

Exploring the Perception of Chemistry Students at Kulliyah of Science in Learning Organic Chemistry

Nurul Nadiah Rosly

*Department of Chemistry, Kulliyah of Science,
International Islamic University Malaysia,
Pahang, Malaysia
nnadiah454@gmail.com*

Shafida Abd Hamid*

*Department of Chemistry, Kulliyah of Science,
International Islamic University Malaysia,
Pahang, Malaysia
shafida@iium.edu.my*

Nor Azlina A. Rahman

*Department of Biomedical Science,
Kulliyah of Allied Health Sciences,
International Islamic University Malaysia,
Pahang, Malaysia
nazara@iium.edu.my*

Abstract

Students perceive organic chemistry as a challenging subject for them to learn and master, which results in a high failure rate. This study investigates the perception of chemistry students of the Department of Chemistry, Kulliyah of Science at International Islamic University Malaysia (IIUM), on organic chemistry courses and identify the topics that the students found difficult to grasp, which may affect their grades. The correlation of students' perception on the difficulty level in studying organic chemistry subjects (I and II) with the grades obtained for both courses, and the correlation of the type of study attitude with the grades achieved for Organic Chemistry I and II, were also investigated. From the data analysis of questionnaires distributed to 160 respondents, stereochemistry (n = 58.8 %), determination of reaction type (n = 59.4 %), construction of the reaction mechanisms (n = 73.2 %), and characterisation of organic reaction (n = 77.5 %), were the topics that the students perceived to be difficult. Perception on the difficulty in studying organic chemistry was positively associated with the achievement of excellent grades for both organic chemistry subjects (I; $r_s = 0.413^{**}$, $p < 0.01$ and II; $r_s = 0.436^{**}$, $p < 0.01$). Quality of study attitude shows no association with the grades obtained for organic chemistry I ($r_s = 0.330^{**}$, $p = 1.00$) but positively associated with grades of organic chemistry II subject ($r_s = 0.140$, $p < 0.01$). This study could serve as a reference for lecturers to search for ways to design appropriate teaching approaches for better learning experiences.

Keywords: *Organic chemistry, Stereochemistry, Organic mechanisms, perception of Chemistry, STEM*

*Corresponding author

INTRODUCTION

Advancement in knowledge and professional career for Science, Technology, Engineering, and Mathematics (STEM) fields is important to produce a scientific and progressive society. Exposure to STEM, especially among students at higher education levels, will produce a greater number of the younger generation who can be trained to think in a logical and holistic way, so that they can be more equipped with the 21st century skills, which mostly deal with rapidly evolving technology devices (Andrew, 2017). The United States of America (USA), the United Kingdom (UK), New Zealand, India and Australia, are among the leading countries focusing on promoting and improving STEM education among their young generations to produce competent professionals in the areas that guarantee their nations' future as well-developed countries (Hunt, 2018).

The Academy of Science Malaysia (ASM), which is an agency under the Ministry of Science, Technology and Innovation (MOSTI), strives to pursue excellence in the STEM fields for the future of our nation. To achieve this vision, ASM predicted that Malaysia should have at least half a million graduates from STEM fields at the higher education level. However, until 2015, the number of graduates in these fields of study was only 85,000, which was far from the target number (Su Lyn, 2015). The government has also constructed a policy of having a 60:40 ratio of science students to non-science in education system. However, despite the government's initiative, there is a decreasing trend of students opting for STEM in both secondary and tertiary levels of education, and the number of students pursuing science-stream courses has been recorded to decline for the past 10 years (Nation, 2017). In 2014, only 21 % of students chose to study science stream subjects in the upper secondary school level, while at the undergraduate level, 88 % of the science stream applicants pursued their dreams in the science programmes. In the academic year of 2015/2016, 59.06 % of students were selected into science programmes at the tertiary level, but only a total of 95 % of them accepted the offer.

Chemistry is a branch of science that deals with the study of matter including its composition, structure, and properties and the transformations that they undergo. Chemistry is regarded as the central core of science, and therefore knowledge of chemistry is important for those who wish to pursue their career either in the chemical industry or other scientific fields such as medicine, biotechnology, engineering, or patent law. Generally, chemistry can be divided into five main branches that differ based on their main focus (Table 1)

Table 1

Five Main Branches of Chemistry

Branches of Chemistry	Focus
Organic Chemistry	Carbon-containing compounds
Analytical Chemistry	Structure and composition of matter
Physical Chemistry	Matters at molecular and atomic level
Inorganic Chemistry	Inorganic and organometallic chemistry
Biochemistry	Substances in living organism

Organic chemistry is one of the pre-requisite subjects for most science programmes. This subject is said to be one of the reasons for students pulling away from science programmes especially at undergraduate level. Organic chemistry is viewed as a demanding, difficult and tiring course to learn as it requires continuous effort in understanding the flow of the organic reactions, memorising countless conditions and requirements for a reaction to occur, predicting the product based on the reactants and conditions given and vice versa. In addition, this course also includes laboratory sessions that come along with laboratory reports, which need to be submitted and evaluated by the course instructors. Incidentally, organic chemistry seems to be a daunting course not only for chemistry students but also other science stream programmes such as medicine. This subject is listed as one of the four most commonly failed classes (Galloway, 2019) due to the difficulties faced by students in learning, understanding and relating the knowledge to the real world. Organic chemistry is said to be the toughest among other sub-subjects of chemistry such as analytical chemistry, inorganic chemistry, biochemistry and physical chemistry. According to Barr, Matsui, & Wanat (2010), about 50 pre-medical students of University of California, Berkeley dropped out of the programme during their second year of study each year. It was recorded that from 2002 to 2004, out of 68 students dropped out from a total of 362 pre-medical students, 33 of them lost interest in the programme because of organic chemistry subject compared to other sciences courses such as biology, mathematics, and physics. In the United Kingdom, the number of applicants for chemistry programme at university level in 2017 dropped by 8.5 % and 13.4 % compared to in 2016 and 2015 respectively (Burke, 2018). In Sweden, although there was an increasing number of applicants in the chemistry programme at tertiary level, the number of students accepted the offer had decreased.

Organic chemistry is known to have notably low success rate or high failure rate, but achieving excellent result in this subject is important to prove the students' competency if they wish to further their studies or work in chemistry-related fields. For example, in a study conducted at University of Northern Colorado, only 86 (24 %) out of 351 undergraduate chemistry students obtained A from 2004 until 2008. In Ireland, 18.2 % of students taking Leaving Certificate at ordinary level, which is similar to undergraduate level failed this subject. The Irish Time reported that in 2013, the failure rate of chemistry subject was the highest compared to other subjects where it was approximately 18.2 % of students at ordinary level failed this subject in Ireland, while at higher level of study, chemistry was the second highest failure rate subject after physics with 11.2 % of students failed (Ahlstrom, 2013).

Unfortunately, there is no record or data found for trend of chemistry subject results in secondary or tertiary level of study in Malaysia. The only information obtained was reported by Su Lyn (2015) that 13 % of students obtained C in science subject for their PT3 examination (Pentaksiran Tingkatan 3) in 2015. This data is worrying since Malaysia is aiming for 60:40 ratio of science to non-science students, but based on the academic achievement, the students are not qualified enough to pursue the science-stream classes in the upper secondary school. Additionally, the Ministry of Education stated that for the past 10 years (Su-Lyn, 2015) only around 30 % of students qualified to be enrolled in science-stream class in the upper secondary school level.

In Malaysia, institutions offering on-campus bachelor's degree in chemistry programmes include Universiti Malaya, Universiti Tunku Abdul Rahman (UTAR), Universiti Sains Malaysia (USM), Universiti Teknologi Malaysia (UTM), Universiti Kebangsaan Malaysia (UKM), Universiti Teknologi Petronas (UTP), Universiti Putra Malaysia (UPM), Universiti Teknologi Mara (UiTM), Universiti Malaysia Sarawak (UNIMAS), International Medical University Malaysia (IMU), Universiti Pendidikan Sultan Idris (UPSI), and International Islamic University Malaysia (IIUM). Many public universities in Malaysia offer a three-year undergraduate level for students. However, there are also a few institutions such as International Islamic University Malaysia (IIUM) that offers a four-year undergraduate programme for students. Upon completion of undergraduate programme under Department of Chemistry at Kulliyah of Science in IIUM, students will be awarded with Bachelor of Science (Hons) in Applied Chemistry.

The perception that chemistry is a difficult subject to learn and teach is common among students and it results in a high number of students pulling away from taking chemistry courses either at high school or university levels in many countries. To the best of our knowledge, there is no study done yet in Malaysia specifically on finding the difficulties faced by undergraduate chemistry students in learning organic chemistry. This prompts us to investigate whether our students also face similar situation as claimed by students in other countries. We are also trying to find out the areas of organic chemistry that these students found difficult to learn and comprehend and whether the students' study attitude on this subject affects their academic achievement in organic chemistry. This study is very crucial to prevent the occurrence of students having negative perception on chemistry programme as a tough programme as well as to ensure the declining trends of students pursuing chemistry as well as other chemistry-related courses do not occur as observed in other countries (Childs & Sheehan, 2009).

The study was conducted at the Department of Chemistry, which is one of the departments under Kulliyah of Science, International Islamic University Malaysia. The department offers a 4-year undergraduate course of Bachelor of Science (Hons) in Applied Chemistry. The population size, N in this study is 193 undergraduate students in the department who consist of 30 fourth year students (or known as Batch 151), 46 third year students from first semester intake (Batch 161), 51 third year from second semester intake (Batch 162), 37 second year students (Batch 171), and 29 first year students (Batch 181). The inclusion and exclusion criteria as in Table 2 must be met by respondents to participate in the study.

Table 2

Inclusion and Exclusion Criteria of Respondents

Inclusion Criteria	Exclusion Criteria
Second, third and fourth-year undergraduate students of Department of Chemistry	Undergraduate Chemistry students who have not learned Organic Chemistry I and/or II subjects
Male and female students of Department of Chemistry	

The first-year students were not eligible to be respondents in this study. Based on Krejcie and Morgan Table (Krejcie & Morgan, 1970), the sample size needs to be at least 127 respondents. From 164 students eligible, 160 students took part in this study. The study was approved by the IIUM Research Ethics Committee (IIUM/504/14/11/2/ IREC 2019-048).

METHODOLOGY

Research Design and Data Collection

Both analytical and non-analytical of cross-sectional study was conducted in this study. Non-analytical study of cross-sectional was done to analyse the areas in organic chemistry subject that the second and third-year students found difficult to learn and comprehend, while analytical study of cross-sectional design was applied to quantify the relationship between two factors, as the effect and outcome. Convenience sampling method was implemented in this study. This method was chosen due to the ease of access to target respondents, which is more time and cost effective. The data were collected through offline and online methods. For offline method, the target respondents were approached at the end of their class and briefly informed on the overview of this study. The data were collected through online medium by distribution of Google Form link using 'WhatsApp' application. Both mediums of survey collection consisted of a consent form on the first page followed by the questionnaires.

There are two types of questionnaires given to the participants. The first type consists of multiple-choice questions and the participants were required to choose the best answer from the options which best suited them. In the first section, the respondents were required to state their Organic Chemistry I grade. The second sections comprised of similar questions as the first section except that it was for Organic Chemistry II subject. From these two sections, the achievement of students from each batch was analysed and compared. The second type consists of Likert scale ratings, which employed score of 1 to 5, where, "1: very easy, 2: easy, 3: neutral, 4: difficult and 5: very difficult". The questionnaires in this section require the respondents to rate the difficulty levels of five main fields of chemistry subjects. The difficulty level perceived by students regarding the five fields of chemistry and the association with their achievements in Organic Chemistry I and II courses were also analysed. Participants also need to rate the difficulty level of the areas in organic chemistry subject to identify the area(s) that they perceived as difficult to learn and have weak understanding on. The last section requires the participants to give their opinions based on the given statements related to their attitude in studying organic chemistry. All questionnaires were validated by face validity, where the questionnaires and the objectives of the research were distributed to randomly selected students. They were asked to fill the questionnaires and the answers, their opinions or comments on the questionnaires were taken into consideration for improvements.

Statistical Analysis

Statistical analysis was done using IBM SPSS STATISTICS 23 and Microsoft Excel 2013. The analysis was done in two ways. The first analysis was descriptive analysis, which focussed on

the count or percentage of answers from respondents based on their batch number. The data were tabulated to compare the major answers of each batch of respondents. The second analysis focused on answering the research questions. Apart from the questions that need the respondents to state their grades in Organic Chemistry I and II subjects, other questions used the five point of Likert scale.

Attitudinal Scale Analysis

There are several steps in measuring the respondents' study attitude towards organic chemistry subject. First, from the 24-statements given to the respondents, the total score of each respondent was calculated. Second, individual's mean score was calculated and finally, from the mean score of each respondent, the types of study attitude were then grouped into five categories (Table 3). The category of the study attitude was calculated by assuming that the least mean score of an individual could be 1, while the highest mean score could be 5. So, from the scale of 1-5, the mean score of 1 until 5 were divided into five equal cut points, which produced the range of mean score as in Table 3. From the highest to the lowest mean score, the quality of the study attitude decreased.

Studies looking specifically at students' IALL knowledge are rare. There is an acute lack of research in this area despite the ubiquity and usefulness of such tools in language learning. Research in IALL has mainly focused on uncovering solutions and practices for the IT industry and businesses, and has largely neglected the importance of examining what end users, especially students in universities and colleges, know about IALL and whether they use it in their language learning. This study is an attempt to address this gap.

Table 3

Type of Study Attitude Based on The Mean Score of Respondents (n=160)

Range of Mean Score	Type of Study Attitude
1-1.79	Highly unfavourable
1.80-2.59	Unfavourable
2.60-3.39	Undecided
3.40-4.19	Favourable
4.20-5.00	Highly favourable

RESULTS AND DISCUSSION

Department of Chemistry is a relatively new department at Kulliyyah of Science IIUM, where the first batch of students enrolled in the programme was in 2013. To this date, there was no study on the students' difficulties in learning organic chemistry conducted not only at IIUM but also in other universities in Malaysia. Although there were many previous studies with similar purpose conducted elsewhere (Adu-Gyamfi & Ghartey Ampiah, 2017; Broman, Ekborg, &

Johnels, 2011; Davis, 2018; Donkoh, 2017), this study is beneficial as the difficulties faced may differ or may not be similar.

The data gathered in this study were quantitatively described and summarised by descriptive statistics. From the questionnaires completed by the respondents, the count and percentage of each answer was calculated and presented. The socio-demographic of the respondents was tabulated in Table 4. The respondents composed of 160 undergraduate chemistry students of Batch 151, Batch 161, Batch 162, and Batch 171. Students from the Department of Chemistry at IIUM were grouped based on their batch number that refers to their session intake into the department. For example, Batch 151 refers to student who enrolled into the undergraduate level of chemistry programme in 2015, and the last number which is 1, refers to the semester they enrolled.

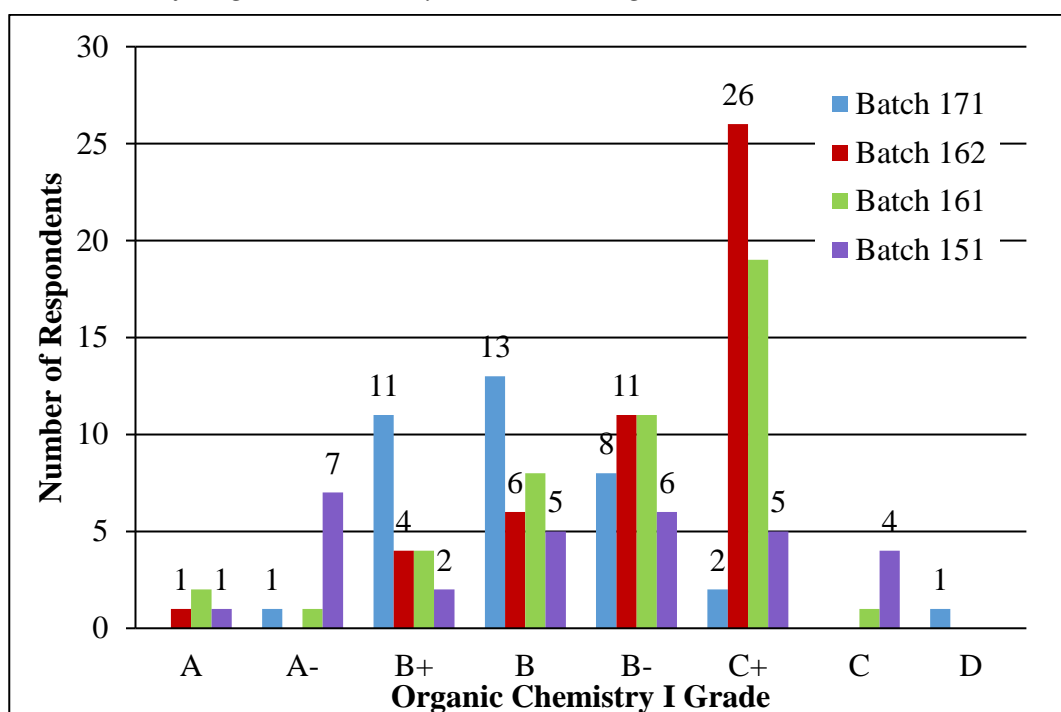
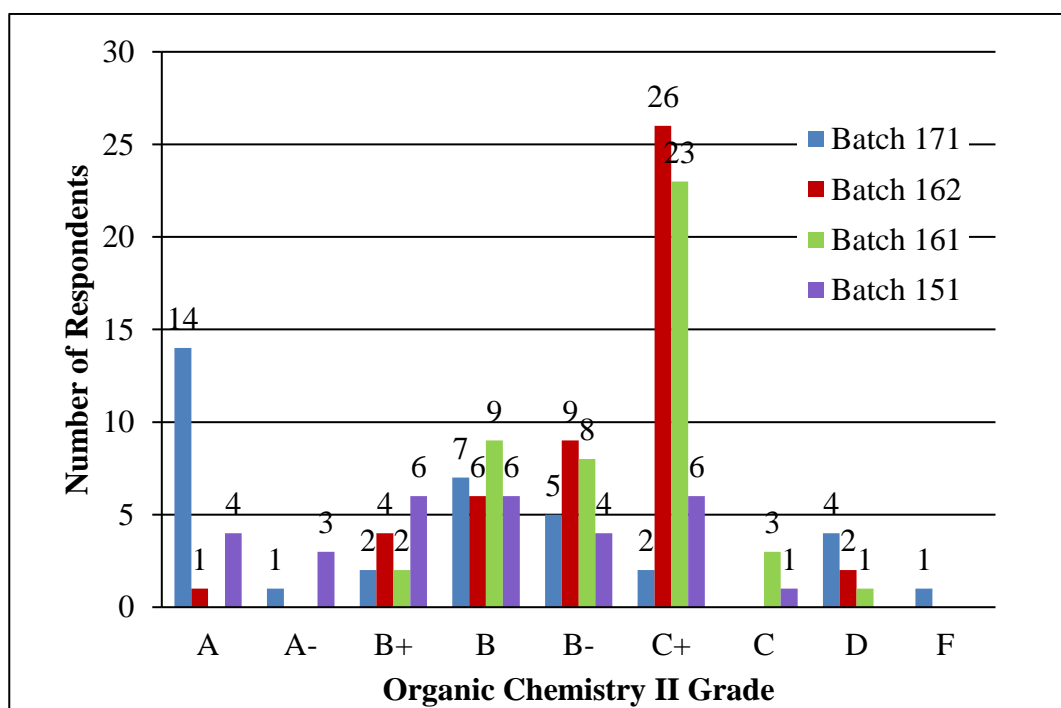
Table 4

Tabulation of Gender and Batch among Respondents (n = 160)

Gender	Batch Number, n (%)			
	Batch 171	Batch 162	Batch 161	Batch 151
Male	10 (27.8)	16 (33.3)	8 (17.4)	6 (20.0)
Female	26 (72.2)	32 (66.7)	38 (82.6)	24 (80.0)
Total	36 (100)	48 (100)	46 (100)	30 (100)

Grades in Organic Chemistry I and II Subjects

Organic Chemistry I is one of the core subjects offered in the second semester of their first year of study, while Organic Chemistry II during the first semester of the second year of study. The distribution of grades in Organic Chemistry I and II subjects among the batches are depicted in Figures 1 and 2 respectively. The achievement of each batch of respondents was compared to determine which batch performed the best according to the majority grades achieved.

Figure 1*Distribution of Organic Chemistry I Grade among Batches (n = 160)***Figure 2***Distribution of Organic Chemistry II Grade among Batches (n = 160)*

Based on both figures, students of Batch 171 performed the best in the examinations for both subjects, with the highest number of students obtained B (n = 13) and A (n = 14) grades. The distribution of grades for Organic Chemistry I and II for both students of Batch 161 and Batch 162 is almost similar. However, students' mastery on the subject learnt cannot be determined through the examination grade only as the examination only judge the students' capability to

answer specific questions at specific time of exam. With limited number and scopes of questions given during the examination, their understanding on each of the areas in organic chemistry subject cannot be evaluated. Nevertheless, the data provides the data of the performance of each batch in general.

Analysis on Difficulty Levels Perceived by Respondents on Several Fields of Chemistry Study

Analytical, inorganic, physical, organic chemistry as well as biochemistry are the five main fields in chemistry, which are the core subjects for students taking chemistry programme on undergraduate level at International Islamic University Malaysia (IIUM). Analytical chemistry was found to be on neutral level of difficulty for most of the respondents (Figure 3). As for organic chemistry subject (Figure 4), it was perceived as a very difficult subject for them to learn. Most of the respondents, except of Batch 171 voted this subject as very difficult for them to learn and comprehend. This finding supports previous studies done elsewhere (Barr et al., 2010; Cardellini, 2018; Dwyer & Childs, 2017; Erika, 2017), where organic chemistry is perceived as a difficult subject for learners to comprehend which resulted in declining of students enrolled in science-stream courses.

There are two main perceptions on inorganic chemistry subject among the respondents (Figure 5). Majority of Batch 162 ($n = 22$) voted inorganic chemistry as ‘difficult’ for them to learn while the rests agreed that the subject was on neutral level for them. Similarly, majority of the respondents considered biochemistry on neutral level of difficulty (Figure 6) while physical chemistry an easy subject for them to learn and understand (Figure 7).

Figure 3

Respondents' Perception on the Difficulty of Analytical Chemistry ($n = 160$)

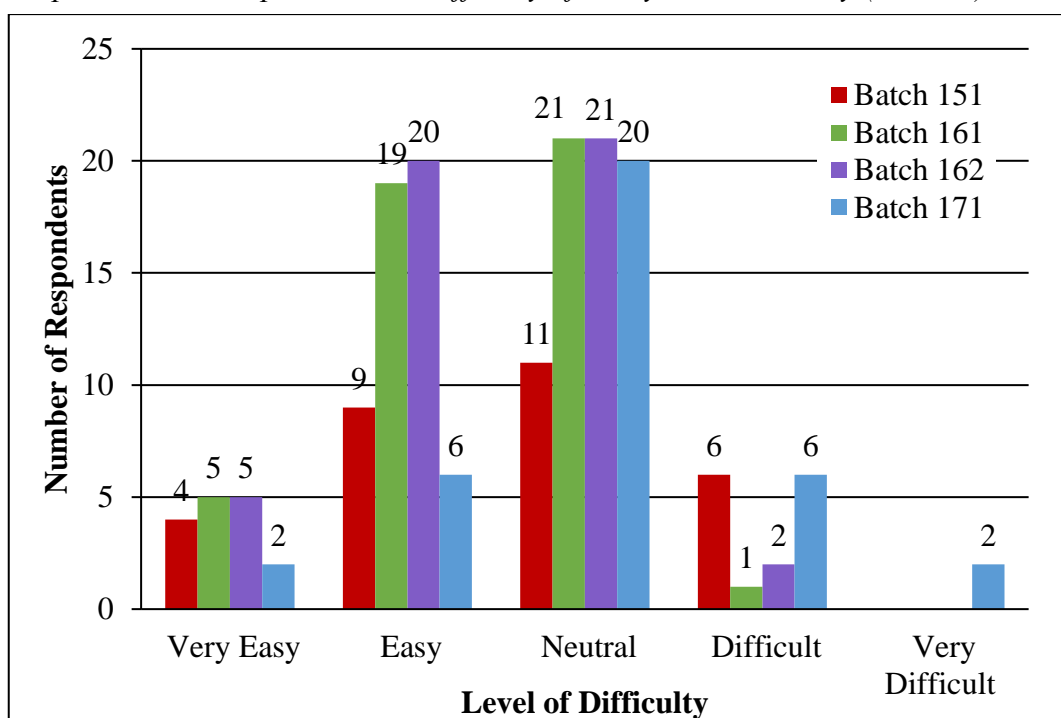


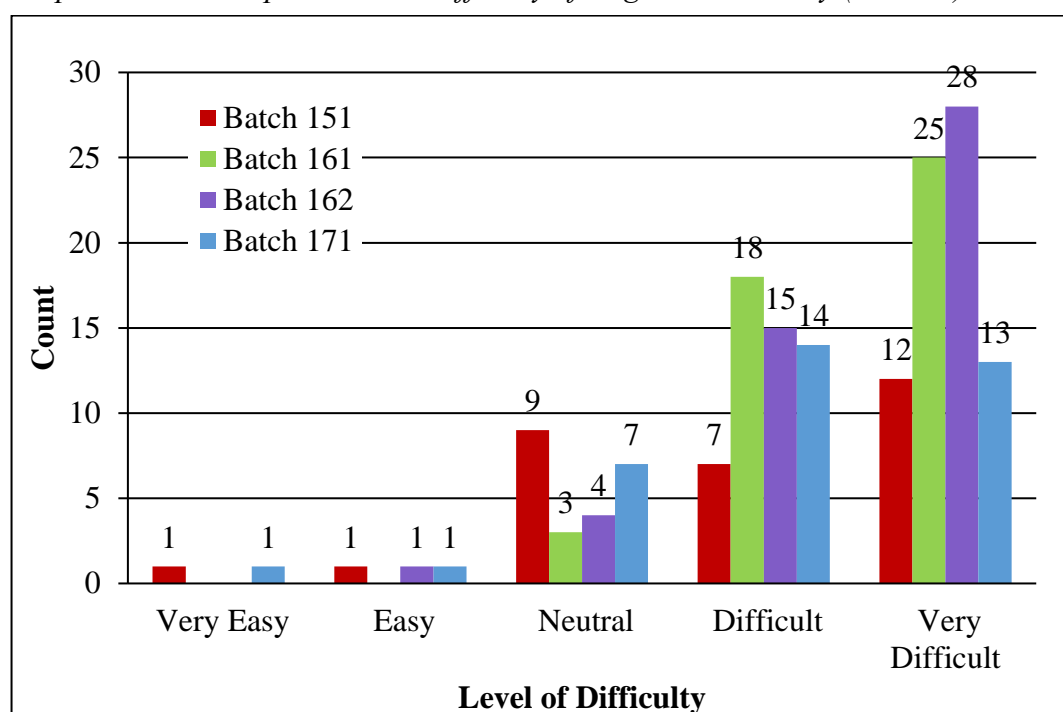
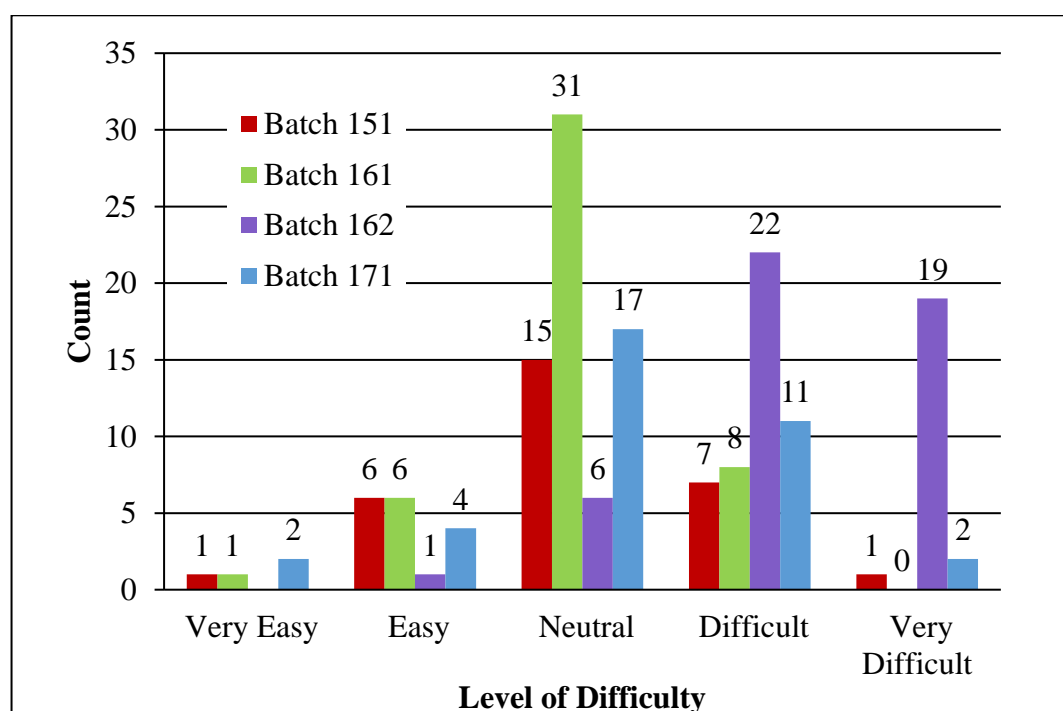
Figure 4*Respondents' Perception on the Difficulty of Organic Chemistry (n = 160)***Figure 5***Respondents' Perception on the Difficulty of Inorganic Chemistry (n = 160)*

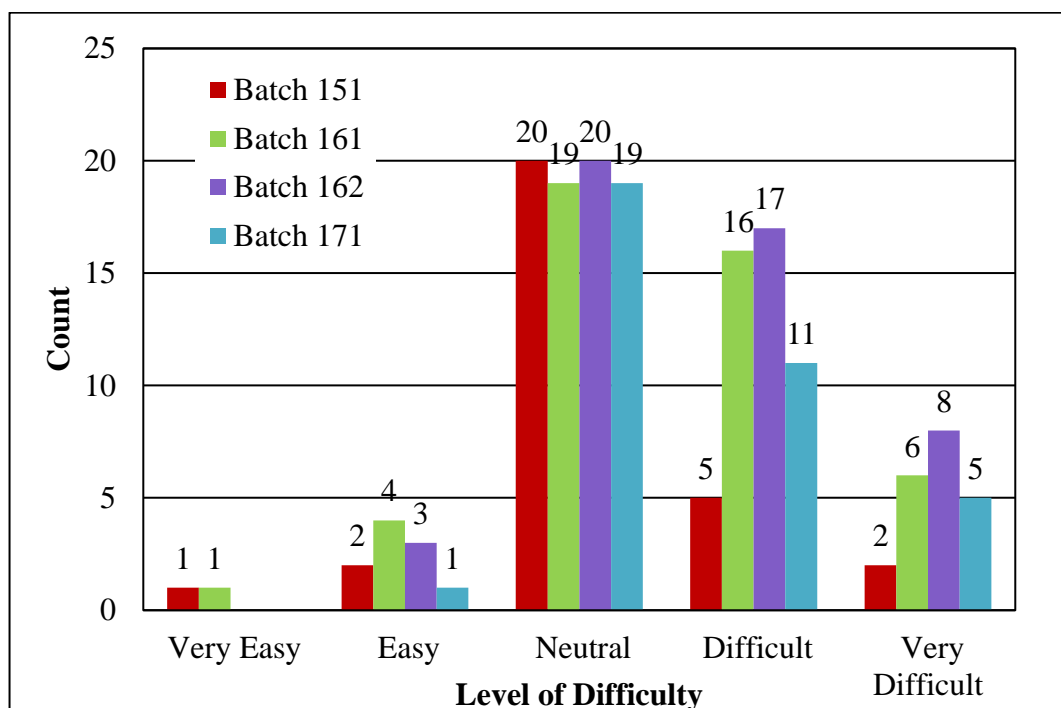
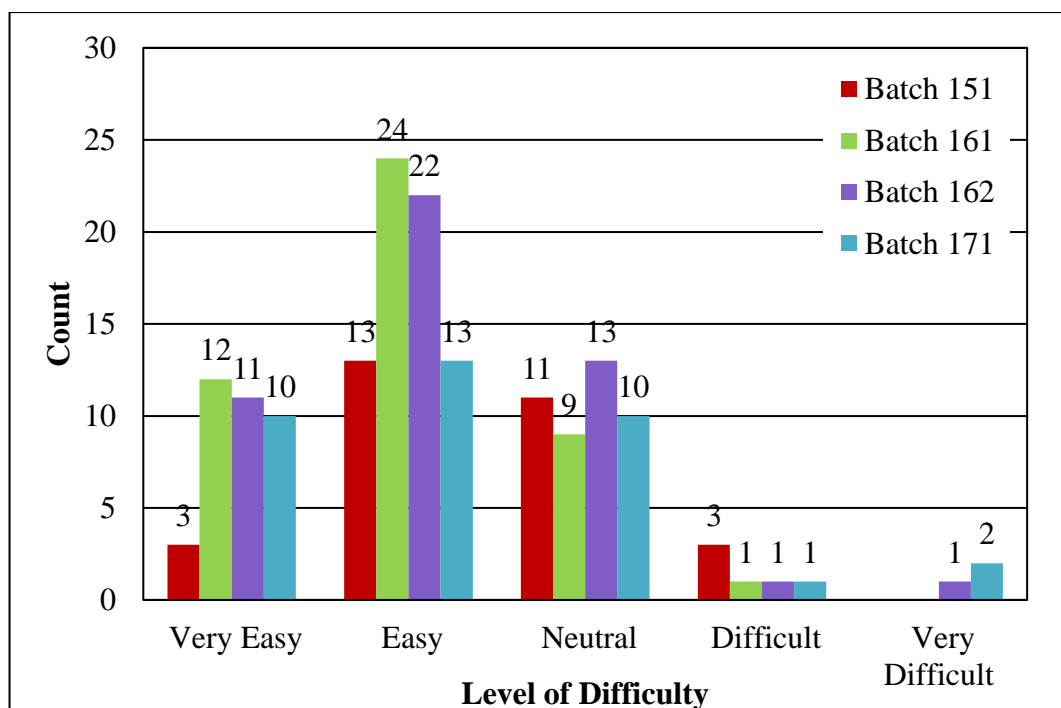
Figure 6*Respondents' Perception on the Difficulty of Biochemistry (n = 160)***Figure 7***Respondents' Perception on the Difficulty of Physical Chemistry (n = 160)*

Table 5 summarised the perceptions on difficulty level for several fields in chemistry study as perceived by the respondents. In general, analytical chemistry, inorganic chemistry, and biochemistry were of neutral level of difficulty. Physical chemistry was perceived as an easy subject for most of them, while organic chemistry as a very difficult subject. According to Lynch & Trujillo (2011), students found organic chemistry as a challenging subject for them to learn because they are used to rely on memorisation as the way of studying as practiced during

their high school years. This method of studying is ineffective in university especially for organic chemistry as this subject demands strong understanding on the basic concept as well as critical thinking in problem solving. Moreover, memorising facts for this subject is of no use for constructing organic reaction since there could be more than one solutions to achieve the product. Thus, students who stick to memorising the facts tend to block their minds to come out with alternative solutions that might be simpler and have higher rate of success to achieve the expected product.

Table 5

Summary of Level of Difficulty in Chemistry Fields as Perceived by Respondents (n = 160)

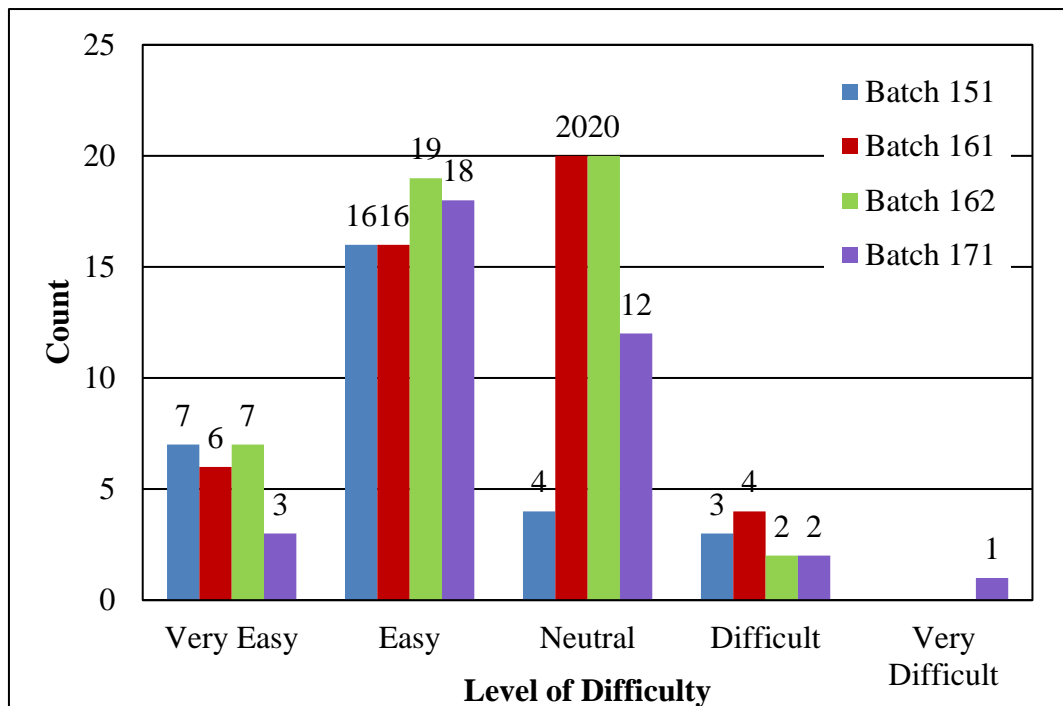
Chemistry Study	Level of Difficulty n (%)				
	Very Easy	Easy	Neutral	Difficult	Very Difficult
Analytical Chemistry	16 (10.0)	54 (33.8)	73 (45.6)	15 (9.4)	2 (1.3)
Organic Chemistry	2 (1.3)	3 (1.9)	23 (14.4)	54 (33.8)	78 (48.8)
Inorganic Chemistry	4 (2.5)	17 (10.6)	69 (43.1)	48 (30.0)	22 (13.8)
Biochemistry	2 (1.3)	10 (6.3)	78 (48.8)	49 (30.6)	21 (13.1)
Physical Chemistry	36 (22.5)	72 (45.0)	43 (26.9)	6 (3.8)	3 (1.9)

Difficulty Levels Perceived by Students on Several Areas in Organic Chemistry Subject

Several topics in organic chemistry covered in Organic Chemistry I and II courses were selected in the questionnaires based on the common areas perceived as difficult for learners (Eticha & Ochonogor (2013); Donkoh (2017)). There are two major perceptions among the respondents for nomenclature topic (Figure 8). Majority of Batch 151 (53.3 %) and Batch 171 (50.0 %) agreed that this topic was easy for them to learn and comprehend. However, majority of respondents from Batch 161 and Batch 162, decided that the nomenclature area was on neutral level of difficulty. Majority of respondents, except for Batch 151 perceived drawing chemical structures on neutral level of difficulty for them to learn (Figure 9). Aromaticity is also another topic perceived as neutral for most respondents (Figure 10).

Figure 8

Respondents' Perception on the Difficulty in Learning and Understanding Nomenclature
(n = 160)

**Figure 9**

Respondents' Perception on the Difficulty of Learning and Understanding Compound Drawing

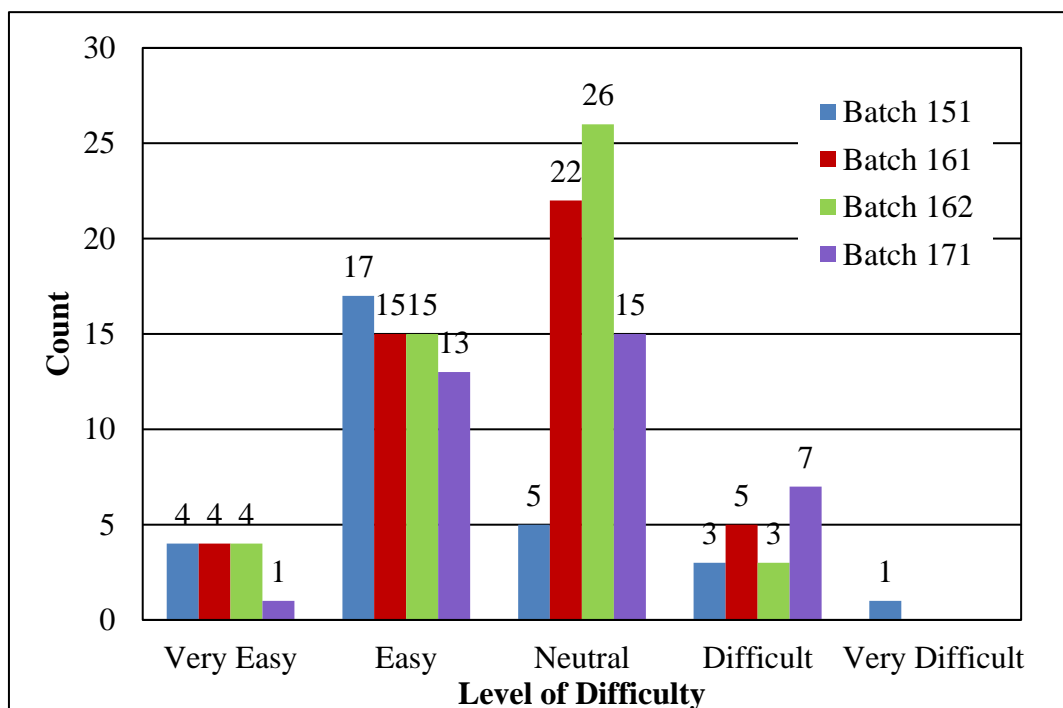
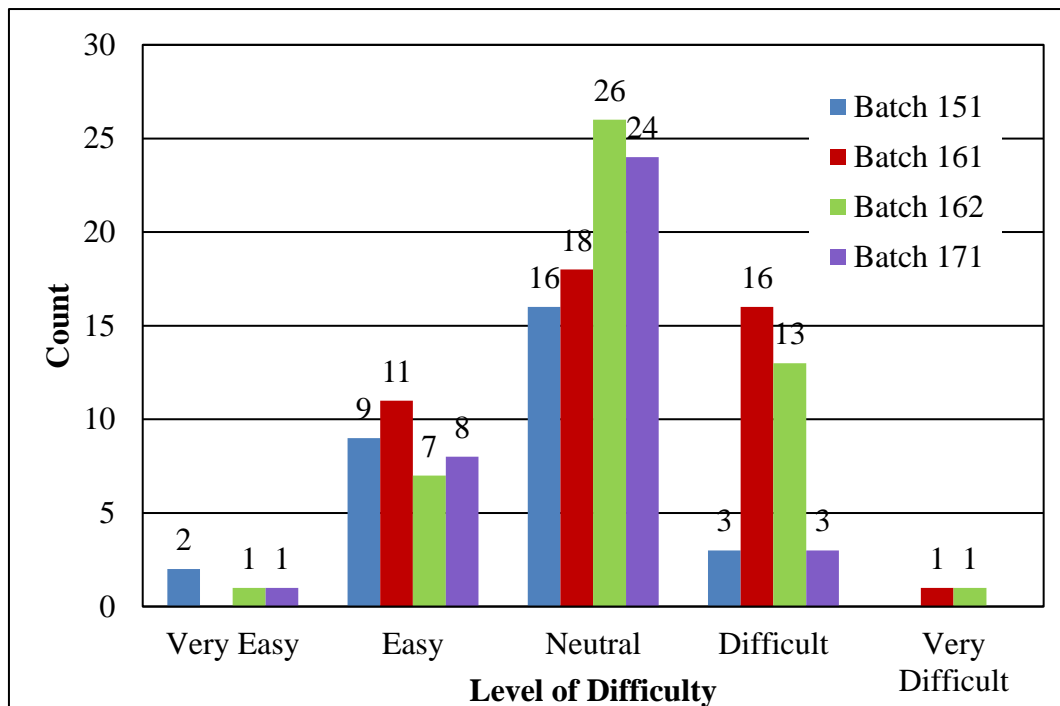


Figure 10

Respondents' Perception on the Difficulty in Learning and Understanding Aromaticity
($n = 160$)



Similar with the findings by Dwyer & Childs, (2017), reaction types (Figure 11), stereochemistry (Figure 12), and organic reactions (Figure 13) were the topics that most students in this study perceived as difficult for them to learn and comprehend. The common factor of the difficulty is probably because the content itself is too abstract and complex. Abstract in this context means that the content of the study has no definite solution that resulted in development of misconceptions among students about the topics learnt. While complex refers to the demand for the learners to integrate the knowledge and mastery on previous topics of study because each topic relates to one another. Students who have weak understanding on earlier topics in organic chemistry would find topics such as reaction types, organic reactions and reaction mechanisms as difficult for them to learn. As can be seen in Figure 14, the reaction mechanism construction seems to be the most difficult area for respondents to learn and master. To master this area of organic chemistry, apart from firm understanding on the previous topics learnt, students need to do consistent and regular practices of different types of organic reaction mechanisms.

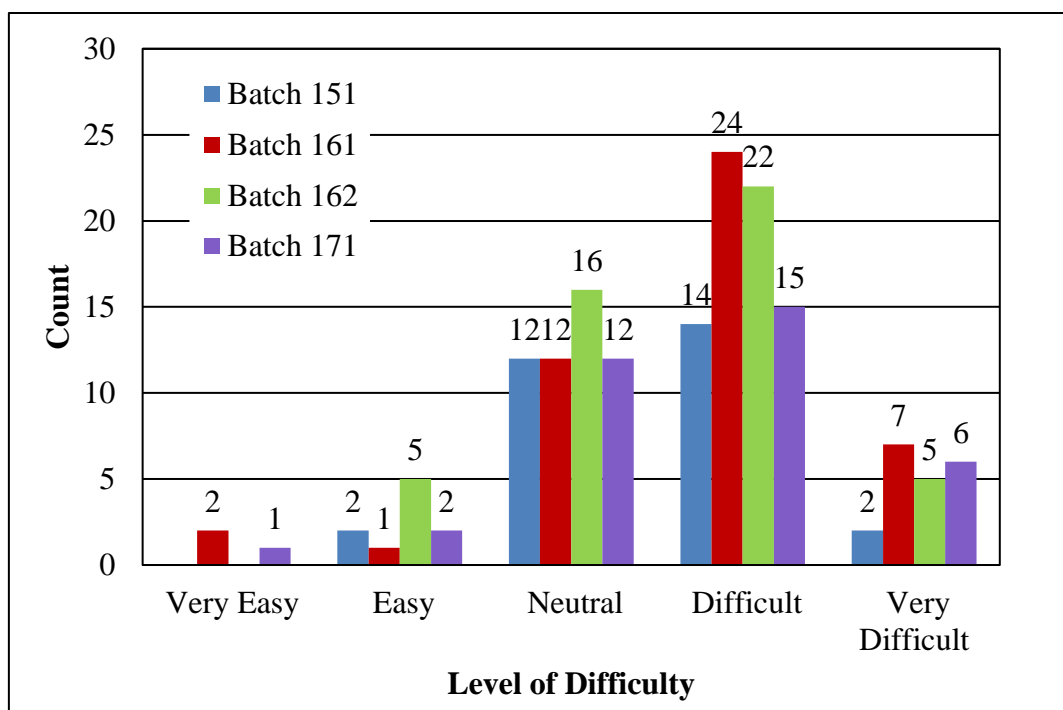
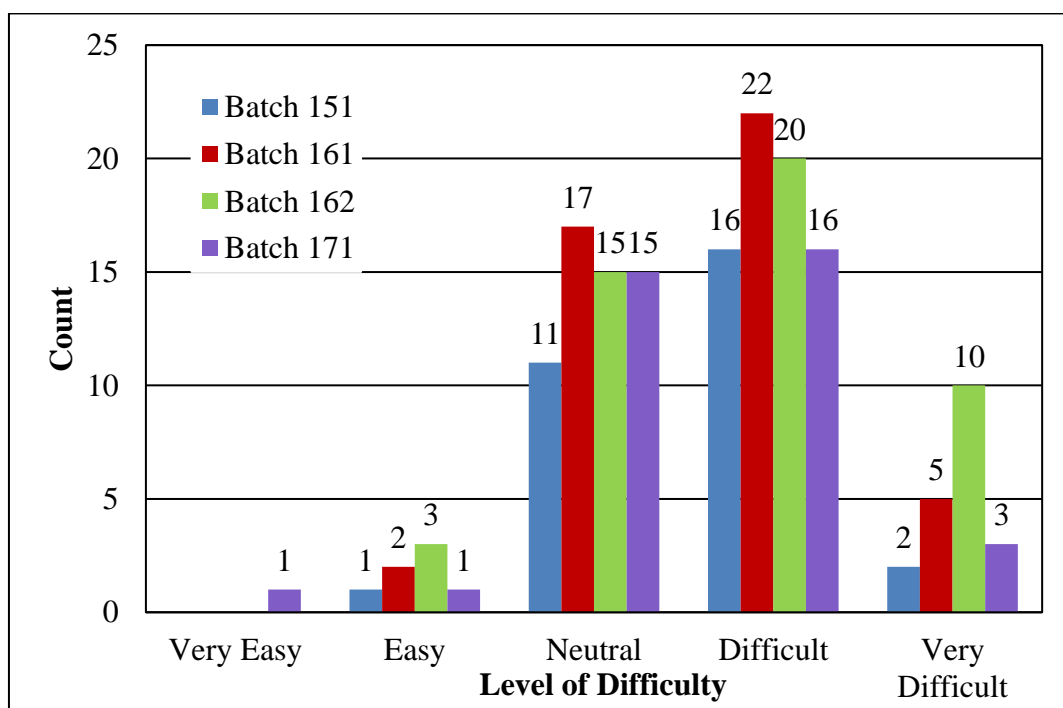
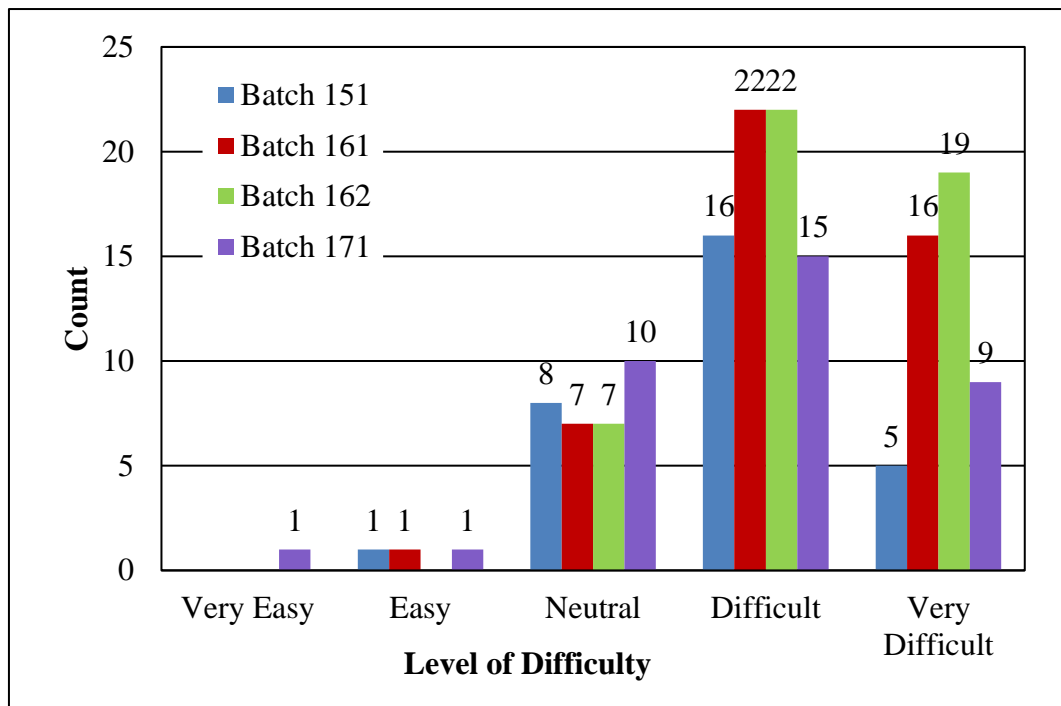
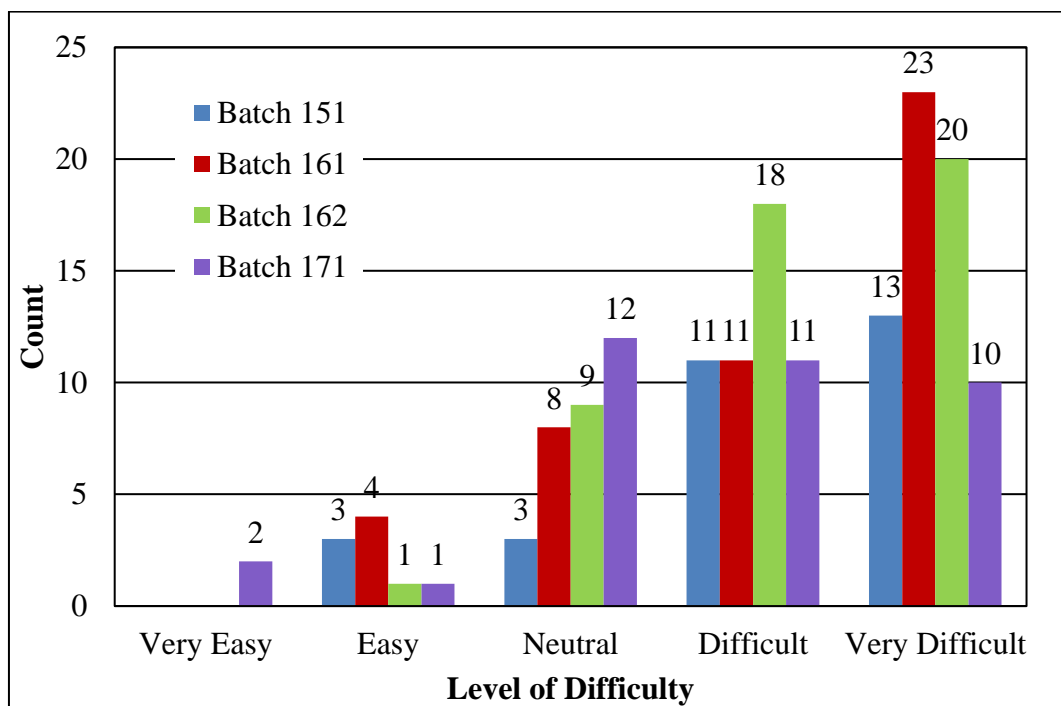
Figure 11*Respondents' Perception on the Difficulty in Identification Reaction (n = 160)***Figure 12***Respondents' Perception on the Difficulty in Learning and Understanding Stereochemistry (n = 160)*

Figure 13

Respondents' Perception on the Difficulty in Learning and Understanding Organic Reactions (n = 160)

**Figure 14**

Respondents' Perception on the Difficulty in Learning and Understanding the Construction of Reaction Mechanism (n = 160)



Overall, three areas that were found to be difficult for majority of respondents were determination of reaction types, stereochemistry and characterising organic reaction based on the information given. The most difficult area was found to be determining the correct reaction mechanism (Table 6).

Table 6

Summary of Difficulty in the Areas of Organic Chemistry (I and II) Subjects (n = 160)

Area	Level of Difficulty, n (%)				
	Very Easy	Easy	Neutral	Difficult	Very Difficult
Nomenclature	23 (14.4)	69 (43.1)	56 (35.0)	11 (6.9)	1 (0.6)
Drawing of compound	13 (8.1)	60 (37.5)	68 (42.5)	18 (11.3)	1 (0.6)
Aromaticity	4 (2.5)	35 (21.9)	84 (52.5)	35 (21.3)	2 (1.3)
Reaction type	3 (1.9)	10 (6.3)	52 (52.5)	75 (46.9)	20 (12.5)
Stereochemistry	1 (0.6)	7 (4.4)	58 (36.3)	74 (46.3)	20 (12.5)
Organic reaction	1 (0.6)	3 (1.9)	32 (20.0)	75 (46.9)	49 (30.6)
Reaction mechanism	2 (1.3)	9 (5.6)	32 (20.0)	51 (31.9)	66 (41.3)

Respondents' Study Attitude towards Organic Chemistry

From the individual's mean score, the type of study attitude between the respondents was determined and summarised in Table 7. The statements involved positive study habits such as the frequency of revision on previously learnt chapters. Higher mean score indicates better study attitude of the respondents, which is likely to yield better result in organic chemistry.

Table 7

Distribution of Study Attitude among Respondents based on the Mean Score of Likert Scale (n = 160)

Range of Mean Score	Type of Study Attitude	Respondent, n (%)
1.00-1.79	Highly unfavourable	0 (0.0)
1.80-2.59	Unfavourable	4 (2.5)
2.60-3.39	Undecided	65 (40.6)
3.40-4.19	Favourable	84 (52.5)
4.20-5.00	Highly favourable	7 (4.4)
Total		160 (100.0)

Effort is a measure of engagement of respondents in terms of time and energy in meeting the academic requirements set by the teachers or university (Carbonaro, 2019). Effort and persistence are goal specific, so, it is suggested that the respondents' persistence in studying both organic chemistry subjects may change depending on their goal or condition that they faced during the study. As shown in Table 8, most respondents revealed that they sometimes exert full effort in both organic chemistry I (n = 78, 48.8 %) and II (n = 64, 40.0 %). In general, most respondents scored higher scores (3 to 5) for most of the statements, except for several statements regarding the "preparation before class (pre-class)" (n = 67, 41.9 %), "participation in class activity" (n = 60, 37.5 %), and "lecturer as reference" (n = 66, 41.3 %). Lack of advanced preparation or reading before attending the class session would likely cause the students to spend most of the time in the class taking notes without paying attention to the lecture delivered, which could lead to losing focus in the class.

The misconception on some topics in organic chemistry study has always been a problem to many students. Frequent discussion and consultation with the lecturers therefore, is very important to solve this problem. However, most of the respondents revealed that they rarely refer to their lecturer during their study. This unfavourable study attitude could generate accumulation of misconceptions during the study, particularly for passive students who will be prone to develop misconception on the topics.

Table 8*Responses of Respondents to the Scale Items (n = 160)*

Simplified Statements	Likert Scale for Frequency, n (%)				
	Never (1)	Rarely (2)	Sometimes (3)	Very Often (4)	Always (5)
Effort:					
Organic Chemistry I	1 (0.6)	13 (8.1)	78 (48.8)	51 (31.9)	17 (10.6)
Organic Chemistry II	1 (0.6)	9 (5.6)	64 (40.0)	60 (37.5)	26 (16.3)
Persistence	1 (0.6)	10 (6.3)	56 (35.0)	63 (39.4)	30 (18.8)
Pre-class:					
Preparedness	35 (21.9)	67 (41.9)	47 (29.4)	9 (5.6)	2 (1.3)
Planned study time	11 (6.9)	28 (17.5)	78 (48.8)	30 (18.8)	13 (8.1)
Study as planned	18 (11.3)	34 (21.3)	89 (55.6)	17 (10.6)	2 (1.3)
Participation in class activity	8 (5.0)	60 (37.5)	57 (35.6)	24 (15.0)	11 (6.9)
Reference:					
Lecturer	32 (20.0)	66 (41.3)	37 (23.1)	12 (7.5)	13 (8.1)
Internet	2 (1.3)	10 (6.3)	30 (18.8)	64 (40.0)	54 (33.8)
Study method:					
Self-study	8 (5.0)	10 (6.3)	52 (32.5)	59 (36.9)	31 (19.4)
Memorisation of facts	5 (3.1)	11 (6.9)	44 (27.5)	71 (44.4)	29 (18.1)
Solve problem by self	2 (1.3)	7 (4.4)	52 (32.5)	68 (42.5)	31 (19.4)
Group-study	9 (5.6)	34 (21.3)	71 (44.4)	32 (20.0)	14 (8.8)
Post-class:					
Revision	1 (0.6)	9 (5.6)	48 (30.0)	59 (36.9)	43 (26.9)
Re-attempt problem	4 (2.5)	15 (9.4)	60 (37.5)	50 (31.3)	31 (19.4)
Submit assignments on time	2 (1.3)	1 (0.6)	11 (6.9)	44 (27.5)	102 (63.8)
Set target marks for:					
Examination	9 (5.6)	18 (11.3)	34 (21.3)	61 (38.1)	38 (23.8)
Assignments	11 (6.9)	30 (18.8)	54 (33.8)	40 (25.0)	25 (15.6)
Determined to reach target	2 (1.3)	12 (7.5)	56 (35.0)	64 (40.0)	26 (16.3)
Interest in study	6 (3.8)	10 (6.3)	71 (44.4)	46 (28.8)	27 (16.9)

Table 8*Continued*

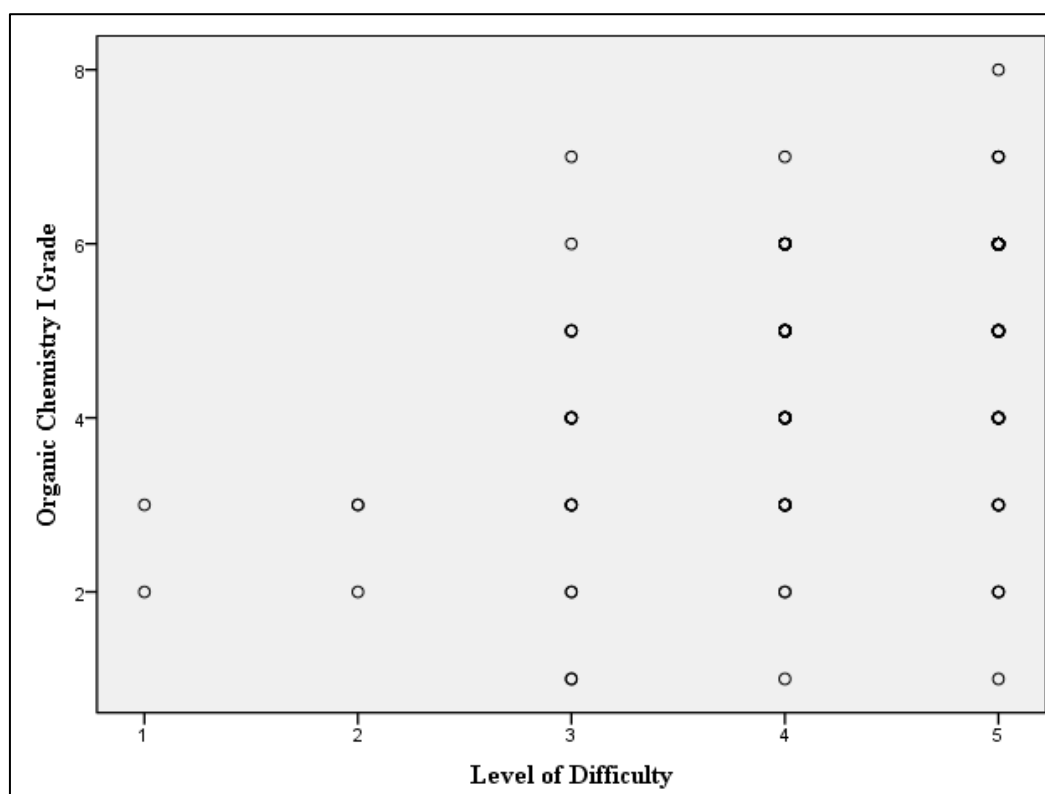
Simplified Statements	Likert Scale for Frequency, n (%)				
	Never (1)	Rarely (2)	Sometimes (3)	Very Often (4)	Always (5)
Relation with theory:					
Laboratory session	3 (1.9)	38 (23.8)	48 (30.0)	48 (30.0)	23 (14.4)
Projects	1 (0.6)	7 (4.4)	31 (19.4)	67 (41.9)	54 (33.8)
Marks of these are important:					
Laboratory reports	1 (0.6)	1 (0.6)	23 (14.4)	66 (41.3)	69 (43.1)
Projects	1 (0.6)	3 (1.9)	17 (10.6)	52 (32.5)	87 (54.4)

Correlation of Perception on the Difficulty in Learning Organic Chemistry with the Grade Obtained

The determination of correlations between difficulty levels perceived by respondents in studying organic chemistry with the grades obtained in both Organic Chemistry I and II courses were done in three steps. First, scatter plot between difficulty levels of organic chemistry as perceived by respondents with grades of Organic Chemistry I was plotted (Figure 15). There was no detectable pattern of difficulty level and organic chemistry I grade as shown in the Figure 15.

Figure 15

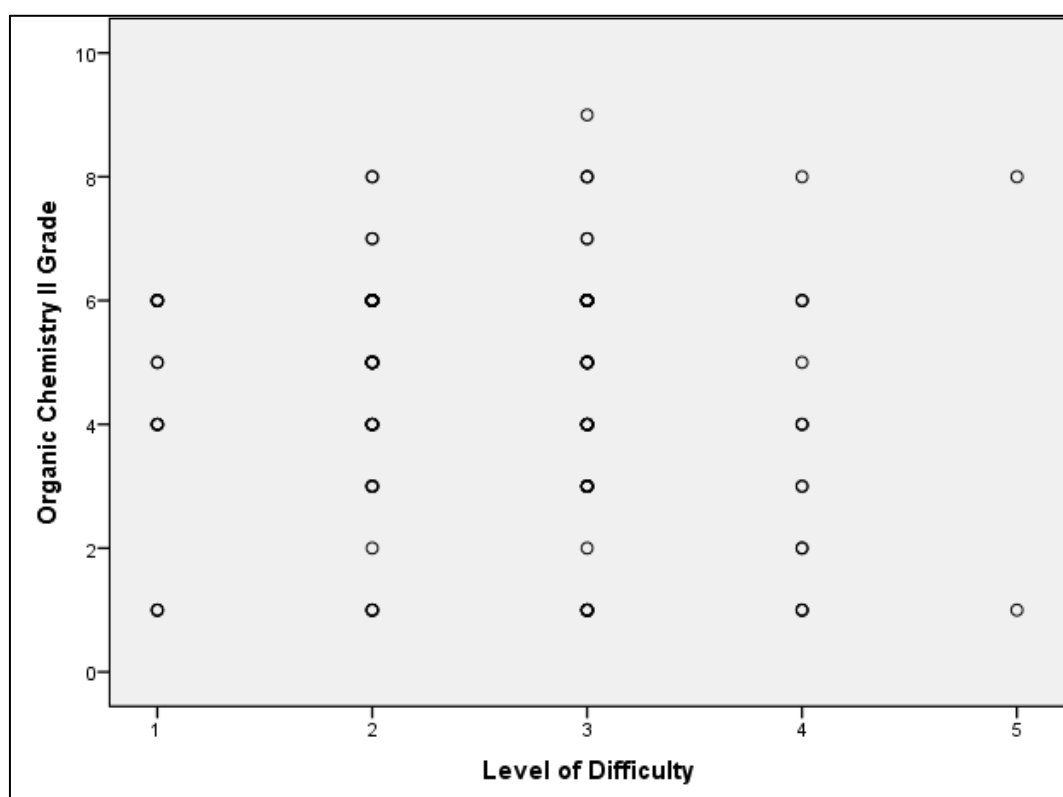
Scatterplot of Difficulty Level in Learning Organic Chemistry with Grade of Organic Chemistry I (n = 160)



The second step was calculation of Spearman rank-order correlation coefficient (Spearman rho, r_s) to statistically measure the strength of association between these two variables; difficulty level and organic chemistry I grade. Following the Spearman correlation coefficient calculation, the p-value was also determined. Similar statistical analysis was conducted to determine the association of difficulties levels of organic chemistry perceived by respondents with Organic Chemistry II grades (Figure 16).

Figure 16

Scatterplot of Difficulty Level in Learning Organic Chemistry with Grade of Organic Chemistry II (n = 160)



The Spearman correlation (Table 9) indicates that there is a significant positive association between level of difficulty perceived by respondents and Organic Chemistry I ($r_s = 0.413^{**}$, $p < 0.01$) and II ($r_s = 0.436^{**}$, $p < 0.01$) grades. The difference of the r_s value denotes the strength of association between the variables, where higher value shows stronger association. Both r_s values are in the range of 0.40-0.69, indicating that the perception on the difficulty in studying and understanding of organic chemistry study moderately affect the grades obtained by the students.

Table 9

Summary of Spearman Correlation Coefficient and p-value (n = 160)

Level of Difficulty	Correlation Coefficient, r_s	p-value
vs Organic Chemistry I grade	0.413 ^{**}	p < 0.01
vs Organic Chemistry II grade	0.436 ^{**}	p < 0.01

Note. Correlation is significant at the 0.01 level (2-tailed)

Correlation of Study Attitude with the Grades Obtained in Organic Chemistry I and II

The scatterplot of study attitude with the grade of Organic Chemistry I (Figure 17) and Organic Chemistry II (Figure 18) subjects showed no detectable pattern, indicating the correlation between these two variables could not be determined.

Figure 17

Scatterplot of Study Attitude with Grade of Organic Chemistry I (n = 160)

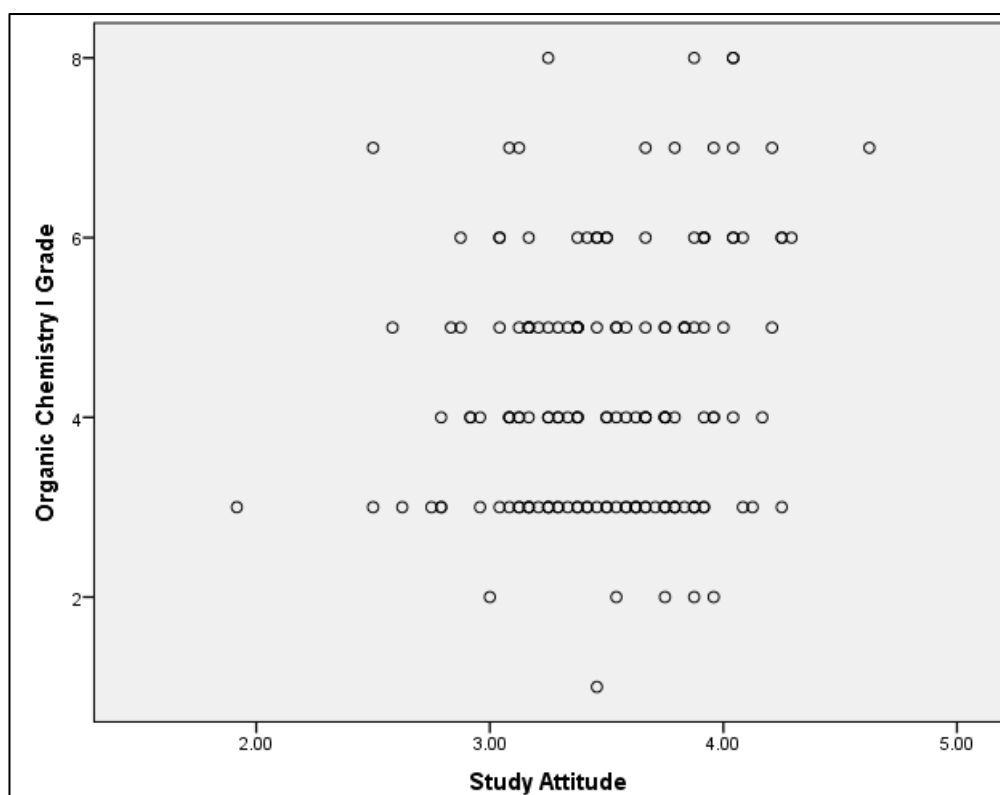
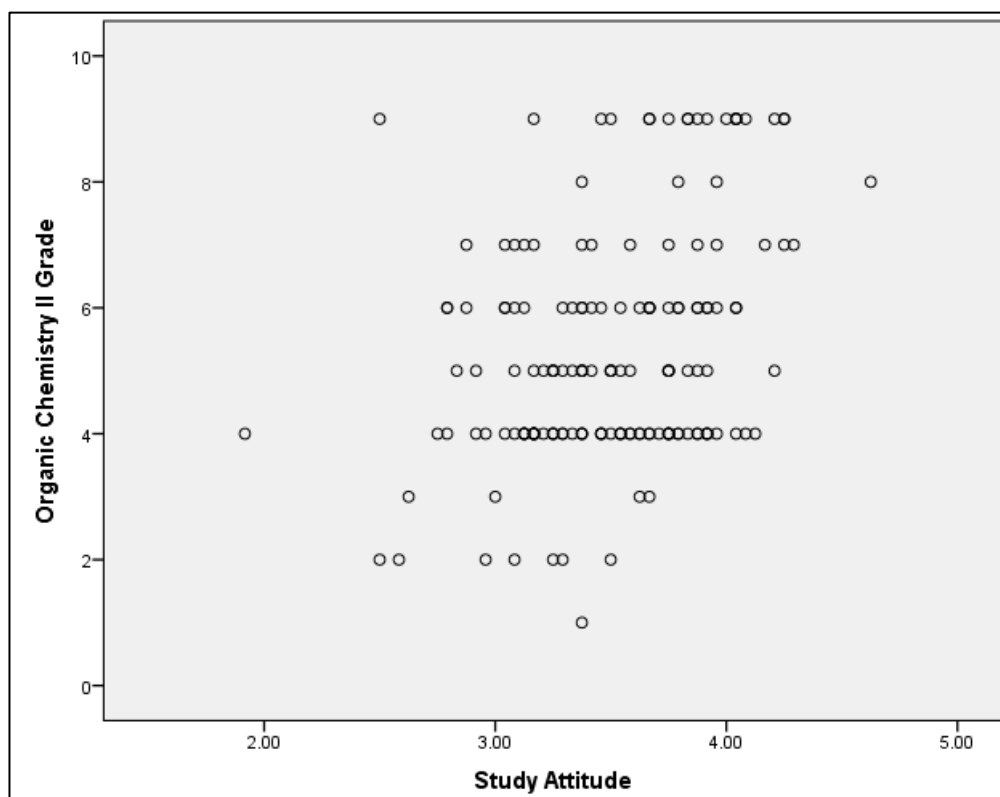


Figure 18Scatterplot of Study Attitude with Grade of Organic Chemistry II ($n = 160$)

Analysis of Spearman correlation coefficient between study attitude with the Organic Chemistry I and II grades is summarised as in Table 10. The Spearman correlation indicates that the study attitude with the grade obtained for organic chemistry I was very weakly correlated ($r_s = 0.140$) or statistically not significant ($p = 1.00$), which means that the study attitude does not affect the grade obtained for Organic Chemistry I subject. However, the Spearman correlation for the relation of study attitude with Organic Chemistry II grade shows that there was a significant positive association between these variables ($r_s = 0.330^{**}$, $p < 0.01$), although the strength of the correlation was found to be weak (0.20 to 0.39). The quality of the study attitude, indicated by higher mean score attitudinal scale gave better grades for Organic Chemistry II subject.

Table 10Summary of Spearman Correlation Coefficient and p-value ($n = 160$)

Study Attitude	Correlation Coefficient, r_s	p -value
vs Organic Chemistry I grade	0.140	1.000
vs Organic Chemistry II grade	0.330 ^{**}	$p < 0.01$

Note. Correlation is significant at the 0.01 level (2-tailed)

Generally, both organic chemistry subjects (I and II) require the students' ability in critical thinking skill rather than memorisation. The difference between Organic Chemistry I and II subjects is that Organic Chemistry I focus more on understanding of the basic concepts in organic chemistry. It is an introductory course for more complex organic chemistry-related subjects such as Organic Chemistry II, Organic Synthesis and Physical Organic Chemistry. For

example, stereochemistry, which is one of the topics covered in organic chemistry study requires students' strong understanding in spatial visualisation, pattern recognition, and critical skills (Lynch & Trujillo, 2011). Therefore, students' firm understanding on the basic concept of organic chemistry is essential to achieve good grades.

Organic Chemistry II subject focuses more on applying the knowledge and understanding of the areas covered in Organic Chemistry I. This subject relies more on problem solving skills in identifying, organising and planning of organic reactions. The mastery in these three aspects of organic chemistry study can be achieved by continuous and systematic effort in practicing the related problem solving. Students who managed to grasp the right pattern in planning the organic reaction are likely to excel in this subject.

CONCLUSION

This study gives a general view on the difficulties in organic chemistry subject faced by undergraduate students at Department of Chemistry, Kulliyah of Science. To this date, there is no study found on comparison of difficulty levels perceived by students on the five areas of chemistry as well as the factors that contribute to the non-performance of students in organic chemistry in Malaysia. Identification of the perceived difficult areas of the subject among students, and investigation on how their grades in these subjects (Organic Chemistry I and II) affect the perceptions on the difficulties in learning organic chemistry and their study attitude. Stereochemistry, determination of reaction type, construction of the reaction mechanisms, and characterising the organic reactions based on the given condition were the top-ranked difficult areas perceived by undergraduate students to comprehend during their organic chemistry study. Students' positive perception on the courses will likely give better grades. The result of this study revealed that the quality of the study attitude of the students throughout their organic chemistry study does not affect the grade obtained for Organic Chemistry I subject. However, better quality of study attitude gave better grade in Organic Chemistry II. This study provides important insights of the difficulties faced by the students so that preventive solutions can be outlined and carried out for the betterment of the students' academic achievement in the future. Further study can be conducted to identify external factors such as the environment of the classroom or interest to learn. Analysis of the students' answers and scores through the implementation of the quizzes on each of the topics in organic chemistry study will also give more detailed view on their understanding of that area.

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