優質教育基金
Quality Education Fund

M:FR/E

Final Report of Project	**Project No. : 2008 /0340**

Part A

Project Title: Explore and Research the Atmospheric Environment (EXPLORE)

Name of Organization/School: Hong Kong University of Science and Technology

Project Period: From January 2010 *(month/year)* to June 2012 *(month/year)*

Part B

*Please read the **Guidelines to Completion of Final Report of Quality Education Fund Projects** before completing this part of the report.*

Please use separate A4-size sheets to provide an overall report with regard to the following aspects:

1. Attainment of objectives
2. Project impact on learning effectiveness, professional development and school development
3. Cost-effectiveness – a self-evaluation against clear indicators and measures
4. Deliverables and modes of dissemination; responses to dissemination
5. Activity list
6. Difficulties encountered and solutions adopted

** Final Report of Project prior to the 8th call should be signed by the supervisor of the school/the head of the organization or the one who signed the Quality Education Fund Agreement for allocation of grant on behalf of the organization.*

** Final Report of Project under the 8th and subsequent calls should be submitted via "Electronic Project Management System" (EPMS). Once submitted, these reports are regarded as already endorsed by the supervisor of the school/the head of the organization or the one who signed the Quality Education Fund Agreement for allocation of grant on behalf of the organization.*

This form/guidelines can be downloaded from the QEF webpage at http://qef.org.hk.

Project Title: Explore and Research the Atmospheric Environment (EXPLORE)

Final Report

1. Attainment of objectives

The project EXPLORE listed the following objectives in the proposal.

1. To promote a hands-on approach to studying air quality in Hong Kong's secondary schools through the proposed project EXPLORE, and
2. To facilitate collaborative learning among schools through a bilingual (Chinese and English) EXPLORE website

Both objectives are well attained. An experimental platform (set-ups for air sampling, preparation of chemicals, analyzing the air pollutants and converting measurements to pollutant concentrations) had been successfully developed for measuring nitrogen dioxide (NO_2), ozone (O_3), black carbon (BC) and visibility. The experimental platform was provided to eight secondary schools with trainings, school visits and group discussions. Students of the participating schools are able to use the platform independently for air pollutant measurement and to conduct their own independent enquiry studies. A publicly accessible website (http://ienv.ust.hk/explore/) had been established for uploading the air quality data collected by schools. Users can read the air quality in other schools.

2. Project impact on learning effectiveness, professional development and school development

2.1 Impact on learning effectiveness

Through the project EXPLORE, HKUST developed a low-cost but user friendly platform applicable to high school students in measuring air pollutants for better understanding the air quality in their proximal environment. In the project, technical knowledge and skills had been delivered to secondary school teachers, technicians and students to facilitate the teaching and learning of atmospheric science. The training the trainer concept was well executed such that both the trained teachers, technicians or even senior students became trainers to their colleagues and junior students in deploying the experimental platform independently in their own schools. The learning effectiveness is also reflected by the wide range of levels (Secondary 2 to 5) of students taking part in the project. The students' work and sharing were highlighted in the School Symposium held in December 2011, which was summarized in the webpage http://ienv.ust.hk/explore/news/html/symposium-20111223.

2.2 Impact on professional development and school development

Students can get hands-on experience to investigate the air quality that would not have been possible previously because of the expensive commercial air pollutant measurement instrument. This project provides students opportunity to conduct their own independent enquiry studies on environmental issue. Through identifying problems, making hypothesizes, designing laboratory investigations, collecting data, analyzing the data and reporting results in the studies, students can develop the skills of critical thinking and problem solving. We believe through the EXPLORE, teachers, technicians and students of the participating schools gained a much better understanding on air pollutants, their potential sources and impact on the air quality through the acquired technical know-how in the EXPLORE project. These can be reflected from the questionnaire results to be summarized in the following section.

3. Cost-effectiveness - a self-evaluation against clear indicators and measures

The project has been implemented with cautiousness financially. The budget checklist is attached (Appendix 1) with this report.

As a means of evaluating the success of the EXPLORE project, a questionnaire was prepared (Appendix 2) and distributed to the participants. The responses are summarized in Appendix 3. Accordingly, all the participants acknowledged the better understanding of the air pollutants, air quality and the Air Pollution Index reported daily by the Environmental Protection Department (Q17 to Q19). Throughout the participation, awareness and concerns of air quality are also enhanced among the participants (Q20 to Q22). In terms of the technical supports provided to schools (training and individual hands-on practice workshops), about 75% of the respondents indicated strongly that the workshops provided adequate knowledge, technical and data analytical skills to them (Q35 to Q38). In terms of the experimental platform, 60 to 70% of the participants indicated that the processes are easy to handle, the scientific principle is understandable and the process is fun (Q23 to Q34). This is probably related to the division of labor among students in their schools in that participating students are divided into groups and each group is just responsible for a single pollutant. We appreciate the feedback on the difficulties encountered by the participants as well.

School visits were conducted to review students' technique in operating the platform. It was found that the proposed hardware platform is well managed and utilized by students from Forms 2 to 5. Discussion with teachers in charge and students involved allowed the EXPLORE team to understand the difficulties they encountered.

The EXPLORE project trained not only the participated students with technical knowledge and skills, but most importantly, instigated students' interest in the topic of air pollution. The results of survey showed that over 80% of respondents would like to investigate further the air pollution issue. In fact, some students had investigated different topics and joined different competitions using the hardware platform.

4. Deliverables and modes of dissemination; responses to dissemination

4.1 Deliverables

- An experimental platform was developed and deployed to schools for measuring air pollutants (NO_2, O_3, black carbon and visibility) by school students.
- A web based platform was designed for dissemination of information and data related to the project (http://ienv.ust.hk/explore/).

4.2 Modes of dissemination and responses to dissemination

- The project web serves as a platform for dissemination to the public.
- Peer-reviewed publication
  - A peer-reviewed paper on the black carbon measurement deployed on the EXPLORE hardware platform was published in the prestige journal, Aerosol Science and Technology in January 2011 (http://dx.doi.org/10.1080/02786826.2010.550960). Support by QEF was acknowledged.
- Articles in local presses and magazines
  - Ming Pao (June 8, 2011);
  - Hong Kong Economic Journal (June 10, 2011),
  - PCM Biz IT Magazine (volume no.951, 18 October 2011)
  - Two other schools (TWGHs YOW Kam Yuen College at Shatin and PAOC Ka Chi Secondary School at Tuen Mun) approached the UST team and joined the EXPLORE project after reading the articles on Ming Pao and Hong Kong Economic Journal.
- TV filming
  - NOW TV filmed the EXPLORE project at HKUST and Kei Hau Secondary School, one participating school, on 6 December 2011 in relation to Hong Kong air quality.
- Seminars/workshops
  - April 2012 – the EXPLORE project was presented to faculties at Occidental College (Oxy) and University of South California (USC). The EXPLORE project was very well received as a potential community project in Los Angeles. ~~Ms Carla Truax (USC) and Miranda Chien-Hale (Oxy)~~ visited UST in May and went through the hands-on experiences themselves. It is under discussion for the possibility to run the EXPLORE between the two cities.
  - June 9, 2012 – the EXPLORE project was presented to a group of teachers through the Virtual University of Hong Kong.
  - June 22, 2012 – the EXPLORE project was shared with members of the Discovery Bay Environmental Group.
  - June 28, 2012 – the EXPLORE project was presented to a delegation (30) from Foshan City, PRD.

5. Activity list

- Optimization of the hardware platform which covered (Feb 2010 – Jun 2010)

- Design and fabrication of the Sun Photometer for Aerosol Optical Thickness (AOT) for visibility measurement
- Streamlining and optimizing the measurement of NO_2 with respect to type of filter papers, flow rates and solvent for absorbent coating
- Streamlining and optimizing the measurement of O_3 with respect to the type of sampling flask
- Design and fabrication of the home-made photometer for O_3 and NO_2 measurement
- Optimization of the particulate measurement with the digital image approach using the software 'Photoshop'

- Calibration of the hardware platform with standard analytical instruments and establishment of the working calibration curves for black carbon for schools. (Feb 2010 – Jun 2010)
- Purchasing the components for the home-made instruments and the pump for air sampling after the prototype testing (Jun 2010 – Jul 2010)
- Development of a webpage for the EXPLORE project (Mar 2010 – Jun 2010)
- A briefing session on the EXPLORE project for seven schools. (25 Mar 2010)
- Two training workshops for the representatives of the participated schools about the technical information of and skills for using the platforms (15 & 23 Jul 2010, 11 Nov 2010)
- Hands-on workshops for individual school and calibration for their own O_3 measurement (Aug – Dec 2010, Table 1)

Table 1 – Summary of the training activities and participants

Date	Workshop	No. of schools	No of participants
15 Jul 2010	Training Workshop I	6	22
23 Jul 2010	Training Workshop II	6	19
13 Aug 2010	Hands-on workshop for Christian Alliance SW Chan Memorial College	1	6
15, 17 Sep 2010	Hands-on workshop for Ying Wa College	1	5
18 Sep 2010	Hands-on workshop for YMCA of Hong Kong Christian College	1	2
20 Sep 2010	Hands-on workshop for Queen Elizabeth School Old Students' Association Secondary School	1	4
30 Oct 2010	Hands-on workshop for STFA Leung Kau Kui College	1	5

27 Nov2010	Hands-on workshop for CNED Lau Wing Sang Secondary School	1	8
11 Nov 2010	Training Workshop I and II for S.K.H. Kei Hau Secondary School	1	42
19 Nov 2010	Hands-on workshop for CNED Lau Wing Sang Secondary School	1	7
29 Nov 2010	Hands-on workshop for S.K.H. Kei Hau Secondary School	1	7
2 Dec 2010	Hands-on workshop for S.K.H. Kei Hau Secondary School	1	6
13 Dec 2010	Hands-on workshop for S.K.H. Kei Hau Secondary School	1	7
14 Dec 2010	Hands-on workshop for S.K.H. Kei Hau Secondary School	1	6

- Air pollutant measurement by the participating schools started (Sep 2010).
- An invited talk for Secondary 3 students of Christian Alliance SW Chan Memorial College to instigate students' interest in the topic of air pollution in their independent projects. (25 Nov 2010).
- Visits to the participating schools to discuss the problems and difficulties they encountered (Dec 2010 to Mar 2011, Table 2)

Table 2 – Summary of the school visits

Date	School
13 Dec 2010	Queen Elizabeth School Old Students' Association Secondary School
15 Dec 2010	CNEC Lau Wing Sang Secondary School
16 Dec 2010	Christian Alliance SW Chan Memorial College
24 Jan 2011	Ying Wa College
2 Mar 2011	S.K.H. Kei Hau Secondary School
13 Mar 2011	S.T.F.A. Leung Kau Kui College

- Air pollutant measurement at the HKUST using the platform started (Apr 2011). Data were also uploaded on the webpage. These data may be useful for students when they analyze their data
- A brief session on the project and two technical workshops for the two newly recruited schools (15 Jul 2011)
- Hands-on workshops and calibration for O_3 measurement for the two newly recruited schools (27 Jul and 3 Sep 2011)
- An extra workshop for the non-science students of YOW Kam Yuen College to help them

set up the platform and start the measurement (19 Nov 2011)

- Individual workshops on the fundamentals of data mining and analysis for the schools (Jul – Aug 2011, Table 3)

Table 3 – Summary the workshops on the fundamentals of data mining and analysis

Date	School	No of participants
4 Jul 2011	Christian Alliance SW Chan Memorial College	13
6 Jul 2011	Ying Wa College	5
12 Jul 2011	S. K. H. Kei Hau Secondary School	32
18 Jul 2011	STFA Leung Kau Kui College	17
20 Jul 2011	Queen Elizabeth School Old Students' Association Secondary School	60
30 Aug 2011	CNED Lau Wing Sang Secondary School	7

- A school symposium for the participating schools to present their data and share their experience was held at the HKUST (23 December 2011). About 60 students and teachers from 7 participating schools joined the symposium. The titles of their presentation are listed in Table 4.

Table 4: The titles of students' presentation in the symposium

School	Title
Queen Elizabeth School Old Students' Assoication Secondary School	2010年天水圍冬季空氣的二氧化氮、臭氧及碳粒分析
T.W.G.Hs. Yow Kam Yuen College	二氧化氮的濃度令空氣污染指數上升
S.F.T.A. Leung Kau Kui College	The Relationship between nitrogen dioxide and ozone
Ying Wa College	Air pollution monitoring in Ying Wa College
PAOC Ka Chi Secondary School	屯門碼頭區空氣素質研究
S.F.T.A. Leung Kau Kui College	An analysis of the seasonal trends of air quality in Tuen Mun

S.K.H. Kei Hau Secondary School	The relationship between air pollution and the absence of students
Christian Alliance SW Chan Memorial College	本校 EXPLORE 計劃實驗成果分享和實驗器材可攜化及延伸應用初探

- A questionnaire survey was conducted to collect participants' comment on the project (Dec 2011). Summary of the results are followed:
  - There are 49 respondents, 11 of them are teachers/laboratory technicians, 28 of them are secondary 4/5 students and 10 of them are secondary 2/3 students.
  - About 80% of respondents understand more about the air pollution index and sources and impacts of air pollutants after joining the program.
  - Over 80% of respondents claimed that they pay more attention to air pollution issue and would like to understand more.
  - 90% of the respondents agree that the EXPLORE project had met their expectation. Most of them expected that the students' scientific knowledge and environmental awareness could be enhanced by joining the program.
  - Only 4 respondents think that the experimental procedures and principle of BC measurement are difficult. Two of them did not attend the workshop about BC.
  - 5 respondents think that the experimental procedures and principle of NO_2 measurement are difficult. Four of them also find the experimental procedures and principle of O_3 measurement difficult although they had attended the workshops about NO_2 and O_3. Two of them are teachers.
  - 5 respondents think that the AOT measurement is difficult. 2 of them are teachers who had attended the workshop about visibility. The difficulties may be due to the alignment of sun photometer on cloudy days.
  - Among the respondents, 43 of them attended workshops, and only 1 student found that the knowledge and skills provided in the workshops were insufficient.
  - Regarding the difficulties they encountered in this project, most of them found difficulties in sparing time to do the experiment and the time required for each analysis is long.

- Visits to the newly recruited schools to discuss the problems and difficulties they encountered (13 and 16 Jan 2012)
- April 2012 – the EXPLORE project was presented to faculties at Occidental College (Oxy) and University of South California (USC). The EXPLORE project was very well received as a potential community project in Los Angeles.
- May 21 -25 - Ms Carla Truax (USC) and Miranda Chien-Hale (Oxy) visited UST in May and went through the hands-on experiences themselves. It is under discussion for the possibility to run the EXPLORE between the two cities.
- June 9, 2012 – the EXPLORE project was presented to a group of teachers through the Virtual University of Hong Kong.
- June 22, 2012 – the EXPLORE project was shared with members of the Discovery Bay Environmental Group.

- June 28, 2012 – the EXPLORE project was presented to a delegation (30) from Foshan City, PRD.

6. Difficulties encountered and solutions adopted

At the beginning of the project, teachers and technicians thought that the procedures of sampling and analysis were time consuming. We therefore simplified the measurement procedures by changing the titration-based measurement of ozone of color reading with the home-made photometer. We also suggested storing samples in cold (4°C) and analyzing in a batch.

It was also found that students had difficulties in data processing and data analysis. Regarding their difficulties, spreadsheets for data processing were prepared for them and workshops on the fundamentals of data mining had been provided for them.

Another difficulty encountered by the participants was about the time allocation. As the students had examinations, tests and different extra-curricular activities, fewer samples were collected than expected.

In order to lower the cost of the platform, a single large pump was used for the measurement of NO_2, O_3 and BC. However, this made the whole platform heavy. Some participants pointed out that the heavy AC pump made further investigation difficult. Hence, a portable platform is under development.

Appendix 1 – Budget Checklist*

Budget Items (Based on Schedule II of Agreement)	Approved Budget (a)	Actual Expense (b)	Change +/- %
Staff Cost	$738,800	$660,777.72	-10.2%
Equipment	$186,850	$79461.00	-57.8%
General Expenses	$145,200	$77,262.65	-46.8%
Services	$8000	$2877.70	-74.2%
Contingency	$3,150		

*Official financial report will be prepared by the Finance Office, HKUST.

感謝你參與此大氣探索活動。為了讓我們對此活動作出評估，並加以改善，請花一點時間回答這份問卷。

請根據你在***參與此探索活動前***，對空氣污染這課題的認識回答 1-5 題：

	非常不同意	有點不同意	一般	有點同意	非常同意
1. 我認識什麼是“空氣污染指數”。	☐	☐	☐	☐	☐
2. 我知道哪些空氣污染物的濃度用作計算“空氣污染指數”。	☐	☐	☐	☐	☐
3. 我知道黑碳、二氧化氮和臭氧的來源和影響。	☐	☐	☐	☐	☐
4. 我關心與空氣污染相關的新聞。	☐	☐	☐	☐	☐
5. 總括而言，我對空氣污染這課題有相當的認識。	☐	☐	☐	☐	☐

你有否參與下列活動?

	有	沒有
6. 工作坊 – 關於黑碳	☐	☐
7. 工作坊 – 關於二氧化氮	☐	☐
8. 工作坊 – 關於臭氧	☐	☐
9. 工作坊 – 關於能見度	☐	☐
10. 建立量度臭氧的標準曲線	☐	☐
11. 量度污染物濃度／能見度	☐	☐
12. 工作坊 – 關於數據處理及分析	☐	☐
13. 向沒參與工作坊同學教授實驗技巧	☐	☐
14. 把所得的數據跟環保署或其他學校的作比較	☐	☐

15. 你對此探索活動有什麼期望？

☐ 增加科學知識
☐ 對自己／學生的學科成績有幫助
☐ 可與其他學校交流
☐ 可用作參與校內／校外比賽
☐ 提高學生的環保意識
☐ 只為參加一項課外活動
☐ 沒有期望
☐ 其他：_____

16. 你的期望有否達到？請加以說明。

☐ 有：_____

☐ 沒有：_____

參與此探索活動後，你對空氣污染的認識有否轉變？請再回答下列各題。

	非常不同意	有點不同意	一般	有點同意	非常同意
17. 我認識什麼是“空氣污染指數”。	☐	☐	☐	☐	☐
18. 我知道哪些空氣污染物的濃度用作計算“空氣污染指數”。	☐	☐	☐	☐	☐
19. 我知道黑碳、二氧化氮和臭氧的來源和影響。	☐	☐	☐	☐	☐
20. 我關心與空氣污染相關的新聞。	☐	☐	☐	☐	☐
21. 總括而言，我對空氣污染這課題有相當的認識。	☐	☐	☐	☐	☐
22. 我希望更深入認識這課題。	☐	☐	☐	☐	☐

請根據提供的實驗硬件及方法回答下列各題

	非常不同意	有點不同意	一般	有點同意	非常同意	不知道
黑碳						
23. 實驗過程容易處理。	☐	☐	☐	☐	☐	☐
24. 實驗原理容易明白。	☐	☐	☐	☐	☐	☐
25. 實驗過程有趣。	☐	☐	☐	☐	☐	☐
二氧化氮						
26. 實驗過程容易處理。	☐	☐	☐	☐	☐	☐
27. 實驗原理容易明白。	☐	☐	☐	☐	☐	☐
28. 實驗過程有趣。	☐	☐	☐	☐	☐	☐
臭氧						
29. 實驗過程容易處理。	☐	☐	☐	☐	☐	☐
30. 實驗原理容易明白。	☐	☐	☐	☐	☐	☐
31. 實驗過程有趣。	☐	☐	☐	☐	☐	☐
能見度						
32. 實驗過程容易處理。	☐	☐	☐	☐	☐	☐
33. 實驗原理容易明白。	☐	☐	☐	☐	☐	☐
34. 實驗過程有趣。	☐	☐	☐	☐	☐	☐

若你有參加過工作坊，請回答下各題（　）

	非常不同意	有點不同意	一般	有點同意	非常同意
35. 工作坊的內容易於明白。	☐	☐	☐	☐	☐
36. 工作坊使我增加關於空氣污染的認識。	☐	☐	☐	☐	☐
37. 工作坊所提供的知識和技巧足夠。	☐	☐	☐	☐	☐
38. 工作坊有助我分析數據。	☐	☐	☐	☐	☐

39. 你認為整個探索活動最困難之處在於：

☐ 每次實驗的時間長
☐ 難以分配時間
☐ 沒有足夠的基本知識
☐ 把所得的數據進行分析
☐ 同學之間的合作
☐ 所提供的支援不足
☐ 沒有困難之處
☐ 其他：_____

40. 你是否有興趣繼續參與探索活動？

☐ 有 → 有沒有一個你希望可以深入探索的題目？

_____

☐ 沒有 → 為什麼？_____

41. 請問你對此活動有沒有其他意見？

_____

_____

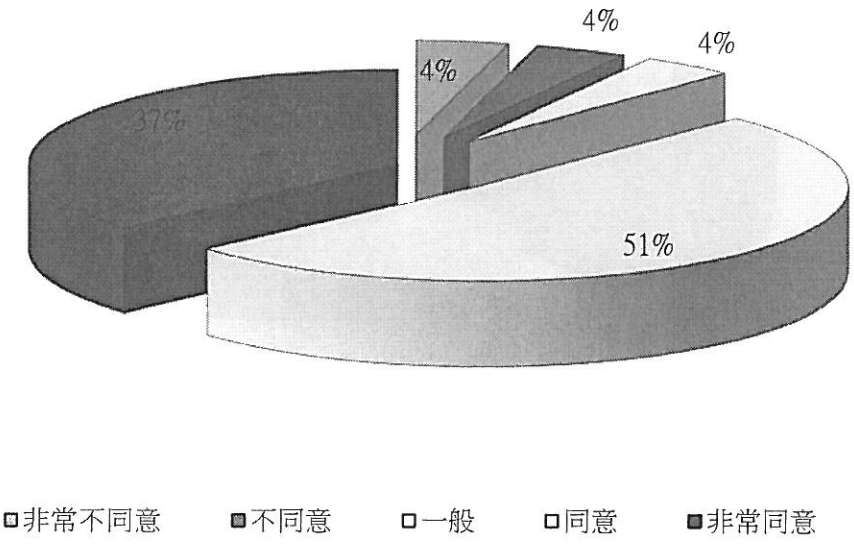
42. 最後，請告訴我們，你是：

☐ 老師
☐ 實驗室技術員
☐ 學生： 年級：_____

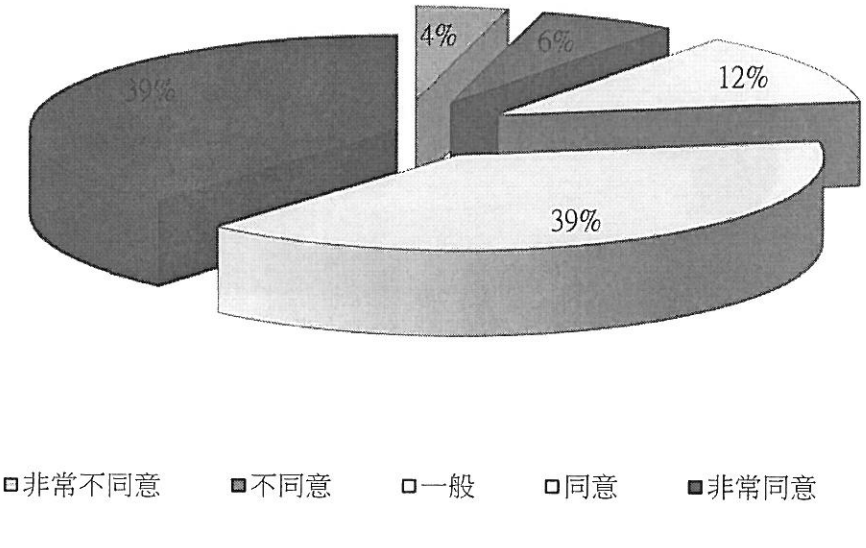
~~謝謝~~

Results summary of the Questionnaire

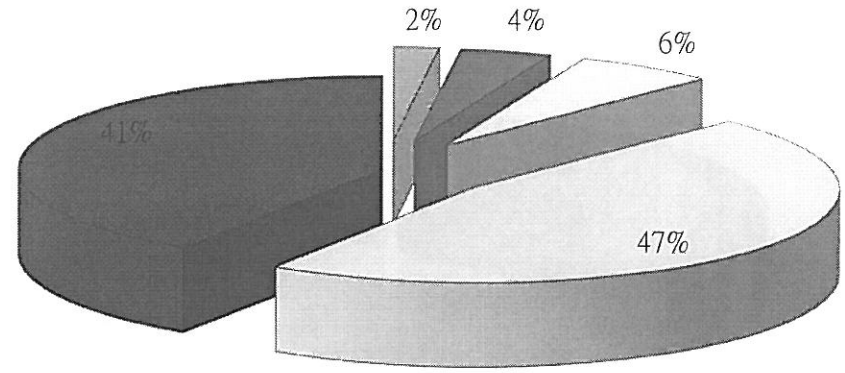
Q17. 我更清楚認識什麼是“空氣污染指數” n = 49



Q18. 我比以往更清楚如何計算“空氣污染指數” n = 49

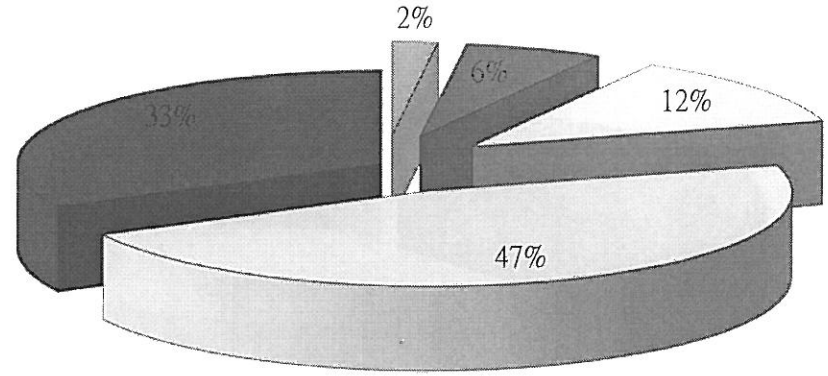


Q19. 我比以往更清楚知道黑碳、二氧化氮和臭氧的來源和影響
n = 49



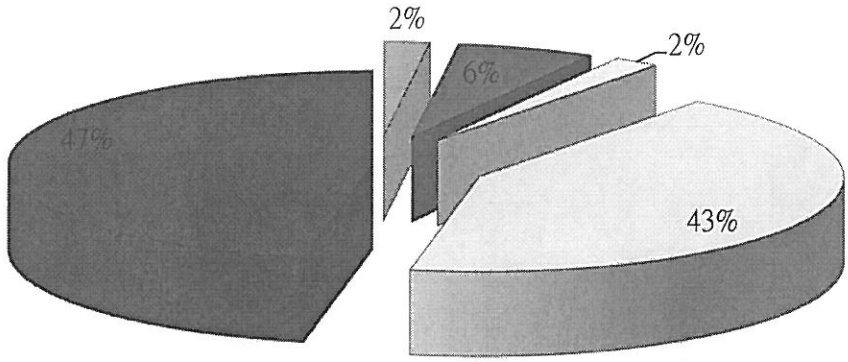
非常不同意 不同意 一般 同意 非常同意

Q20. 我更關心與空氣污染相關的新聞 n = 49



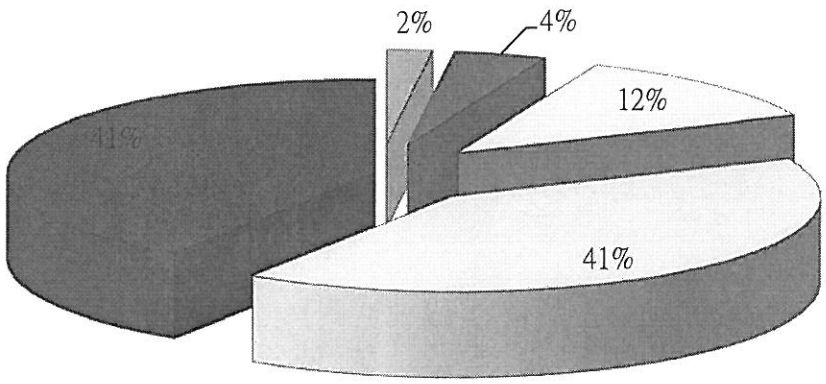
非常不同意 不同意 一般 同意 非常同意

Q21. 總括而言，我對空氣污染這課題有更深入的認識 n = 49

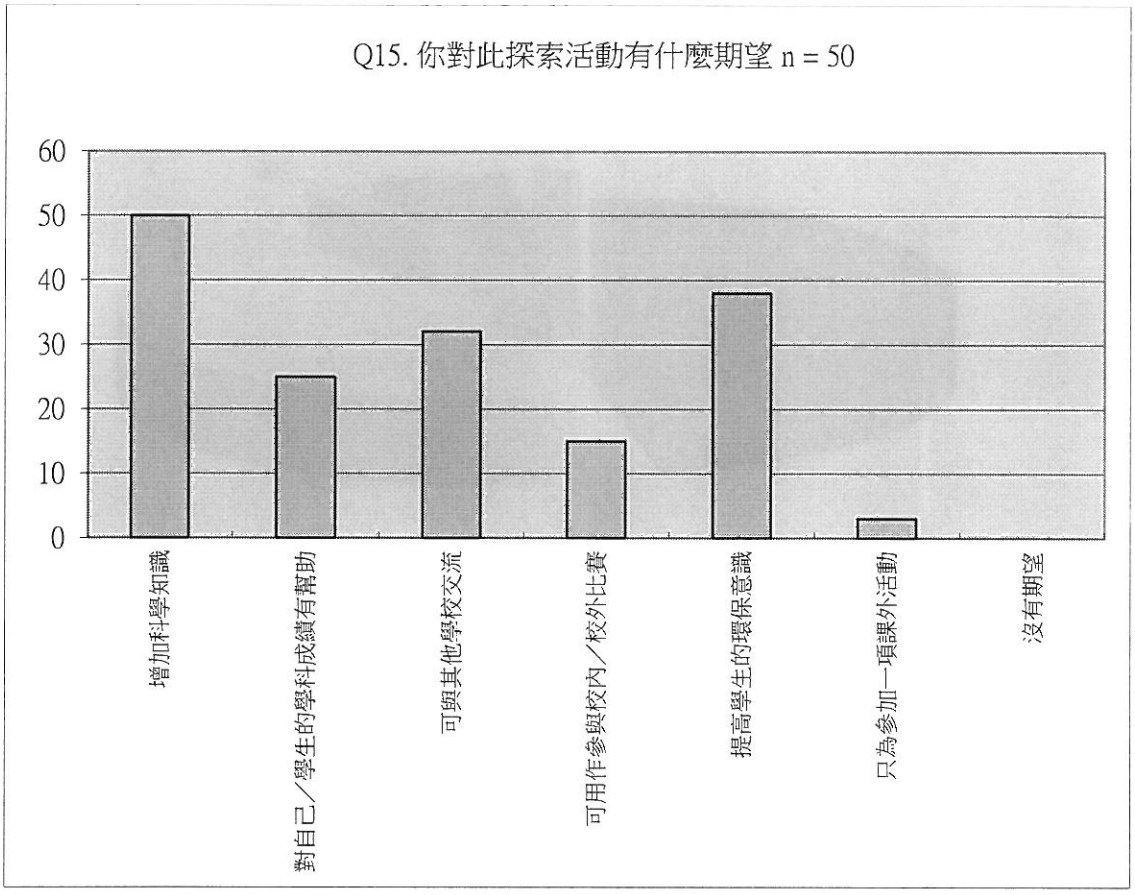


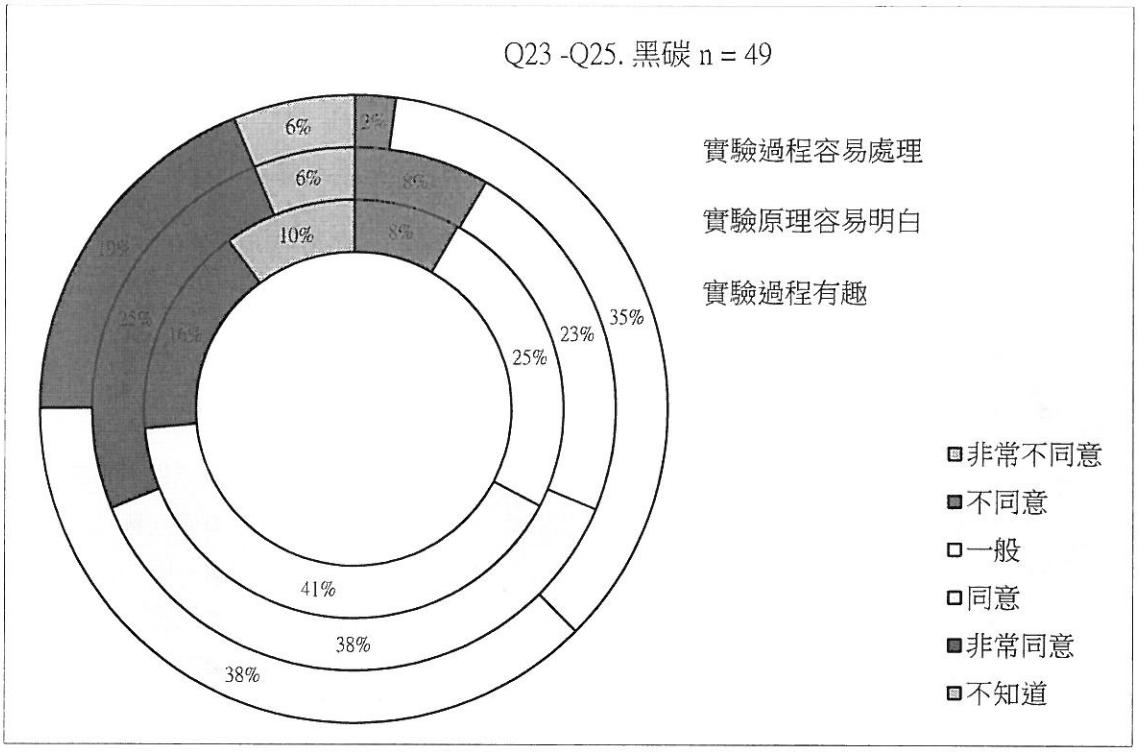
□非常不同意 ■不同意 □一般 □同意 ■非常同意

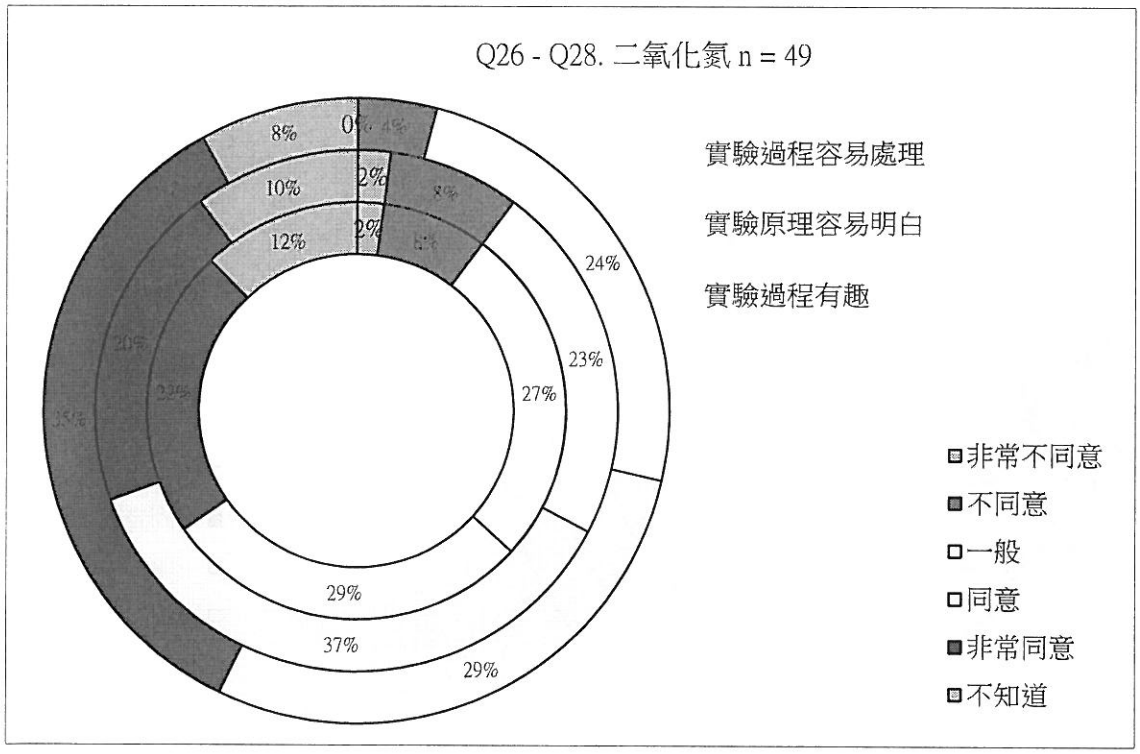
Q22. 我希望更深入認識這課題 n = 49

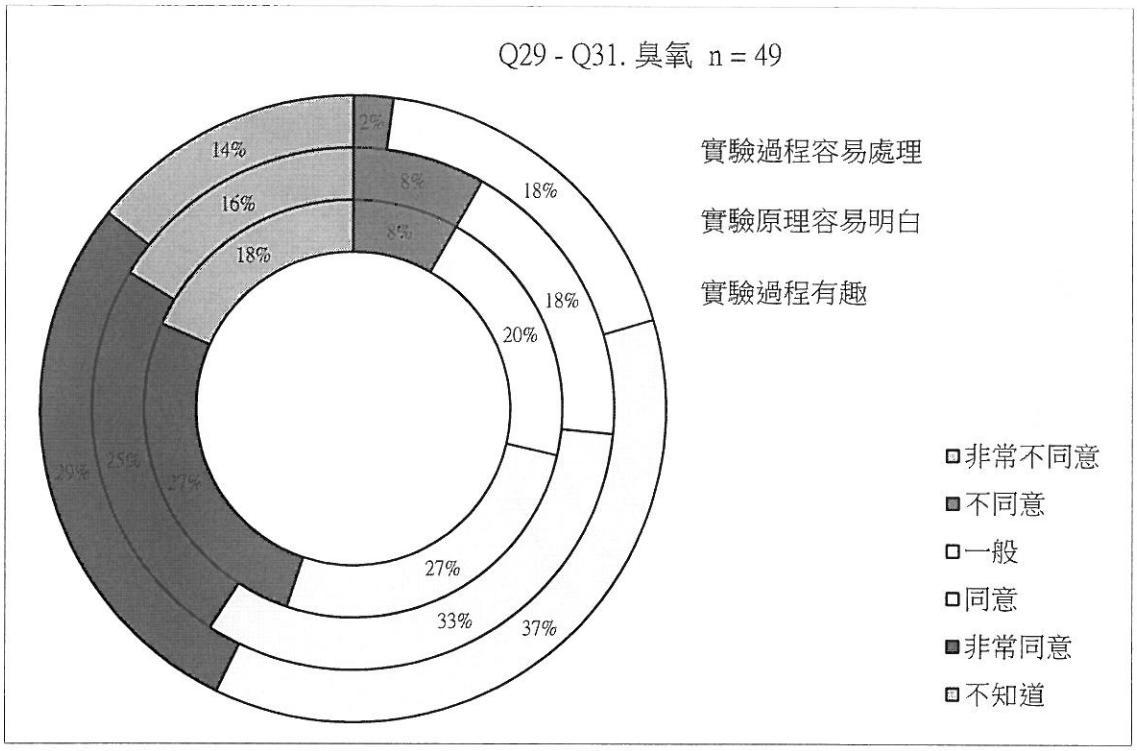


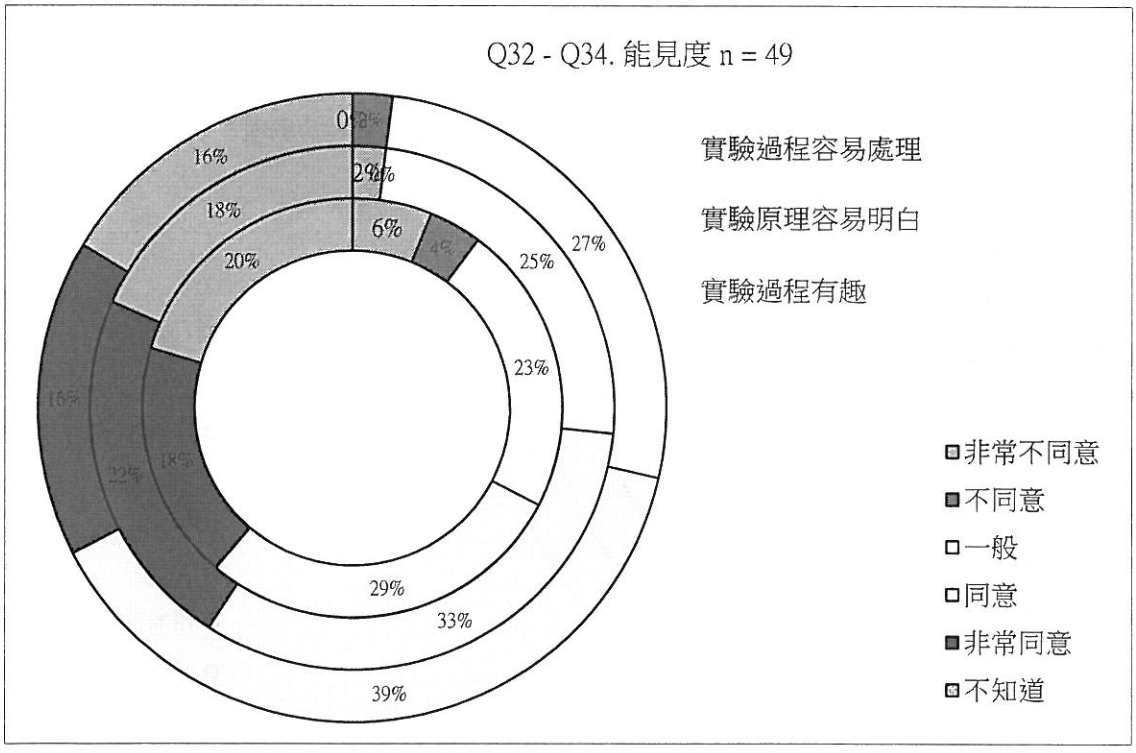
□非常不同意 ■不同意 □一般 □同意 ■非常同意


Q15. 你對此探索活動有什麼期望 n = 50
60
50
40
30
20
10
0
增加科學知識
對自己／學生的學科成績有幫助
可與其他學校交流
可用作參與校內／校外比賽
提高學生的環保意識
只為參加一項課外活動
沒有期望

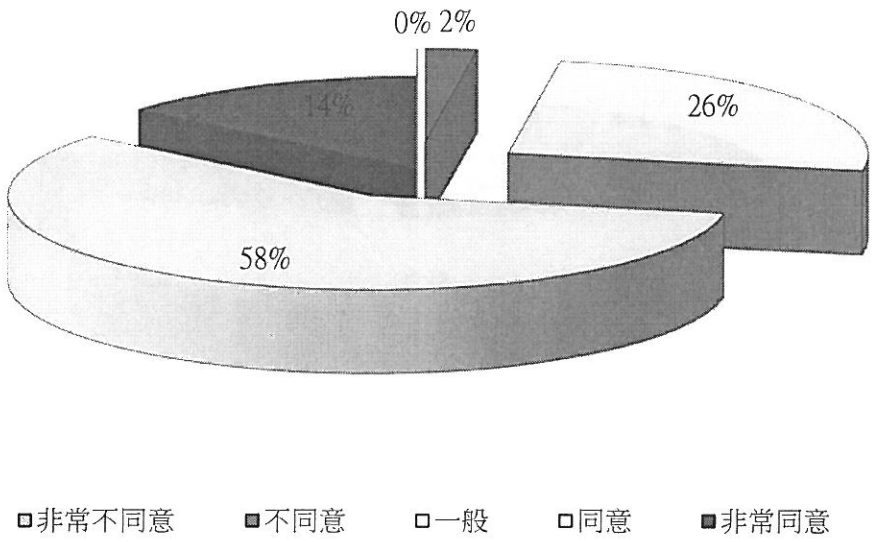

Q23 -Q25. 黑碳 n = 49
6%
6%
10%
35%
23%
25%
41%
38%
38%
實驗過程容易處理
實驗原理容易明白
實驗過程有趣
非常不同意
不同意
一般
同意
非常同意
不知道


Q26 - Q28. 二氧化氮 n = 49
8%
10%
12%
24%
23%
27%
29%
37%
29%
實驗過程容易處理
實驗原理容易明白
實驗過程有趣
非常不同意
不同意
一般
同意
非常同意
不知道

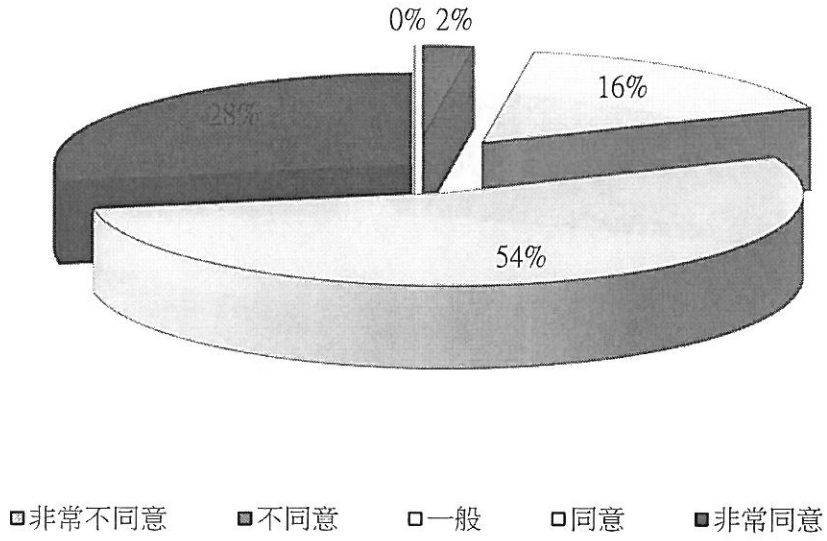

Q29 - Q31. 臭氧 n = 49
2%
8%
8%
18%
18%
20%
27%
33%
37%
14%
16%
18%
20%
25%
27%
實驗過程容易處理
實驗原理容易明白
實驗過程有趣
非常不同意
不同意
一般
同意
非常同意
不知道


Q32 - Q34. 能見度 n = 49
2%
6%
4%
18%
20%
23%
25%
27%
16%
18%
22%
29%
33%
39%
實驗過程容易處理
實驗原理容易明白
實驗過程有趣
非常不同意
不同意
一般
同意
非常同意
不知道

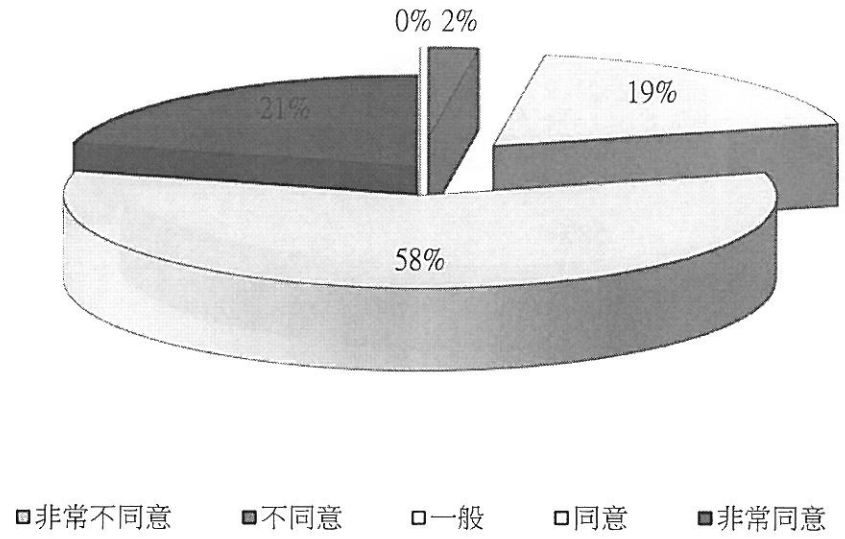
Q35. 工作坊的內容易於明白 n = 44



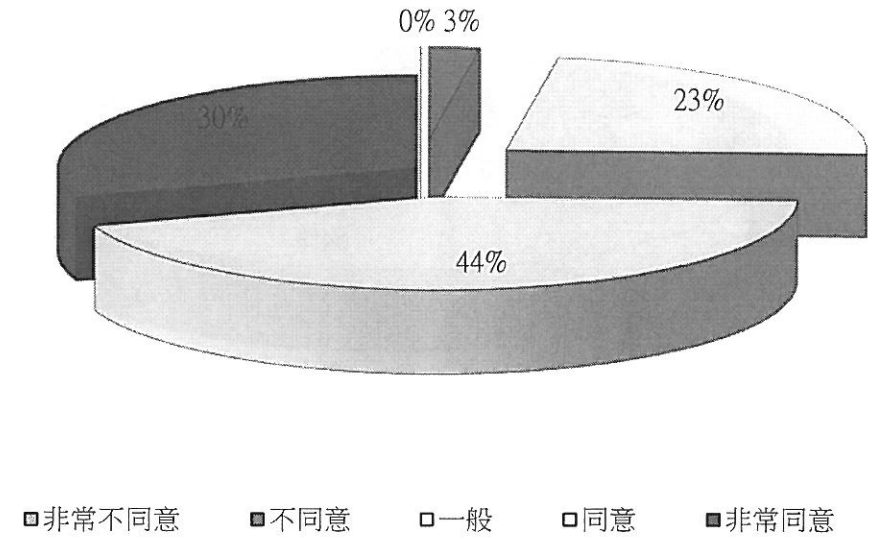
Q36. 工作坊使我增加關於空氣污染的認識 n = 43

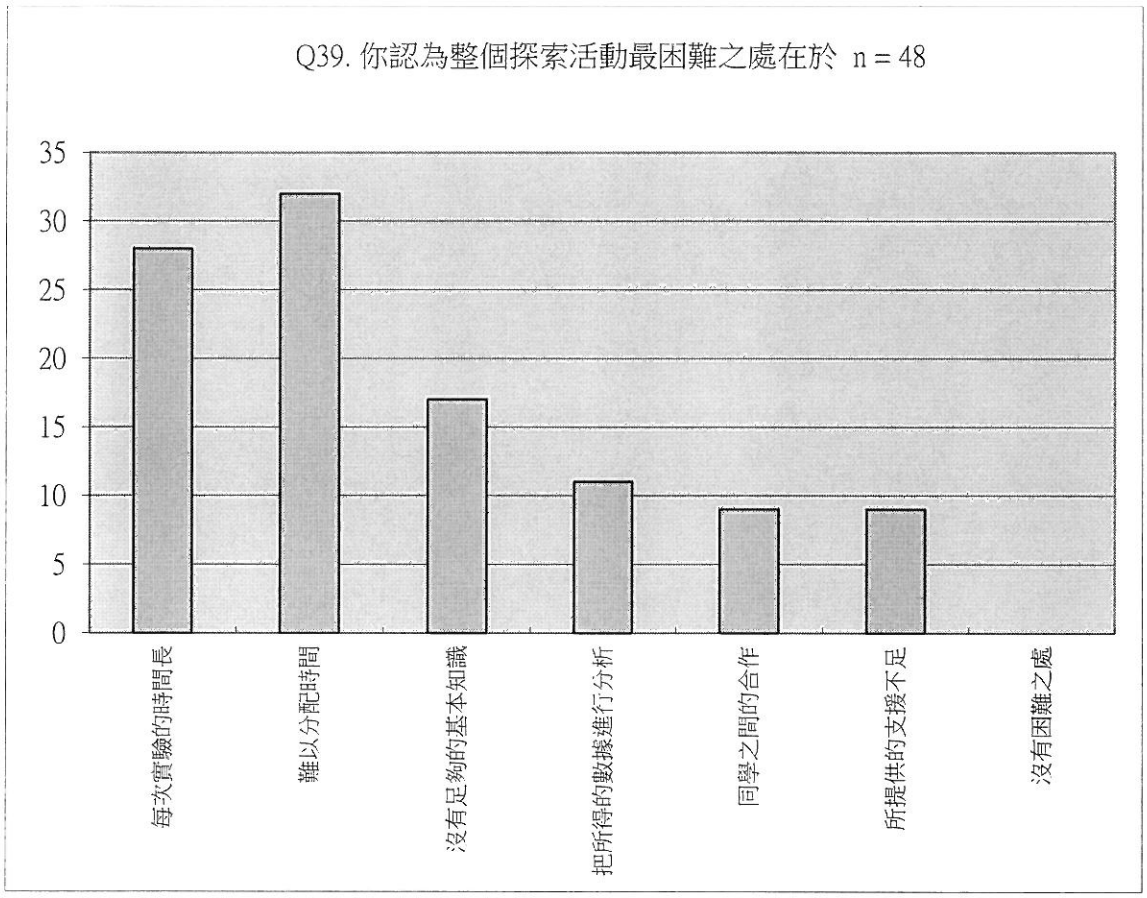


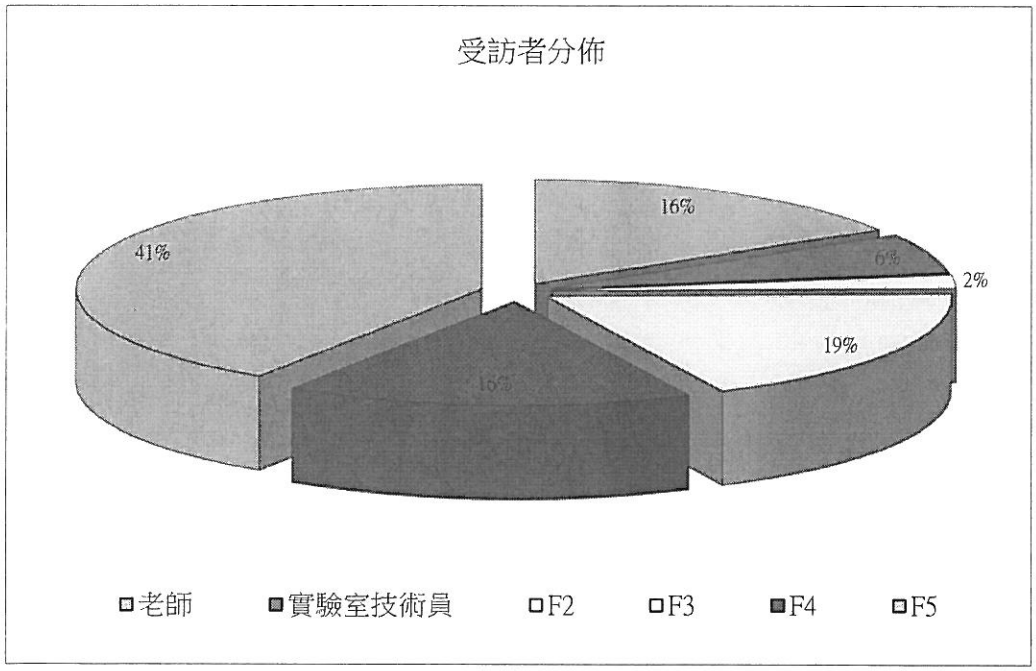
Q37. 工作坊所提供的知識和技巧足夠 n = 43



Q38. 工作坊有助我分析數據 n = 43




Q39. 你認為整個探索活動最困難之處在於 n = 48
35
30
25
20
15
10
5
0
每次實驗的時間長
難以分配時間
沒有足夠的基本知識
把所得的數據進行分析
同學之間的合作
所提供的支援不足
沒有困難之處


受訪者分佈
41%
16%
6%
2%
19%
16%
老師
實驗室技術員
F2
F3
F4
F5