CHAPTER FIVE

FINDINGS, IMPLICATIONS AND SUGGESTIONS FOR FURTHER STUDIES

5.0 Introduction

This dissertation was intended to study Form Four students' alternative frameworks of energy using the interview-about-instances methodology introduced by Osborne and Gilbert (1980a, 1980b). The subjects comprised of 33 Form Four girls from a selected urban school in Kuala Lumpur. These girls were interviewed at the beginning of the 1997 school academic year which was during the month of January before they were taught the energy concept later in the year.

The interview was carried out using four instances and three events. Preceding the analysis of data, the students' verbatim responses which had been audio-taped were transcribed. The transcripts were carefully scrutinized for the alternative frameworks of energy manifested by the students.

The analysis of data was divided into three sections. Firstly, analysis was made to identify the frameworks of energy manifested by the students in each instance and event as well as in all the instances and events taken as a whole so that a comparison of the alternative frameworks of energy obtained from this study could be made with those found in other studies.
Secondly, analysis was made to identify the common frameworks of energy manifested by the students in each instance and event as well as in all the instances and events taken as a whole so that a comparison could be made between these frameworks and those obtained by Finegold and Trumper (1989), Trumper and Gorsky (1993) and Trumper (1997). Thirdly, analysis was made with regard to the multiple frameworks of energy manifested by the students in all the instances and events taken as a whole and to compare the results obtained with those reported by Lijnse (1990).

5.1 Findings from the Study

The findings from the present study could be divided into three major segments in line with the three research questions posed in Page 5. The findings are:

1. There were six different frameworks of energy manifested by the students in this study. The frameworks were the Human Centred, Depository, Ingredient, Obvious Activity, Product and Flow-transfer Frameworks. The Functional Framework which was found in Watts’ (1983), Finegold and Trumper’s (1989), Linjse’s (1990) and Trumper’s (1997) studies was, however, not found in the present study. This could be partly due to the selection of the instances and events for the study and also due to the convergent thinking of the students interviewed.
2. The common frameworks of energy manifested by the students were as follows:

- **Instance 1**: the Depository and Product Frameworks
- **Instance 2**: the Obvious Activity Framework only
- **Instance 3**: the Human Centred and Depository Frameworks
- **Instance 4**: the Human Centred and Depository Frameworks
- **Event 1**: the Depository and Flow-transfer Frameworks
- **Event 2**: the Depository and Product Frameworks
- **Event 3**: the Product Framework only

The common frameworks of energy manifested by the students in all the instances and events taken as a whole were the Depository and Product Frameworks. These findings could be quite similar to the frameworks of energy shown by many of the students in Finegold and Trumper's (1989), Trumper and Gorsky's (1993) and Trumper (1997) studies. In Finegold and Trumper's study, many students were found to manifest the Antropocentric, Depository and Product Frameworks. However, they did not provide a definition for the number of students which they classified as 'many'. In Trumper and Gorsky's (1993) study, the Cause, Product and Anthropocentric Frameworks were more frequently used by the students. And in Trumper's (1997) study, the college elementary trainee teachers mainly used the Cause, Anthropocentric, Product and Depository Frameworks. However, the
statistics provided by Trumper and Gorsky (1993) and Trumper (1997) were in relative and not in absolute terms. Thus, it could be concluded that in general the students manifested different common frameworks in different instances and events. The frameworks manifested were dependent on the contexts of the instances and events.

3. Findings from the study showed that the students not only manifested multiple frameworks of energy across all the instances and events, but they also manifested multiple frameworks in each instance and event. However, the students only manifested a maximum of two different frameworks of energy in an instance or event as compared to a maximum of five different frameworks of energy manifested across all the instances and events. In fact there were also students who did not manifest any framework of energy in a particular instance or event. However, analysis of the frameworks of energy across all the instances and events as summarized in Table 4.6 (see page 96) showed that the students manifested at least one framework. None of them showed no framework in all the instances and events taken as a whole. There were all together 75.75% of the students with either two, three or four different frameworks of energy. Another 15.15% and 9.09% showed five and one frameworks of energy respectively. A similar pattern was also observed in Lijnse’s (1990) study, which found 92% of the students showing between one and three frameworks of energy, with only 5% and 3% showing four and no framework of energy respectively.
5.2 Implications

Unwaveringly, findings from the present study showed that the group of students selected for the interview manifested a number of different frameworks of energy which were quite similar to those found by Watts (1983), Finegold and Trumper (1989), Linjse (1990), Trumper and Gorsky (1993) and Trumper (1997). This finding showed that some of the Malaysian Form Four students still possessed some frameworks of energy even after having been formally introduced to the energy concept in their lower secondary school sciences. It also implied that their conceptions of energy were not unidimensional as their tendencies to express certain frameworks of energy were dependent upon the contexts of the tasks provided.

Thus, teachers who would be teaching Form Four students on the topic of energy, need to be aware of the different frameworks of energy shown by the students in their discourses on energy. These different frameworks of energy are actually different ways of looking at energy with respects to the tasks where students are required to express their ideas of energy. For example, it is just natural for the students to relate energy to a human being when they are shown a picture of a man lifting weight. Likewise, when the students are allowed to play with an electric toy train, it is just normal for them to express that the movement of the toy train is due to the energy stored in the battery.

As mentioned earlier, some of these frameworks of energy manifested by the students (such as the Depository, Product and Flow-transfer
Frameworks) were parts of the correct conceptions of energy and some (such as the Human Centred, Ingredient, Obvious Activity and the Functional Frameworks) were imperfect conceptions of energy. These frameworks of energy obviously showed that the students’ conceptions of energy were still far from the correct conceptions of energy. These correct conceptions of energy involved the knowledge of energy in different forms, the interconvertibility of the different forms of energy, the principle of conservation of energy and the degradation of energy.

Due to the fact that the expressions of energy can take many forms depending on the tasks involved, the students are expected to hold multiple frameworks of energy. In fact, the multiple frameworks of energy which form the students’ conceptions of energy can be analogously compared to the different conceptions of the elephant as perceived by a group of blind men each touching a different part of the elephant. Thus teachers’ mere awareness of the existence of the frameworks of energy of the students was not enough. They need to go beyond to identify some better strategies for teaching the energy concept so as to expand the students’ conceptions of energy towards the correct conceptions of energy. Again, this is analogous to guiding the blind men to conceive the complete conceptions involving all the parts of an elephant.

Instead of just playing the role of imparting their knowledge to the students, teachers should take into account their students’ preconceived ideas or alternative frameworks of energy. Since the more pervasive frameworks
of energy among the students interviewed in the present study were the Depository and Product Frameworks, it is suggested that teachers teaching this group of students should take into consideration these frameworks while dealing with the energy topic, so that, as commented by Solomon (1983a), the students' conceptions of energy could be bridged between the 'life-world' thinking and the 'symbolic' thinking.

Since the concept of energy is generally accepted as an important and difficult concept in the science curriculum everywhere around the world, teachers should not solely be entrusted with the task of leading students to the accepted scientific conceptions of energy (without totally eliminating their frameworks of energy). The curriculum planners and the textbook writers, too, have their roles to play in the sequencing of the learning activities and exercises so that correct conceptions of energy can be developed in the students. The activities and exercises should be designed so as to stimulate the awareness among students with regard to the inconsistencies of their alternative frameworks of energy in their explanations and descriptions of physical phenomena involving energy.

5.3 Suggestions for Further Studies

The present study had presented some findings on the frameworks of energy manifested by some selected Malaysian Form Four students. The findings here could not be generalized to the whole Malaysian student population due to the restrictions posed by the interview methodology in the collection of data. Thus, work should be replicated with other samples to
see if similar frameworks would be manifested by other students. Further investigations could also be carried out to see if the frameworks manifested by the students are dependent on the age, gender, social economic background, language background and the school's location in terms of rural and urban settings.

At the formative stage of this study, the present researcher initially had the intention to compare the frameworks of energy of the arts and science students. However, after interviewing the students from both the arts and science streams, the researcher found that it was not meaningful to compare their frameworks as the sample size for the arts and science students who manifested frameworks of energy was too small. Thus, future investigations could be carried out separately with the arts and the science students, so that a comparison can be made between the results obtained from these investigations.