solving activities provide impetus for written work. Here, pupils with teacher guidance need to identify a problem clearly. Clarity is important so that the problem is amenable to a solution. A hypothesis needs to be developed in answer to the problem. The hypothesis is tentative and subject to testing. Information then needs to be gathered from a variety of reference sources to arrive at a solution. Deliberation and thought are definitely involved here. Information secured must be ordered and summarized. The hypothesis may then be tested and left as is, modified, or refuted. Each of these flexible steps in problem solving need to be accurately recorded. Scientific thought

stresses the importance of objectivity in thinking. One of the abilities identified by Gardner (1993), is scientific intelligence. Scientific intelligence stresses the viewing of evidence with an open mind and subject to assessment witout bias or opinion.

Each writing activity must be developmentally appropriate. Thus, pupils need to possess the background skills to secure the information successfully. Being able to summarize the findings of research, such as in problem solving, involves definite writing skills. Notes need to be taken which relate directly to the hypothesis. The contents then might come from the following sources of information, among others:

* the internet and world wide web
* science texts and library books
* newspaper and newsmagazine articles on relevant science infomation
* classroom experiments and demonstrations
* discussions and committee endeavors (Ediger and Rao, 1996).

Critical and creative thinking need to be used to assess the information. Conclusions then need to be written to provide information to problems and questions identified.

Peer Groups

Pupils should have ample opportunities to work in small groups. Searson and Dunn (2001), in discussing styles of learning, emphasize the importance of small group work as a favorite learning style of selected pupils as compared to individual endeavors. Peers might then learn from each other as ideas are being communicated. Interaction among peer members encourage clarification of content as well as problems chosen. It is important for the committee to stay on the topic being discussed as well as give each a chance to participate in an atmosphere of respect. No one should dominate nor refrain from participation. The work of the committee should be summarized in writing and referred to in a sequential meeting. Oral communication and related written work complement each other. A bound volume might well result from a series of committee meetings (Ediger and Rao, 2002).

Science Notebooks

Keeping a science notebook assists the learner to develop writing skills. Guidelines need to be available as to what should go into these notebooks. Thus, a pupil may write up observations made of a grasshopper when studying insect life in a science unit of study. Very careful observations need to be made and could include, for example, a drawing of an insect. Developing a notebook encourages pupil thinking skills such as noticing the purposes/functions of the head thorax, and abdomen.This experience may encourage further research involving detailed knowledge of the three parts of a grasshopper as well as of other insects. The science notebook should contain relevant learnings obtained.

Notebooks complement what is being emphasized in an ongoing science unit of study. Diagrams and other visuals might well be included. In assessing each notebook, the teacher may notice what pupils understand and what is hazy in the minds of learners. Reteaching and review might then be necessary. When writing science learnings in a notebook, the pupil uses and applies subject matter acquired. Writing skills are being enhanced.

Science literacy is being enhanced with the keeping of notebooks. New vocabulary terms should be included in the notebook. Thus, if pupils are studying vertebrates in an ongoing unit, new terms such as spinal column, chambers of the heart, lungs, and digestion,among others, may be defined and illustrated. Illustrations might include internet sources as well as those completed by the pupil. Reading and rereading as well as writing are stressed in science. In an integrated curriculum, writing may be stressed throughout the school curriculum. Present day and future scientists are good readers and writers.

Individual differences may be provided for in science when notebooks are being kept. Learners record what is of personal interest and relevant in science. Diverse levels of proficiency are being stressed due to varied ability levels. Each pupil may receive recognition when optimal personal achievement is in evidence. Teachers serve as guides and as motivators in these writing endeavors. They also assess their own teaching by evaluating student notebook quality (See, Gilbert and Kotelman, 2005).

The National Research Council (1996) emphasizes the importance of teaching strands which stress assisting student learning in the science curriculum as well as teachers receiving feedback pertaining to teaching quality as in the following standards;

Standard B: Teachers of science guide and facilitate learning.

Standard C: Teachers of science engage in ongoing assessments of their teaching and of student learning.

Writing endeavors involving students keeping science notebooks with teacher guidance assist in fulfilling the above two science standards.

Without doubt, writing can optimize student learning of content subjects.

Being able to express thinking in writing is a skill students take with them beyond the elementary science classrooms. High school teachers and college instructors continue to build on what students have learned and help them persist in refining their writing skills. Likewise in today's job market, written communication skills are extremely important for success.

Good content writing is the result of quality instruction. In writing to learn, students need to guided through a series of steps requiring good teaching and modeling (Knipper and Duggan, 2006). The science teacher must present a model of good writing in a variety of situations. Pupils then have examples which guide quality in written work. With guided practice, pupils may increase skills in writing.

Assessing Written Work

Assessment needs to be continuing and ongoing. Assessment may be considered when emphasizing teacher observation, using agreed upon standards as well as when using more structured approaches such as in testing. It is important to receive feedback from learners. The science teacher in return obtains information as to which objectives need more attention as well as what pupils have already achieved.

Formative evaluation is that which is stressed within an ongoing science unit of study. Diverse procedures may be used including teacher written tests.

What might teachers notice about learner achievement in writing for a variety of purposes in science?

* knowledge of science facts, principles, and other vital subject matter
* clearness of content written
* proper sentence structure
* variety in sentence patterns used
* diversity in sentence types
* objectivity and accuracy in written work as well as interesting means of writing

Quality rubric development and use assist in assessing written work in a consistent manner. Criteria in the rubric need to be shared and explained to pupils involved in the writing activity. In this way, pupils understand the objectives to be attained. The objectives must be challenging and achievable. Generally, the rubric criteria are developed by the teacher, however they also may be developed by learners with teacher guidance. The teacher needs to demonstrate samples of previous pupils work showing the different levels

of achievement related to those contained in the rubric. Usually, there are five levels from excellent to poor. The teacher may appraise each pupil's achievement in written work as well as learners might well engage in self evaluation. How specific should each criterion level be? The following should stress teacher thought about items such as

* agreement of subject and predicate
* misplaced modifiers
* dangling participles
* correct spelling of words. This becomes less of a problem when a word processor is used in writing.
* proper use of capitol letters and indentation
* correct punctuation including commas, semi-colons, and colon marks
* knowledge and use of sentence patterns (Ediger and Rao, 2003).

Perhaps, this may be resolved by determining flexible developmental levels of pupils. However, there is always room for increased levels of pupil achievement in science writing experiences.

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