

## Verbal Interaction in Chemistry Secondary School Classrooms

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### Abstract

Chemistry should be taught using inquiry approach to enhance understanding of concept of phenomena investigated. The way teacher implement inquiry teaching in chemistry classroom is vital as it affects the teaching and learning process. This study was carried out to investigate verbal interaction of chemistry teachers who applied inquiry approach in their chemistry lessons. Twenty three chemistry teachers and their pupils were involved in this study. Data collection method was mainly based on observation using Observation Instrument in Inquiry Teaching through Verbal Interaction (OIITVI), which was developed and modified based on previous existing classroom observation instruments. Even though the teachers claimed that they practiced inquiry, findings from this study showed that teachers are still dominating interaction in chemistry classroom. This research also revealed that percentage of teacher's question is lower compared to teacher's statement. Besides that, mean percentage of pupils' questions has increased as observed in this research compared to previous researches. Nevertheless, teachers' questions and pupils' questions were found to be of low order thinking questions. Silence or confusion category contributes 37.0% of verbal interaction occurred in chemistry classrooms. Implication of this study showed that teachers should move towards creating inquiry-based classroom with focusing on quality pupil talk.

**Keywords:** Verbal interaction; inquiry teaching; teacher's question; teacher's statement; pupils' question; pupils' statement; silence or confusion

### Abstrak

Pendekatan inkuiri seharusnya digunakan semasa mengajarkan mata pelajaran kimia bagi meningkatkan pemahaman konsep tentang fenomena yang dikaji. Perkara penting dalam pengaplikasian pendekatan inkuiri ini ialah bagaimana pelaksanaan tersebut. Hal ini disebabkan cara pelaksanaan tersebut memberikan kesan kepada proses pengajaran dan pembelajaran. Oleh itu, kajian ini dijalankan untuk mengkaji pelaksanaan pengajaran inkuiri dalam kalangan guru kimia yang mengaplikasikan pendekatan ini melalui interaksi verbal bilik darjah. Seramai 23 orang guru bersama-sama dengan pelajar mereka terlibat dalam kajian ini. Kaedah pengumpulan data utama ialah melalui pemerhatian. Instrumen pemerhatian yang digunakan, iaitu *Observation Instrument in Inquiry Teaching through Verbal Interaction* (OIITVI) dibina berdasarkan pengubahsuaian instrumen-instrumen pemerhatian sedia ada. Analisis dapatan kajian menunjukkan bahawa guru masih mendominasi interaksi di dalam bilik darjah walaupun mereka menyatakan mereka mengamalkan pengajaran inkuiri. Dapatan kajian juga menunjukkan min soalan guru adalah kurang berbanding dengan pernyataan guru. Tambahan pula, min peratus soalan pelajar adalah lebih tinggi berbanding dengan kajian-kajian lepas. Namun demikian, soalan guru dan soalan pelajar dikategorikan sebagai soalan pemikiran aras rendah. Keadaan senyap atau keliru menyumbang 37.0% daripada interaksi verbal yang berlaku di dalam bilik darjah kimia. Implikasi kajian menunjukkan guru perlu mewujudkan bilik darjah inkuiri yang memberi fokus kepada percakapan pelajar yang berkualiti.

**Kata kunci:** Interaksi verbal, pengajaran inkuiri, soalan guru, pernyataan guru, soalan pelajar, pernyataan pelajar, senyap atau kekeliruan

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## ■1.0 INTRODUCTION

There are vast teaching approaches that could be applied by teachers. One of the teaching approaches is inquiry. In Malaysia, inquiry approach has long been suggested by Ministry of Education to be used in teaching chemistry (Curriculum Development Centre, 2001). Inquiry is considered as one of the best approach in teaching science subjects, for example chemistry as this pedagogical approach has proven to enhance students' ability to think critically, emphasize science process skills (Tan & Law, 2002; Ainon, 2006; Simsek & Kabapinar, 2010), and most importantly students' understanding on the science content increased (Abd-El-Khalick *et al.*, 2004; Kottler & Costa, 2009; Tajularipin & Nor Azlina, 2010). In other words, active learning takes place during the lesson as students inquire, and go through the process of hand-on activities which is more student-centred. Furthermore, science is supposed to be taught using this approach (Mohamed Najib & Mohammad Yusof, 1995). In applying this approach, teachers and students are directly involved in the process of observation, obtaining evidence, discussion and generating explanation based on evidence obtained (Kim, Tan, & Talaue, 2013).

As mentioned before, there are many benefits of implementing this approach in chemistry lessons. Nevertheless, Keys and Bryan (2001) discovered that this approach was implemented differently as suggested by the experts. How do chemistry teachers implement inquiry teaching in classroom? Therefore, this study addresses this issue by investigating how chemistry teachers implement inquiry teaching.

There are two types of interactions that could occur in any classroom, either verbal or non-verbal. Verbal interaction is anything that is being uttered. Verbal interaction in classroom comprises of teacher's question, teacher's statement, student's question, student's statement or silence or confusion (Mohamed Najib, 1997; Tay & Mohammad Yusof, 2008). There are two main subcategories of teacher's questions, i.e. teacher's questions related to content/science process skills; or not related to content/science process skills. The teacher's statement are subcategorized as teacher's statement related to content and science process skills, pupils' statement, pupils' questions, or teacher giving instruction. As for pupils' questions, there are two subcategories; either pupils' questions related to content or science process skills; or not related to content or science process skills. Pupils' statement are either related to teacher's question or statement; or related to content. Finally, silence or confusion category comprises of silence with teacher's activity or pupil's activity, wait-time one, wait-time two, confusion due to pupils' activity and confusion due to other than pupil's activity. This research will focus on verbal interaction that occurs in the chemistry lessons as most interactions that occur in any classroom are mainly verbal. Furthermore, inquiry approach involves a high verbal interaction between teacher and students, or between student and other students (Suchman, 1966). Bass, Constant and Carin (2009) stated that teacher will guide and challenge students' ideas either through questions or statements to assist students obtain and understanding scientific views. In order to investigate the implementation of inquiry teaching in chemistry lessons, observations on verbal interactions of respondents in the classroom are carried out.

## ■2.0 PURPOSE OF THE STUDY

In this research, focus will be on how chemistry teachers implement inquiry teaching through verbal interaction. The implementation of inquiry teaching is studied in terms of teacher's

question, teacher's statement, pupils' question, pupils' statement and silence or confusion.

## ■3.0 METHODOLOGY

A total of 23 chemistry teachers from national secondary schools were involved in this study. They implemented the same chemistry curriculum which was developed by Ministry of Education, Malaysia (Curriculum Development Centre, 2005). Two respondents hold master degree in education and the others have bachelor degree in education. In terms of teaching experience, more than half of the respondents have teaching experience less than five years (Table 1).

Four observations were made for each chemistry teachers. Each lesson was of 60 to 80 minutes. Each teacher was observed average of two non-practical classes and two practical classes. Ninety two chemistry lessons were videotaped and audiotaped after consents were obtained from the respondents. An Observation Instrument in Inquiry Teaching through Verbal Interaction (OIITVI) (Sim and Mohammad Yusof, 2012b) was used in this research. This instrument was developed based on the previous observation instruments by Flanders (1970), Eggleston, Galton & Jones (1975) and Mohamed Najib (1997). This instrument was modified to cater the purpose of the research. In this instrument, there are five main categories, which are teacher's question, teacher's statement, pupils' question, pupils' statement and silence or confusion. A mark on the observation form was made of each behaviour observed at three seconds interval to ensure a thorough and detail observation as proposed by Flanders (1970), and Mohamed Najib (1997). Data obtained was then analysed using Microsoft Excel in determining the mean percentage of categories in OIITVI.

## ■4.0 RESULTS AND DISCUSSION

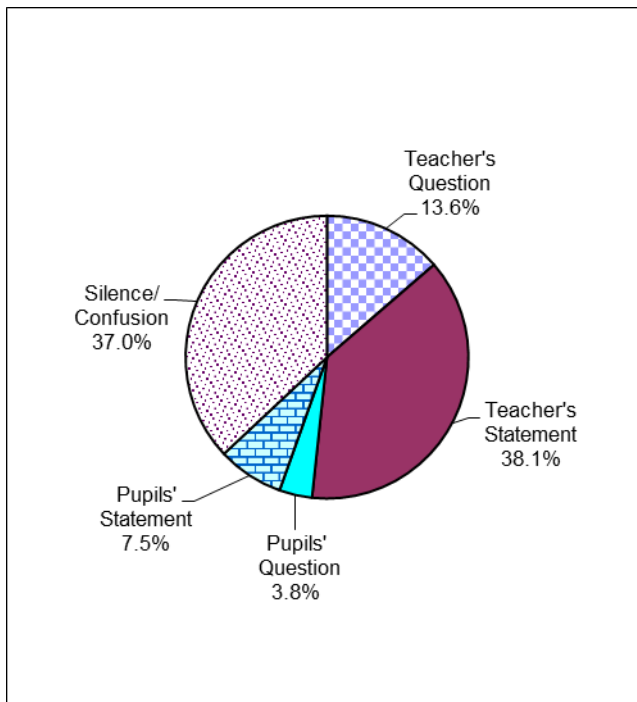
In this section, discussion will be on the results obtained on the five main categories of verbal interaction and overall comparison between teachers' talk and pupils' talk. Comparison of verbal interaction between teacher's talk and pupils' talk will be viewed generally in the first part. Teacher's talk can be categorised into two main categories, which is teacher's question and teacher's statement. For pupils' talk, it also can be categorised into two main categories, pupils' question and pupils' statement. Comparison will be made between teacher's question and teacher's statement and also between pupils' question and pupils' statement. In the later part of this section, discussion will be more detail on each category mentioned.

**Table 1** Teaching experience of respondents

Teaching Experience (years)	Frequency	Percentage (%)
1-5	14	60.9
6-10	4	17.4
11-15	4	17.4
More than 20 years	1	4.3
<b>Total</b>	<b>23</b>	<b>100.0</b>

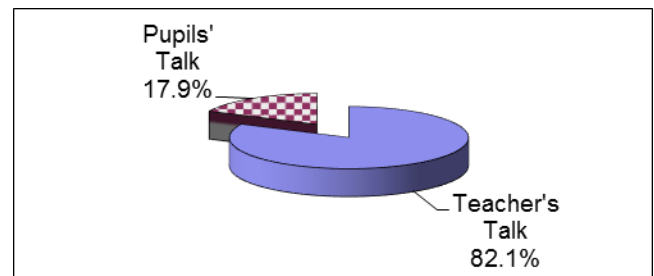
### Five Main Categories of Verbal Interaction

Figure 1 illustrates five main categories of verbal interaction that occurred during chemistry lesson. It was based on the observations done on 23 chemistry teachers and their pupils. It was found that teachers' statement and silence or confusion constitutes more than half of the total verbal interaction occurred. This shows that teachers are still dominating the interaction in chemistry lessons compared to pupils.

**Figure 1** Percentage of five main categories of verbal interaction

### Overall Comparison of Verbal Interaction between Teachers' Talk and Pupils' Talk

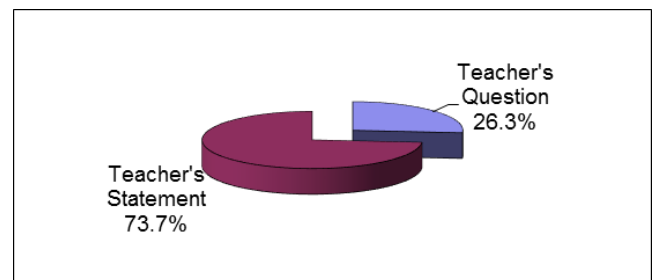
This part revealed overall comparison of percentage of verbal interaction between teachers' talk and pupils' talk in this research. It could be seen that percentage of teacher's talk is higher than pupils' talk (Figure 2). Result obtained was similar as discovered by previous researchers such as Tamir (1981), Mohamed Najib & Mohammad Yusof (1995), Tay & Mohammad Yusof (2008), and Albergaria-Albergaria-Almedia (2010).

**Figure 2** Comparison of verbal interaction between teacher's talk and pupils' talk

In terms of ratio, teachers' talk was 4.6 times higher compared to pupils' talk. The result obtained in this research was slightly lower than the ratio of teachers' talk to pupils' talk found in Albergaria-Almedia (2010) study which was 4.9:1. Nevertheless, the ratio showed that chemistry teachers dominate the interaction during chemistry lesson. This was also reported by Jegede & Olajide (1995); Mohamed Najib & Mohammad Yusof (1995); and Galton *et al.*, (1999) in their studies. It also suggests that teacher-pupil verbal interaction may be affected by authoritarian factor as proposed by Jegede and Olajide (1995).

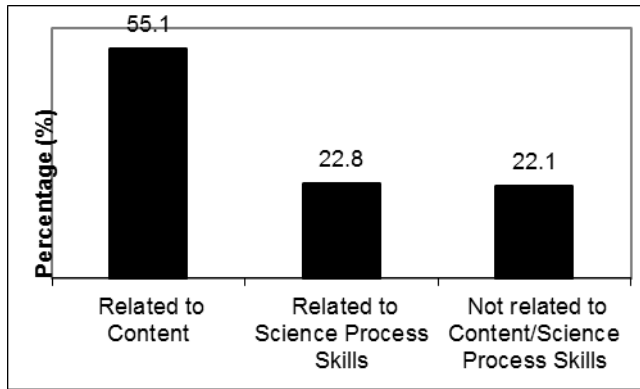
### Teacher's Talk

Teacher's talk comprises of teacher's question and teacher's statement. Teacher's statement is nearly three times higher than teacher's question (Figure 3), almost similar to findings from research done by Newton, Driver and Osborne (1999); Galton *et al.* (1999); Tay & Mohammad Yusof (2008).

**Figure 3** Comparison of teacher's question and teacher's statement

Analysing teacher's question, it was found that teacher's questions are mainly related to content (Figure 4). This result is similar with result obtained by Albergaria-Almedia (2010); Sim and Mohammad Yusof (2012a). However, this research also showed that nearly 22.1% of teacher's questions are not related

to content, which is parallel with Albergaria-Almedia (2010) findings.



**Figure 4** Subcategories of Teacher's Question in OIITVI

Besides that, questions posed by teachers were of low order thinking questions. This type of questions hindered the thinking skills among pupils. Examples of questions asked were:

Group seventeen, what do we call it?  
Pass the gas coming out to the... lime water. Make sure the tube is inside your... lime water. So, lime water will turn...?

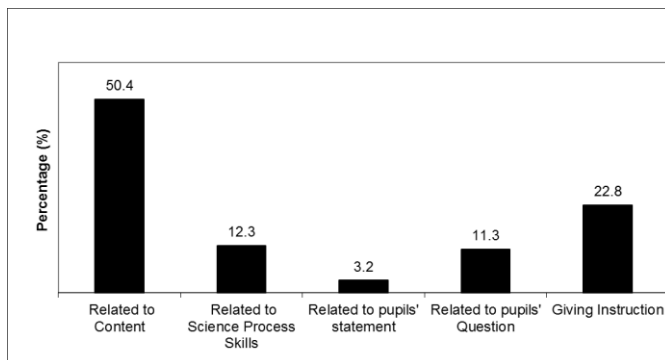
[R01:practical class-related to science process skills]

Ok, so no question? Clear?

[R05: not related to content or science process skills]

R01: Respondent number 1; R05: Respondent number 5

Based on the analysis on subcategories of teachers' statement, teachers' statement mainly focuses on giving explanation and giving instruction similar as findings from Newton, Driver and Osborne (1999) (Figure 5).



**Figure 5** Subcategories of teacher's statement in OIITVI

Example of teachers' statements:

Magnesium ok.. So, when we dipped the two different metal, ok... it will produce electricity.  
[R05: teacher giving explanation]

Very corrosive. So I want you to read the procedure carefully and properly.

[R02: teacher giving instruction]

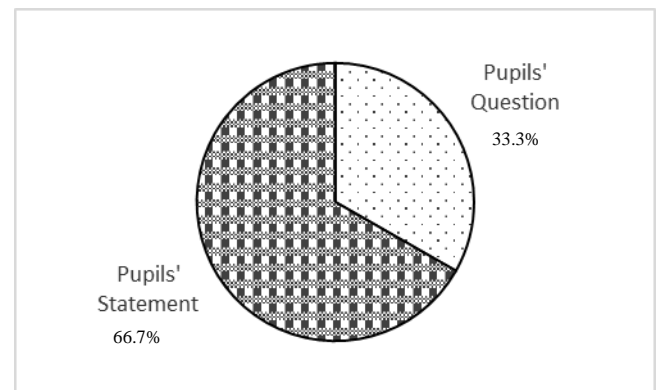
On the thing, faster...

[R06: teacher giving instruction]

R02: Respondent number 2; R05: Respondent number 5;  
R06: Respondent number 6

### Pupils' Talk

Pupils ask questions occasionally (Chin, 2002) or do not ask any question (Dillon, 1988). In terms of pupils' talk, findings from this research showed that the ratio of pupils' statement to pupils' question was 2:1 (Figure 6). These two tasks whether pupil asks or answers question(s) are vital in inquiry-based classroom (Gillies *et al.*, 2013). This shows a good sign as pupils ask question, they do inquire, especially about nature of the subject (van Zee *et al.*, 2005; Hofstein *et al.*, 2005). The high proportion of pupils' questions in this research is similar with research done by Whittaker (2012). It is also found pupils' questions contribute 3.8% of the total verbal interaction occur in chemistry inquiry classroom (see Figure 1). However, this mean percentage from this study contradicts with findings by previous researchers, such as Mohamed Najib and Mohammad Yusof (1995); Jegede and Olajide (1995); Tay and Mohammad Yusof (2008), which the mean percentage of pupils' questions was very low, 0.3%, 2.3% and 0.5% respectively.



**Figure 6** Comparison of pupils' question and pupils' statement

In this study, pupils ask questions mainly on content or science process skills, which is 2.5 times higher than questions not related to content or science process skills, which is on classroom management (Figure 7). This result contradicts with findings from Albergaria-Albergaria-Almedia (2010), which showed that 75% of pupils' questions are not content-related. This finding also opposed to findings by Dillon (1988), which students' question is very rare.

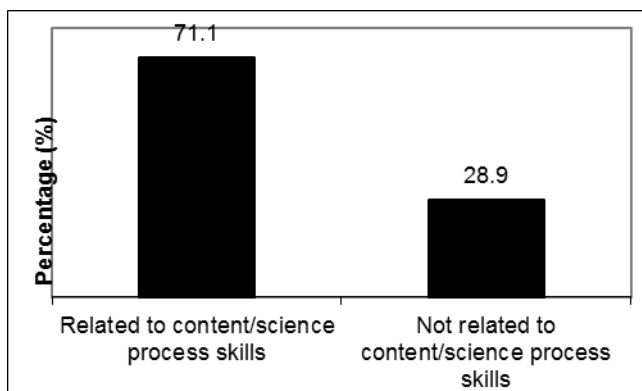


Figure 7 Subcategories of Pupils' Question in OIITVI

However pupils' questions related to content or science process skills were mainly on getting confirmation or clarification from teachers. Examples of questions asked were:

Teacher is this right?  
[R02: getting confirmation]

Different types of oil produce different soap?  
[R07: getting clarification]

R02: respondent number 2, R07: Respondent number 7

On the other hand, pupils' statements were mainly related to questions or statements made by their teacher. Only 1.3% related to content, which is to argue (Figure 8). This may suggest that pupils only talk when requested by teachers, mostly to answer questions posed.

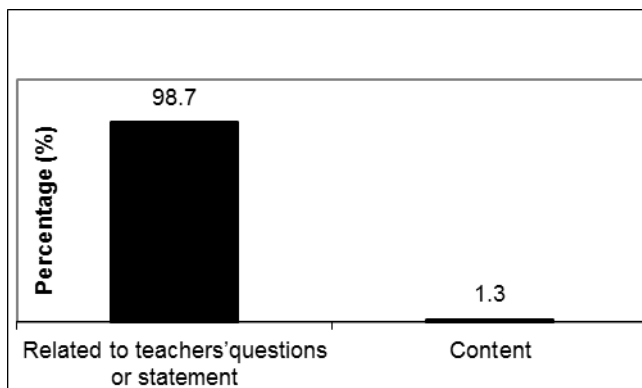


Figure 8 Subcategories of pupils' question in OIITVI

Example of part of transcript of this scenario is shown below:

T: What gas is coming out?  
S: Carbon dioxide.  
T: Copper (II) carbonate, green colour. So, green colour changes to what colour?  
S: Brown

[R01: Practical Class]

T: Group eighteen?  
S: Noble gases.  
T: Noble gases. What about this one?

S: Transition.  
T: What transition?  
S: Element.

[R02: Theory class]

T: Teacher; S: Student; R01: Respondent number 1,  
R02: Respondent number 2

### Silence or Confusion

This final category is vital as it 'completes' an interaction cycle in classroom. Important subcategories in this category are silence with teacher's activity or pupils' activity, wait-time one, wait-time two, confusion due to pupils' activity or confusion due to other than pupils' activity.

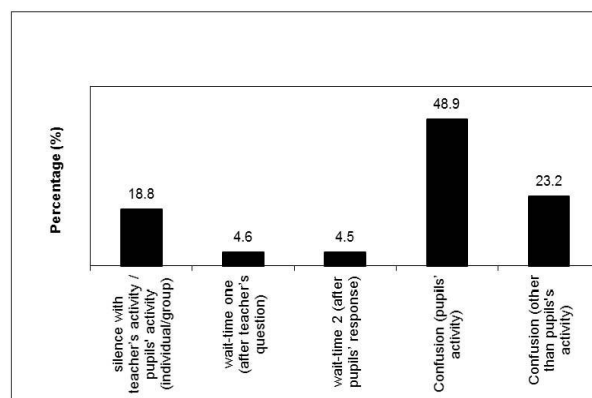


Figure 9 Subcategories of silence or confusion in OIITVI

Mean percentage of the final category in OIITVI which is silence or confusion obtained from this research is 37.0% (see Figure 1), which is slightly higher than mean percentage obtained by Tay and Mohammad Yusof (2008), which is 33.9%. Based on Figure 9, highest subcategory was confusion (pupils' activity) which showed similar finding with Tay and Mohammad Yusof (2008). Analysis on the video recording showed that mostly were carry out experiments, activities done in groups or discussions in groups. These activities have contributed to the high percentage of this category.

Silence' with the purpose of wait-time is vital in inquiry-based classroom. Mean percentage of chemistry teachers' practice of wait-time one and wait-time two are 4.6% and 4.5% respectively, which is higher than mean percentage obtained by Tay and Mohammad Yusof (2008). This shows a positive indication of inquiry practices among chemistry teachers in this study as they are do wait for pupils' response.

### 5.0 CONCLUSION AND IMPLICATION OF THIS STUDY

This study has shed light to on what and how verbal interaction of chemistry teachers who practice inquiry approach. Generally, chemistry teachers in this study dominate interaction in classroom, as teacher's talk is more than pupils' talk. As in teacher talk, teacher's statement is more than teacher's question. Teachers should emphasize practice of asking high order thinking questions inculcate thinking skills in pupils. This is to ensure that pupils able to ask scientifically oriented questions which is one of the important characteristics of inquiry-based



classroom (National Research Council, 2000). The importance of silence with the purpose of wait-time is very important as it provides opportunity for pupils to think and to restructure their questions or statements before they say it aloud. In order to create an inquiry-based environment in chemistry classroom, it is highly recommended that teachers should move towards student-centred approach, which is more pupil talk and less teacher talk in inquiry chemistry classroom. In addition, this is to ensure effective learning takes place (Whittaker, 2012) as pupil participate actively during the teaching and learning process. Furthermore, scientific literacy among pupils could be achieved with the implementation of 'right' inquiry approach. Hence, it is time for chemistry teachers to have a positive mindset in implementing this approach.

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