香港教育大學
The Education University of Hong Kong

Capstone Project Research Proposal

Submitted by

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Enhance students' Self-directed Learning through Action Learning

submitted to The Education University of Hong Kong

Enhance students' self-directed learning through action learning

1. Introduction

1.1 Current Issues and Problems of Mathematics lesson in Hong Kong

All primary and secondary schools of Hong Kong have begun homeschooling in February due to the outbreak of COVID-19. Most of the teachers needed to adapt online learning mode, such as synchronous teaching by Zoom or posted videos through Google classroom for students to watch. A survey conducted by the Youth IDEA between March and May 2020, interviewed 1,039 students aged 12 to 19, more than 40% (42.3%) of the students surveyed agree that E-learning will reduce the depth of teaching. Therefore, it is time to consider the students' self directed learning rather than teacher oriented learning mode.

In the Quality Assurance Inspection Report[1], 12 secondary schools were covered, it pointed out the math class teaching was often teacher-centred with insufficient opportunities for interaction among pupils. The questioning skills of some teachers need improvement. They seldom used open questions to guide pupils' thinking. For most teachers, the skills of applying IT in teaching need to be developed.' It pointed out the learning mode in the Mathematics classroom were teacher-oriented, and students lack of opportunities to learn by themselves and learn self-directed.

1.2 Research methods of the Project

This project will be conducted in a secondary school, focusing on examining how to promote secondary students' self-directed learning through action learning in the Mathematics lessons. Therefore, interviews will be conducted with school teachers and students. Before and after every learning topic, pre-assessment and post-assessment will be conducted. It is hoped that 3 mathematics teachers will accept my interviews and 60 students will accept my questionnaires, 30 of them will come from the junior high school and 30 of them will come from the senior high school.

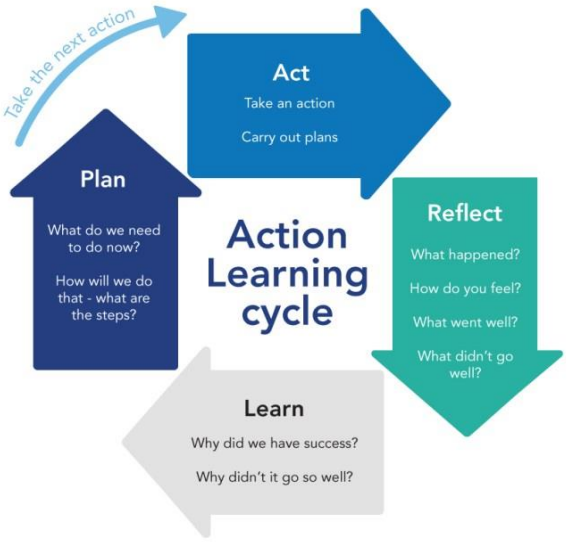
[1] 2000/2001 Quality Assurance Inspection Annual Reports of the Education Bureau

2.Background

2.1 What is Action Learning

Action learning is an educational process where the participants study their own actions and experiences to improve performance(Welskop, 2013). According to the survey[2] results for the 2000/01 school year, the average teacher-student ratio in each secondary school's class is 1:37.3, which means that every teacher needs to monitor the learning process of 37 students, or even more. It implies that teachers may not be able to monitor the learning progress of every student, and design the course schedule based on the student's personal need. Without the supervision from the teacher, relying on the one-off examination to assess the performance of students couldn't achieve maximum efficiency. Therefore, it is crucial for students to master the skills which can help them study their own performance to improve.

There are four major steps in action learning cycle[3], which are Act, Reflect, Learn and Plan.



Before the project, students should be informed about the process and steps of the Action learning cycle clearly, it would help them to have a better understanding. Since students know that they will need to reflect on their action and performance, they will start to focus more on and be aware of the experience during the lessons. Students may even jot down the key points to help reflect in the later part which helps the knowledge to stay fresh in their mind. In the next level, reflection requires students to think critically on performance of themselves or on the other peers.

[2] In the meeting of LEGCO QUESTION in 19 December 2001

[3] Adapted from Taylor, J., Marais, D. and Kaplan, A. (1997)

Reflection helps students review their work and how they performed in the progress, what they achieved and what had failed.

Reflecting doesn't mean students have learned anything from the experience. Making an effort to learn from the reflection is crucial, otherwise, students will probably forget the mistakes they made, and face a similar situation next time. Thinking about what was happening, the learning would be shallow, and deep learning would be considering what happens that leads to such circumstances, and how can students improve their performance.

Planning helps students link the past learning and the future performance. To have an actionable plan,we should identify and reflect on this key learning cycle and help students incorporate it into the next cycle.

2.2 What is Self-directed Learning

Self-directed learning may be viewed as a process of learning where individuals take the primary responsibility in the learning process, as well as a set of personal attributes or personal characteristics of the learner (Brockett & Hiemstra, 1991; Caffarella, 1993; Merriam, Caffarella, & Baumgartner, 2007). Self-directed learning is a tool that helps students identify their own learning needs, setting their own learning goals, choosing the most suited learning strategies and reflecting on their learning outcomes.

Self-directed learning has two significant characteristics: (a) it requires students to take personal responsibility for their own learning, and (b) the Self-directed learning process or teaching-learning transactions often involve interactions with the teacher as well as with other learners (Brockett & Hiemstra, 1991). The school teachers would not follow the students for their whole life. If we would like our students to meet the expectations from the society, which hopes them as life-long learners, we would better help our students to prepare for independent learning. The attitude of self-directed learning encourages students to be responsible for their own learning.

There are 5 key components in Self-directed learning[4], which are

a) Goal setting

[4] Black & William, 1998; Brockett, 2002; Candy, 1991; Clarke, 2001; Garrison, 1997; Guglielmino, 1977; NCREL, 2003

Students set their own learning goals and learning objectives. Such as what are the targets of the new school academic year, or what they would like to achieve after every topic.

b) Self-planning

Students plan and regulate for the detailed timetable for learning based on their own needs. Such as designing the timetable for their revision before the exam or after school.

c) Self-monitoring

This stage refers to students managing their time by themselves and adjusting their own learning way according to their personal learning progress and need. Such as students will design the timetable based on their own learning advantages and putting more effort on the disadvantages.

d) Self-evaluation

Students are sensitive to the assessment criteria and they would evaluate their own performance according to the relevant criteria.

e) Revision

This is the last but important stage that students will revise and review their work according to the teachers' and peers' feedback. And students will need to reflect on their own performance and learn from the experience to apply in a new context.

If students could master self-directed learning, students will be more responsible for their personal growth, which helps students recognize their own strengths and weaknesses, and helps them in their future life planning. However, self-directed learning doesn't mean students working alone, exclude teachers and peers, it is more important for students to take personal responsibility.

2.3 Inquiring School Background

Since the school teacher may not have time to follow up every students' learning problem and the lesson should focus on the majority. In teacher-centered learning, students are passive learners, they don't have a chance to change the learning pace in the lesson. Schools focus on teaching knowledge, but neglect to teach students self-learning skills, students are not sure about the weakness and strength of themselves.

To fix the problem of learning diversity, students need to monitor and reflect on their own learning. It can better suit the needs and abilities of students, students can review the wrong questions by watching the steps again and again. They can also adjust the speed based on their own needs. This could greatly improve learning and teaching effectiveness. Virtual learning environments fill the gap of learning diversity.

2.4 Expected outcome

The foremost expected outcome is students could attempt self-directed learning. By applying the diversified mode of assessment, students would have a pretest before the lesson, alternative assessment during the lessons and self-reflection after the lesson. These kinds of assessments encourage students to combine knowledge, skills and attitude to construct their own learning method. Even outside the classroom, students could try to learn and explore more by themselves.

Pre-test helps students to find the learning objectives and the key learning point. With comparison to the post-test, students could find out the weakness and strength on those parts, which is an independent learning process. Compared to the traditional learning method, which answers are often provided by the teachers, using GeoGebra to solve the problem is more flexible and gives space for students to choose different methods and stand on the other point of view to solve the problem. Students would have higher motivation to learn and be responsible for their own learning.

2.5 School background

The proposal is designed based on secondary school's math classes. Students are in Form 3 and 4, they have high learning motivation, and are willing to participate in the lesson. There are some excellent students and some unsatisfactory performance students in the class. There will be two classes in different forms taught by me and the block practice time will last for around 2 months. The proposed school would be a self-funded secondary school.

2.6 Limitation

The project base is not big enough, and there is no data from other schools, which means it may not be applicable to other secondary schools. And since there may be limited class size, there are no control groups to make comparisons.

3. Design of the project

According to the Education Breuer, schools and teachers should take care of students' learning diversity. Since every student is individual, they have different learning characteristics.We could see that there are three main points to improve students' performance to more successful results (Guskey, 2010). They are to identify problems immediately, providing feedback and further follow up. Accordingly, the design of this project will follow the ALPD Cycle, which was modified by Dr Ng Cheuk Wing, from the action learning cycle[5].

3.1 Experience

At this stage, the background of school would be inquired. I would like to study the background of students' learning, including the teaching materials and learning objectives of the original school. Since the teacher flexibly adjusts the teaching plan according to the needs of the students in individual classes, we should treat every class according to its own characteristics. Also, I will collect students' background information, including their interests, performing better and weaker topics.

The original learning activities will be observed as a basis for analysis. I would like to study the performance of students in class and homework to get to know more about their strengths and weaknesses. It would help me better understand the school based assessment and learning activities through a real life classroom. Therefore, class observation is needed before the planning.

Based on the study of the Education Bureau's documents[6], lessons are designed teacher-oriented and fail to fulfill the needs of individual students. Students are not active in learning, they rely on teachers to guide them and receive knowledge passively.

[5] Developed by Reg Revans in1940s.

[6] 2000/2001 Quality Assurance Inspection Annual Reports of the Education Bureau

3.2 Understanding

After experiencing the real life classroom, it will be followed by a selection of assessment methods. Teachers must select, adapt or design suitable teaching materials and assessment according to the different abilities of students. The original assessments are quizzes and exams only, which are both assessments of learning. The single testing method will lead to incomplete understanding of the student's learning ability by the teacher.

According to the original teacher, quizzes would be given to students after every chapter. But there is a lack of pretest and post-test, teachers and students could not make comparisons with the previous and after performance. Also, after every test and quiz, teachers will not analyze the strengths and weaknesses of the students' performance. In this case, there will be pre-test and post-test as one of the assessment and reflection of students would be added.

3.3 Planning

The project will also consider selecting and designing different class materials based on different levels of students. Such as allowing students of different abilities to take different examination papers. The advantage of using different examination papers is that it can provide an assessment of flexibility according to what each student has learned in each class and according to their specific abilities. The information obtained from the evaluation can also reflect the criteria for the performance of students and achieve the purpose of assessment for learning.

Homeworks that are too simple or too deep are unable to inspire or maintain the learning motivation of students to learn. Relatively simple and basic tasks should be given to the lower abilities students, so as to improve the students' sense of satisfaction and strengthen their self-confidence. On the other hand, students with higher abilities can do some more challenging tasks to cultivate and maintain their interest in learning mathematics.

Formative assessment was taken as part of the planning. Formative assessment was more focused on the collection of evidence of students' learning and providing feedback to enhance learning. (Sadler, 1989). The benefits of formative assessment are a lot, and we could use it as a tool to provide information about the learning process that teachers can use for instructional decisions. Taking some under-satisfaction questions as an example, teachers can further explain in the lesson and give more clarification about the concept.

The other importance of formative assessment is that it could motivate students in their studies. More than just providing the answer and just telling students whether they are correct or not, the feedback should focus on "What, how and why" of the problem. Through self-assessment, students have gained experience in improving their own performance. Taking the reflection from students themselves helps them recognise the standards they are aiming for, that leads them to the next step. According to Bloom, one of the reasons that one to one tutoring is so effective, is that the tutor is able to identify errors in the student's work immediately and then to provide clarification, and further follow-up if necessary (Guskey, 2010).

3.4 Action

When implementing the planning, put into practice step by step are crucial elements for students to learn self-directed learning as an example and through action learning. Throughout the process, there would be different assessments in the project, including Assessment for Learning, Assessment as Learning and Assessment of Learning. At the same time, quizzes and assignments provide evidence to record the performance of students. In the later part, those evidence would help students measure their learning outcomes and make summative decisions.

Experiential learning[7] is another key learning theory in the project. Such as Locus is a vague and deep learning concept that should connect students' life and the mathematics concept. The learning and teaching process bring students from theory to practice. Students are required to finish a GeoGebra work in the lesson to ensure they know the learning objectives. The teachers share learning objectives with students to guarantee students achieve the ability to handle the problem solving questions and formula of locus. During the process of constructing the concept of Locus and applying it on the App, helps students to try it out and see what happens, that they would view from more perspectives.

The nature of experiential learning is being 'meaningfulness' to the learners, and that's subjective to every different individual(Moon, 1987,P18). The cycle of experiential learning includes "Thinking, acting, experiencing and reflecting". Every step is crucial during the process. Based on the model of Kolb's(1984), we could see every student is having different feelings about every topic. To connect the meaningfulness of the abstract concept to a concrete

[7] Developed by David Kolb in 1984

experience should through active experimentation and reflective observation. Students should recognize the strength and weakness of themselves to achieve self-directed learning.

The problem of teachers cannot follow up every student's case. I chose the virtual learning system to create online quizzes that can improve students' learning. Teachers can also upload answers shown to students when they finish, students can choose to review the wrong part and do correction. The performance tracking system helps teachers and students to analyze the performance. Students can monitor their study progress by themselves.

3.5 Evaluation

The importance of evaluation is allowing students to learn from their performance. Helping students develop their abilities to self-monitor are not attain the highest level in one step. We need to help them and guide them through the procedure. Therefore, showing them how to evaluate their accomplishment through their own work, learn from their mistakes and analyze how could lead to a better performance. The most important is to encourage students to try out their own way to achieve self-directed learning.

Evaluation helps to emphasize the learning process, not the result anymore. Peer assessment on the lessons will give students an opportunity to correct themselves through correcting others. And the self-assessment after the lesson will give a chance for students to reflect on their own performance and precision in understand their own abilities in various aspects.

4. Procedures

There are three major parts in the project. Before the class, students are required to take a pre-test on understanding their pre-knowledge of the topic. Students are also required to take a questionnaire[8] in collecting their opinion of self-directed learning. After the test, which is followed by the lesson, students would be separated into different groups and they would use tablets to work in classes and fill in the guided worksheet.

During the lessons, peer-assessment will be conducted, students would need to correct and analyze other students' work as a practise on their own assessment. During the process, a detailed marking scheme will be provided for students to help them understand the standards expectations.

[8] See Appendix 1

After the lesson, students need to complete the homework which is considered as the post-test at home. The Learning Management System on Virtual Learning Environment system could manage every student's data and allow teachers to make comparisons on every question. Teachers could adjust the learning progress according to the result. Besides, each student would have a grade book. After the chapter, they will complete the self-reflection form on the grade book to check the strengths and those should improve parts.

The project will last for around 6 teaching cycles and these require 4 to 5 iPads for students to use online materials in the class. The project will also interview[9] 1 teacher and 1 coordinator about their opinion of self-directed learning.

5. Evaluation

During the learning process, the project aims to develop students' abilities to self-monitor, self-assess, self-evaluate, and self-correct. But there should be some assessment to monitor the process, and their performance changing should be more than just academic. Since the project is using multiple ways to explore the research problem. Therefore, the mixed research method will be adopted.

This project will adopt a mixed research method that combines quantitative and qualitative research. Quantitative research is mainly conducted to students in the form of questionnaires and allows the project to describe the result from an etic perspective. Also, the analysis of pre-test and post-test are the other forms of quantitative research to help analyze the performance and understanding of students in the project.

Qualitative research focuses on some students picked from the class randomly and the teachers in school. During the teaching method, there will be an interview with the teachers who observed the lesson and students in class. The interview will focus on what are their feelings about using GeoGebra in the classroom, and the confidence and motivation of learning compared to traditional learning methods. The interview mainly focuses on the non-academic area of students.

6. Conclusion

9 The interview questions see in Appendix 2

By adopting the ALPD cycle, it is hoped that it helps students achieve self-directed learning through action learning.With the continuous development of a socialized and technological society, if we want our next generation to maintain or enhance their competitiveness, the school education system must be continuously improved. Teaching the students knowledge is not enough, educators should step forward to let students learn to reflect on their own performance and learn from it. Teachers must also understand that mastering the skills of self-directed learning is not easy. Providing enough guidance and practices through the process will help students better and easier learn the skills.

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8. Appendix

A.Pre-assessment question for students

（4: Strongly agree, 3: Partly agree, 2: Partly disagree 1: Disagree 0: Totally Disagree）

1. Before the lesson, I will preview the content of the lesson.
2. I will do exercise apart from the homework given by my teacher.
3. I am clear about my weaknesses and strengths in every topic.
4. I will do revision after daily learning.
5. I will do revision before the exam.
6. I will do revision based on the examination area.
7. I will do revision based on my weaknesses.
8. I will do revision by myself.
9. I will do revision with my classmates.
10. I will help my friends when they have some unsolved problems.
11. I will ask help from my teacher if I cannot solve the questions.
12. I will have extra tutorial classes when close to the exams.
13. I am confident about how to get a better grade.
14. I can get more exercise easily if I want to.
15. I know how to correct the mistakes of my homework.
16. I know how to do better in the next exams.
17. I will reflect on my own performance after every topic.
18. I will find a method to learn better next time.
19. I will summarize the strengths and weaknesses of myself.
20. I will study by myself if I can.

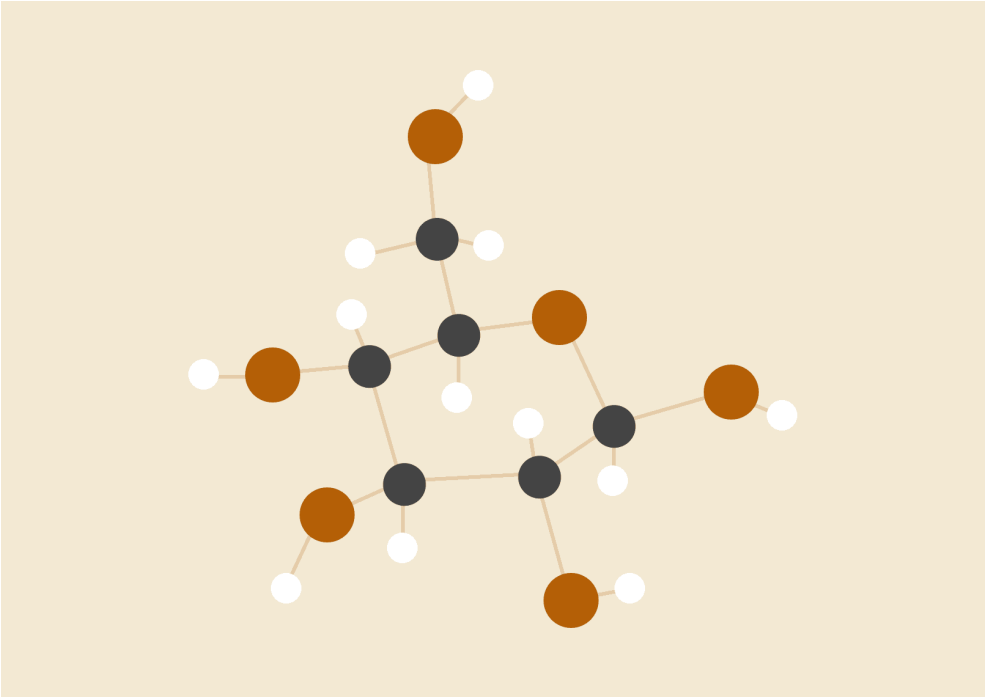
B. Questions for teachers

1. Do you think the students have strong enough learning motivations? Why or why not?
2. Do you think action learning will help to improve the learning effectiveness of students? Why or why not?
3. Do you think self-directed learning could improve students' learning motivation? Why or why not?
4. Do you think self-directed learning could solve the learning diversity in the classes? Why or why not?
5. Do you think self-directed learning should be promoted in school?

CAPSTONE PROJECT

Teaching Package

Enhance students' Self-directed Learning through Action Learning



WONG Lee

Professor: Dr. Ng Cheuk Wing

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CONTENT

1. Introduction

1.1 Design of the project

The design of this project will follow the structure of the Aspiring Leader Development Program(ALDP) that was modified by Dr. Ng. The learning cycle focuses on what students think and concludes from the experience they have. After that, they plan the next set and perform better. This project tries to examine the most effective teaching and learning method to empower the students to develop their own learning styles. The project also combined the design of scaffolding(Wood, Bruner & Ross, 1976), providing support for students to learn in various methods. Choosing the modeling scaffolding as the main teaching method, give a structure to think and guide the students to reflect. The purpose of applying to scaffold is to inspire students to develop or create a learning habit, lower the difficulty of habits, the ultimate goal is to assist students to develop from the zone of proximal development to the zone of work independently without help.

The preparation of the project is based on the learning difficulties of the students and diagnosing the learning focus to set out suitable work. Round the learning topics to create experiments, students explore independently. At the beginning of the experiment, the teacher will give some instructions, and the students will complete and analyze the experiment by themselves.

Date	**Procedure**
Sep 2021	Planning of the project and design course materials
18th Oct 2021	Pretest
18th Oct to 26th Nov	Implement project and collect data
26th Nov 2021	Post test
Dec 2021	Organize and analyze data

1.2 Teaching Objectives

After the project, students should be able to have an insight on their own identity, behaviors, and performance. Strengthening the self-development of students, preparing their identity as lifelong learners, and promoting self-directed learning as the goal of students to achieve. The design principle of the project encourages students to be independent learners and take responsibility for their own learning. This project focuses on examining the methods of promoting secondary students' self-directed learning through action learning in Mathematics lessons.

It is expected that the students will enhance their performance in the cognitive domain, affective domain, and psychomotor domain. They are expected to reflect on their own performance and plan the learning process according to the reflection. Students are required to take up the responsibility of learning in the affective domain of the project.

Design Checklist

No.	Teaching Objectives	Learning content	Activities	Expected Learning Outcomes
1	Develop the concept of the cylinder from the circle	Volume of cylinder	Using coins to make a cylinder and invite students to find the answer	Students can apply the concept of the cylinder and convert it into the formula.
2	Apply the formula of cone and cylinder appropriately	Volume of Cone and cylinder	Reflection sheet	Learners learn from the strength and weakness of their learning
3	Relate the formula of circle and sphere	Surface Area of sphere	Finding the formula of the surface area of a sphere using an orange	Draw a conclusion from the experiment and apply in exercise

1.3 Action Learning

Action learning is an educational process where the participants study their own actions and experiences to improve performance(Welskop, 2013). Action learning is learning progress from the idea of development and improvement from an individual, it is based on the relationship between reflection and action. Reflection helps students to learn from the experience and take future action clearly. R. W. Revans create the term ‘action learning’ as a development, through involvement in some complex and challenging tasks, to improve the observable behavior in the aspect. In this project, I designed some class activities and self-reflection forms to evaluate the effectiveness of action learning. Before and after every learning topic, pre-assessment and post-assessment will be conducted.

1.4 Self-directed learning

Self-directed learning has 5 key components, which are goal setting, self-planning, self-monitoring, self-evaluation, and revision(Brockett & Hiemstra, 1991; Caffarella, 1993; Merriam, Caffarella, & Baumgartner, 2007). Self-directed learning may be viewed as a process of learning where individuals take the primary responsibility in the learning process(Brockett & Hiemstra, 1991; Caffarella, 1993; Merriam, Caffarella, & Baumgartner, 2007). Such as students can monitor their learning progress by themselves.

Self-directed learning helps students to maintain and violate their efforts, increases learning motivation. Motivation helps to persist longer, learn more deeply and perform better. Therefore, a mixed research method, including quantitative and qualitative research methods is carried out in order to access the validity of action learning. The benefit of self-directed learning promote learners to have more learning motivation and be more effective learner.

2. Lesson Plan

2.1 Volume of cylinder

教學目標

知識 -學生能聯繫面積和體積的關係(4, 5) -學生能辨識圓柱體的組成部分：半徑、底、高(5, 9) -學生能分析應用題題意，正確透過體積逆向求高(6, 9) 情意 -學生能應用圓柱體體積的概念適當運用於日常生活中(3, 7) -學生能透過自評表建立自我評核能力(6, 8) 技能 -學生能通過繪圖分辨圓柱體的組成部分(4, 5) -學生能運用公式求圓柱體體積(6) -學生能運用公式和題目資料解答應用題(6, 7, 9)	九種共同能力： 1. 協作能力 2. 溝通能力 3. 創造力 4. 批判能力 5. 運用資訊科技能力 6. 運算能力 7. 解決問題能力 8. 自我管理能力 9. 研習能力
年級:中三 課題: 面積與體積（圓柱體體積） 節數:一節(40分鐘) 學生背景: 大部分學生能力中等。整體學習氣氛良好,且樂意回答問題。	
前置知識： 1. 學生能運用公式求圓的面積 2. 學生能處理與圓相關的應用題 教學資源: 1. 前測題目 2. 工作紙 3. iPad 4. 自評表	

教學過程

時間(分鐘)	內容	學生活動	目的	資源
10:05-10:10 5分鐘	前測	-完成前測題目	-檢視已有知識	-前測工作紙
10:10-10:15 5分鐘	-問學生一元硬幣的形狀 -用一元硬幣引入圓面積 -填寫公式 -試做1a	-回答問題 -寫公式 -跟隨老師解題	-重溫圓面積公式 -直接代公式求圓面積	工作紙概念部分 一元硬幣
10:15-10:18 3分鐘	-學生試做1b,1c -計算一元硬幣面積 -講解答案	-嘗試解題 -對答案	-重溫圓面積公式 -用直徑求出圓面積	工作紙1b,1c
10:18-10:21 3分鐘	-將一元硬幣搭起，展示一個圓柱，問學生怎樣得到圓柱體積 -在黑板上畫出圓柱，要求學生將上底的圓畫上斜線	-回答問題 -跟隨老師解題 -畫面 -填寫圓柱公式	-建立圓柱概念 -帶出圓柱體積公式	工作紙概念部分 十個一元硬幣
10:21-10:26 5分鐘	老師示範1a，2a	-跟隨老師解題 -回答問題	-讓學生熟悉格式 -示範用半徑和高找出圓柱體積 -示範用直徑和高找出圓柱體積	工作紙1a2a
10:26-10:30 4分鐘	學生試做1b，2b	-做練習	-用半徑和高找出圓柱體積 -學生用直徑和高找出圓柱體積	工作紙1b2b
10:30-10:33 3分鐘	示範4a （已知圓體積求高）	-跟隨老師解題 -回答問題	學會用公式逆向求高	工作紙4a
10:33-10:37 4分鐘	學生試做4b 講解答案	-做練習		工作紙4b
總結 10:37-10:40 3分鐘	-總結重點 -交代家課	-聆聽 -記筆記 -抄下家課	總結課堂重點	自評表

2.2 Volume of cone and pyramid

教學目標

知識 -學生能界定圓柱體和圓錐體的關係(4) -學生能辨識圓柱體的組成部分：斜高、半徑、底、高(5, 9) -學生能運用圓錐題體積公式解問題(6, 7) -學生能分析應用題題意，正確透過體積逆向求高(4, 6, 7) 情意 -學生能應用圓錐體體積的概念適當運用於日常生活中(3, 9) -學生能建立及欣賞數學的探究精神(1, 2, 9) -學生能透過自評表建立自我評核能力(4, 8) 技能 -學生能運用畢氏定理的概念解答題目(5, 7) -學生能運用高階思維利用相似三角形求高(5, 7, 9) -學生能運用公式和題目資料解答應用題(6, 7, 9)	九種共同能力： 1. 協作能力 2. 溝通能力 3. 創造力 4. 批判能力 5. 運用資訊科技能力 6. 運算能力 7. 解決問題能力 8. 自我管理能力 9. 研習能力
年級:中三 課題: 面積與體積 （角錐和平截頭體） 節數:兩節(80分鐘) 學生背景: 大部分學生能力中等。整體學習氣氛良好，且樂意回答問題。	
前置知識： 1. 適當運用圓柱體體積公式 2. 處理與圓體積相關的應用題 教學資源: 5. 前測題目 6. 工作紙 7. iPad 8. 自評表	

教學過程

時間(分鐘)	內容	學生活動	目的	資源
前測（**20 mins**）				
9:25-9:35 10 min	前測	做題目	-重溫圓柱體體積	前測工作紙
9:35-9:45 10 min	講解前測答案	對答案	-擬清概念 -改正	前測工作紙
重溫圓柱，帶出圓錐體積公式（15min）				
9:45-9:47 2min	問學生圓柱體體積公式	回答問題	重溫圓柱體體積	黑板寫公式
9:47-9:50 3min	用短片帶出圓錐體與圓柱體的關係	-回答問題 -寫公式 -跟隨老師解題	帶出圓錐體體積公式	iPad+黑板
9:50-9:52 2min	-填寫公式 -示範1	-回答問題 -寫公式 -跟隨老師解題	-直接代公式求圓面積	工作紙1
9:52-10:02 10min	-學生試做2-4 -計算圓錐題體積	-嘗試解題	-用半徑求出圓錐體積 -用直徑求出圓錐體積	工作紙2-4
10:02-10:05 3min	-講解答案	-對答案	-判斷自己能否正確套用公式	工作紙2-4
（升級）已知體積求高 + 斜邊求高 + 相似三角形求高（45 min）				
10:05-10:10 10min	-已知體積和直徑，求高 -設未知數 -先求半徑	-回答問題 -跟隨老師解題	運用錐體體積公式求未知數	P5.33，# 4
10:10-10:15 5min	-學會分斜邊，底半徑，高 -示範例5.10	-跟隨老師解題 -回答問題	-運用畢式定理求高	gmath-錐體截面 P5.23 #例5.10

10:15-10:20 5min	學生試做5.10	-做練習	-用半徑和高找出圓柱體積 -學生用直徑和高找出圓柱體積	P5.23 # 試做5.10
10:20-10:25 5min	老師講解答案	-修正答案 -回答問題	-學生檢視自己能否做到	
10:25-10:30 5min	介紹平截頭體	聽	學會用 大圓錐體積-小圓錐體積	書P5.25
10:30-10:40 10min	講例5.12 試做5.12	聽	利用公式解題	書P5.26 #例5.12+試做5.12
10:40-10:45 5min	-總結重點 -交代家課	-聆聽 -記筆記 -抄下家課	總結課堂重點	自評表

2.3 Volume and Surface area of sphere

教學目標

知識 -學生能界定球體體積和圓錐體體積的關係(4, 9) -學生能分辨球體體積和表面面積的分別(5) -學生能利用球體公式求球體體積(6, 7) 情意 -學生能透過課堂活動增加對數學的探究精神(1, 2, 3) -學生能透過自評表建立自我評核能力(8, 9) -學生能將球體體積的概念運用於日常生活中(3, 5) 技能 -學生能運用公式求球體體積(6) -學生能運用公式和題目資料解答應用題(5, 6, 7) -學生能利用方程求球體半徑(4, 6, 9)	九種共同能力: 1. 協作能力 2. 溝通能力 3. 創造力 4. 批判能力 5. 運用資訊科技能力 6. 運算能力 7. 解決問題能力 8. 自我管理能力 9. 研習能力
年級:中三 課題: 面積與體積(球體體積) 節數一節(40分鐘) 學生背景: 大部分學生能力中等。整體學習氣氛良好，且樂意回答問題。	
前置知識: 1. 分辨圓面積和球體特性 2. 適當運用圓柱體體積公式 3. 圓柱體體積應用題的相關知識 教學資源: 1. 前測題目 2. 工作紙 3. iPad 4. 自評表	

教學過程

時間(分鐘)	內容	學生活動	目的	資源	備註
引入(**3 mins**)					
11:00-11:03 3 mins	-用生活化例子引入球體 (使用橙子作為例子，橙皮:表面面積，橙肉:體積)	-回答問題	1. 令學生明白課堂目的 2. 令學生思考球體公式	iPad	展示影片
證明球體體積公式(**7 mins**)					
11:03-11:10 7 mins	-用圓錐體體積x2=球體體積 -帶出球體體積	-寫上半徑和直徑 -推導出球體體積公式	-重溫圓錐題體積 -擬清概念	工作紙	將橙子榨汁，剛好可以填滿兩個杯
應用球體體積公式(18mins)					
11:10-11:13 3 mins	-示範1a，2a	跟隨老師完成1a	-熟悉格式 -用公式計算答案	工作紙	介紹立方(三次)點樣按計算機
11:13-11:20 7 mins	-學生試做1b，2b -講解答案	-試做1b，2b	-嘗試自己運用公式求答案	工作紙	
11:20-11:23 3 mins	-示範3a	跟隨老師完成3a	-計算半球體體積	工作紙	要按(pie)
11:23-11:28 5 mins	-學生試做3b -講解答案	-試做3b	-嘗試自己運用公式求答案	工作紙	嘗試用pie求答案
升級:利用已知球體體積求半徑(12mins)					
11:28-11:33 5 mins	-示範4 -示範運用公式求出半徑	-跟隨老師完成4	-能進行較高階的運算 -通過方程求未知數	工作紙	幫助分辨立方根和平方根
11:33-11:36 3 mins	-試做4	-試做4	-嘗試獨自運算	工作紙	
11:36-11:40 4mins	總結 -佈置功課	-回答球體公式	幫助學生記認球體公式	功課工作紙	功課:重溫球體表面面積和體積公式

3. Teaching Package

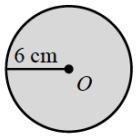
3.1 Pre-test

Pre-test 1　　姓名：_____（　）班別：____ 日期：

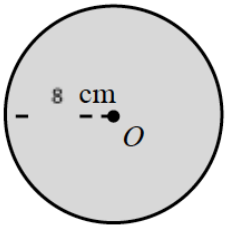
圓面積

1. 求下列各圓的面積，答案以π表示。

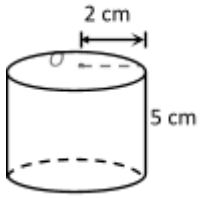
(a)



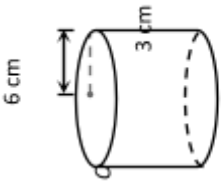
(b)



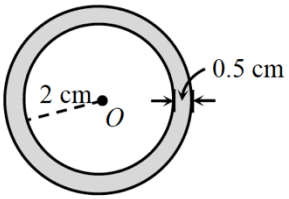
(c)



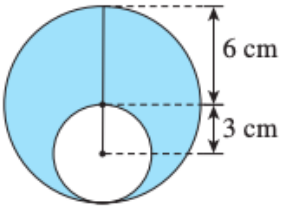
(d)



2. 圖中顯示的圓環由兩個同心圓所組成。外圓的直徑是5 cm，而圓環的闊度是0.5 cm。求圓環的面積。



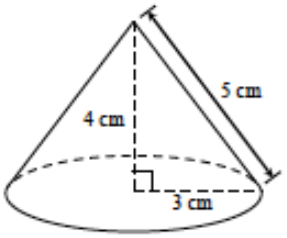
3. 求右圖著色部分的面積。



Pre-test 2

姓名：_____（　）班別：____ 日期：

1. 圖中，直立圓錐的高、底半徑和斜高分別是 4 cm、3 cm 和 5 cm。心萍用以下方法求圓錐的體積：



圓錐的體積 $= \frac{1}{3} \times \pi \times 3^2 \times 5\ \text{cm}^3$

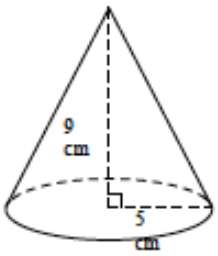
$= 15\pi\ \text{cm}^3$

(a) 心萍的答案（ 正確 / 不正確 ）。

(b) 若 (a) 部的答案是「不正確」，則正確的答案是：

圓錐的體積 =

3. 圖中，直立圓錐的高和底半徑分別是 9 cm 和 5 cm。
求該圓錐的體積，答案以 π 表示。



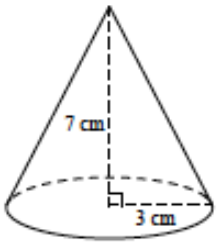
解

圓錐的體積

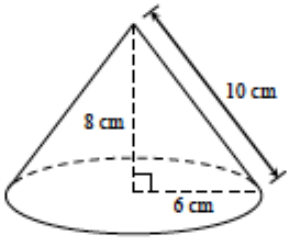
$= \frac{1}{3} \times \pi \times (\quad)^2 \times (\quad)\ \text{cm}^3$ ◀ 圓錐的體積

$= (\quad)\ \text{cm}^3$ $= \frac{1}{3} \times \pi \times (\text{底半徑})^2 \times \text{高}$

4. 圖中，直立圓錐的高和底半徑分別是 7 cm 和 3 cm。
求該圓錐的體積，答案以 π 表示。



5. 圖中，直立圓錐的高、底半徑和斜高分別是 8 cm、6 cm 和 10 cm。
求該圓錐的體積，答案以 π 表示。



解

圓錐的體積 $= \frac{1}{3} \times \pi \times (\quad)^2 \times (\quad)\ \text{cm}^3$

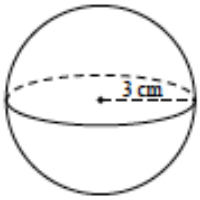
$= (\quad)\ \text{cm}^3$

Pre-test 3

姓名：_____(　　) 班別：_____ 日期：_____

5.3 球體

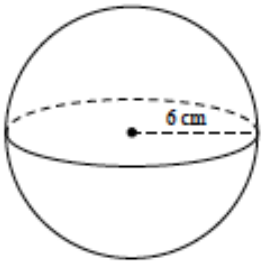
1. 圖中顯示一個半徑為 3 cm 的球體。



以下為四名學生計算球體體積的步驟。判斷哪個是正確的解。若是正確的，在空格內填「✓」；否則填「×」。

鏡泓 ☐	潔綾 ☐	曼遙 ☐	德培 ☐
體積	體積	體積	體積
$= \frac{4}{3} \times \pi \times 3^2\ \text{cm}^3$	$= \frac{4}{3} \times \pi \times 3^3\ \text{cm}^3$	$= \frac{2}{3} \times \pi \times 3^3\ \text{cm}^3$	$= 4 \times \pi \times 3^3\ \text{cm}^3$
$= 12\pi\ \text{cm}^3$	$= 36\pi\ \text{cm}^3$	$= 18\pi\ \text{cm}^3$	$= 108\pi\ \text{cm}^3$

2. 圖中是一個球體，它的半徑是 6 cm。
求球體的體積，答案以 π 表示。

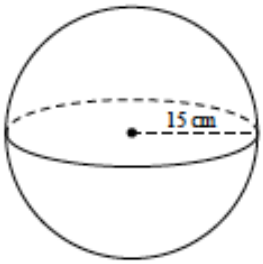


解
球體的體積

$= \frac{4}{3} \times \pi \times (\quad)^3\ \text{cm}^3$

$= (\quad)\ \text{cm}^3$

4. 圖中是一個球體，它的半徑是 15 cm。
求球體的體積，答案以 π 表示。



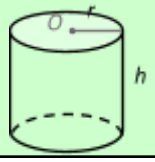
3.2 Worksheet

Worksheet 1

圓柱體積

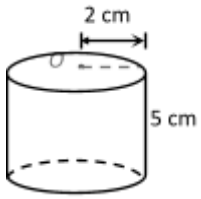
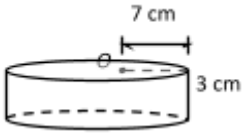
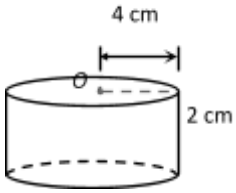
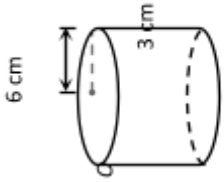
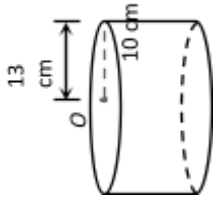
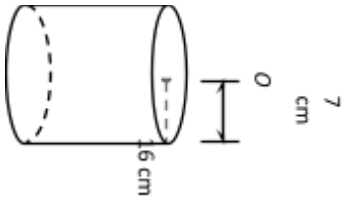
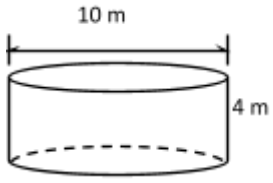
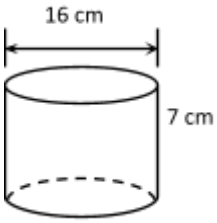
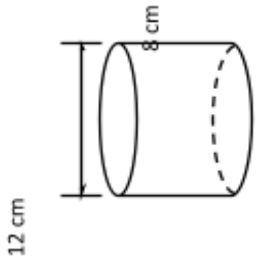
學習目標：解有關圓柱體積的問題。

右圖的圓柱中，
底面積 = _____
高 = _____
體積 = _____ (底面積 *x* 高)



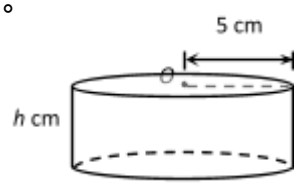
答案以 π 表示

求下列各圓柱的體積。

1(a) 	(b) 	(c) 
2(a) 	**2(b)** 	**2(c)** 
3(a) 答案準確至三位有效數字 	3(b) 答案準確至三位有效數字 	3(c) 答案準確至三位有效數字 

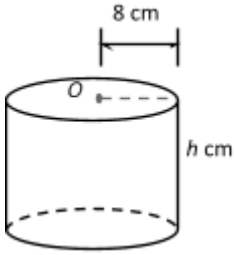
4(a)

圖中顯示一個底半徑為5 cm和體積為300π cm^3的圓柱。求h的值。

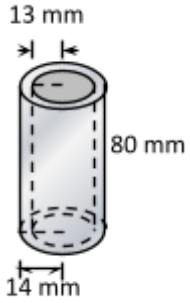


4(b)

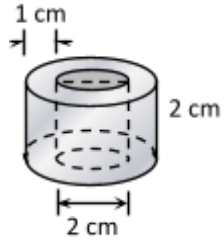
求h的值。



5. 圖中所示為一條銅管。銅管的內底半徑和外底半徑分別是13 mm和14 mm，而銅管的高是80 mm。求製造銅管所需的銅的體積。



6. 圖中所示為一卷中空的紙巾，其中中空部分的底直徑是2 cm。紙巾的高是2 cm，而厚度是1 cm。求紙巾的體積。



Worksheet 2

圓錐體積

學習目標：運用圓錐體積的公式。

一般而言，

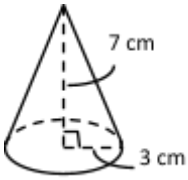
1. 圓錐的底是一個圓，
2. 頂點與底的垂直距離是圓錐的高。

對於一個底半徑為r和高為h的圓錐，

圓錐的體積=_____

1.

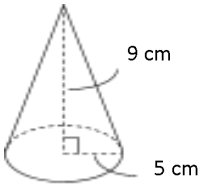
圖中顯示一個底半徑為3 cm和高為7 cm的直立圓錐。以 π 表示圓錐的體積。



2.

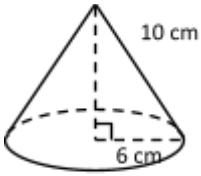
圖中顯示一個底半徑為 5 cm 和高為 9 cm 的直立圓錐。以　表示圓錐的體積。

π



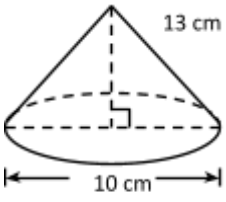
3.

圖中顯示一個底半徑為6 cm和斜高為10 cm的直立圓錐。以 π 表示圓錐的體積。



4.

以　　表示圓錐的體積。



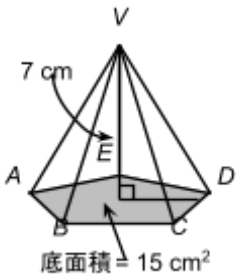
學習目標：運用棱錐體積的公式。

一般而言，
1. 棱錐的底是一個多邊形，
2. 頂點與底的垂直距離是棱錐的高。

對於任何棱錐，

$$\text{棱錐的體積} = \frac{1}{3} \times \text{底面積} \times \text{高}$$

1. 圖中顯示一個五棱錐*VABCDE*。棱錐的底面積是15 cm^2，高是7 cm。求棱錐的體積。



示例

圖中顯示一個三棱錐*VABC*。棱錐的底面積是8 cm^2，高是6 cm。求棱錐的體積。

解

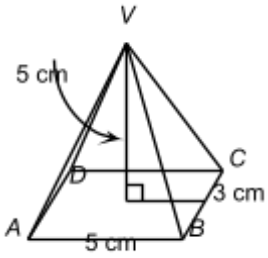
棱錐的體積

=

=

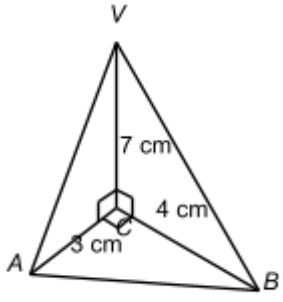
練習5.1: 1 – 2

2. 圖中顯示一個高為5 cm的棱錐*VABCD*，其底是一個長度為5 cm和闊度為3 cm的長方形。求棱錐的體積。



示例

圖中顯示一個高為6 cm的棱錐*VABCD*，其底是一個邊長為4 cm的正方形。求棱錐的體積。



解

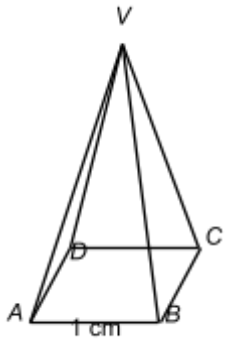
棱錐的體積

=

=

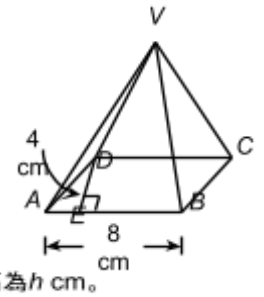
3. 圖中顯示一個三棱錐*VABC*, 其中*AC* = 3 cm、*BC* = 4 cm和*VC* = 7 cm。求棱錐的體積。

4. 圖中顯示一個棱錐*VABCD*, 其底是一個邊長為1 cm的正方形。若該棱錐的體積是2 cm^3, 求它的高。



示例

圖中顯示一個棱錐*VABCD*, 其底是一個底為8 cm和高為4 cm的平行四邊形。若該棱錐的體積是96 cm^3, 求它的高。



解

設該棱錐的高為*h* cm。

EMBED Equation.3 $\times (8 \times 4) \times h = 96$

$h = 9$

∴ 該棱錐的高是9 cm。

練習5.1: 5 – 7

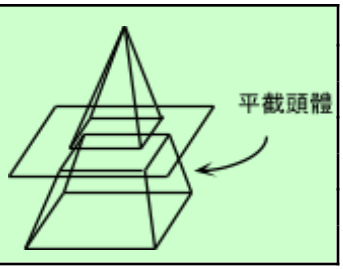
進階題

5. 某一個高為12 cm的棱錐的體積是36 cm^3, 求該棱錐的底面積。

課堂工作紙:平截頭體

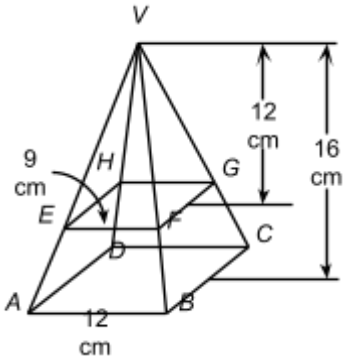
學習目標：求出棱錐的平截頭體的體積。

當一個棱錐沿一個平行於其底的平面切割時，可得一個平截頭體。



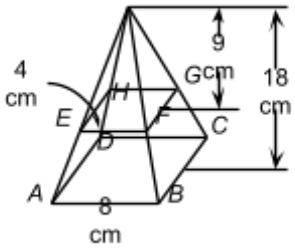
平截頭體的體積
= 原來的棱錐的體積 – 較小的棱錐的體積

1. 圖中顯示一個平截頭體*ABCDHEFG*。該平截頭體的上底和下底分別是邊長為9 cm和12 cm的正方形。棱錐*VEFGH*和*VABCD*的高分別是12 cm和16 cm。求平截頭體的體積。



示例

圖中顯示一個平截頭體*ABCDHEFG*。該平截頭體的上底和下底分別是邊長為4 cm和8 cm的正方形。棱錐*VEFGH*和*VABCD*的高分別是9 cm和18 cm。求平截頭體的體積。



解

大棱錐的體積 = EMBED Equation.3 × (4 × 4) × 9 cm^3

= 48 cm^3

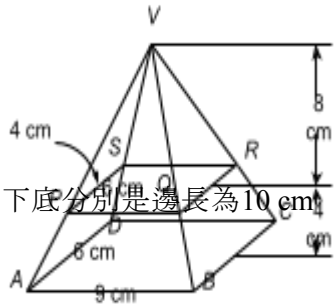
小棱錐的體積 = EMBED Equation.3 × (8 × 8) × 18 cm^3

= 384 cm^3

平截頭體的體積 = (384 – 48) cm^3

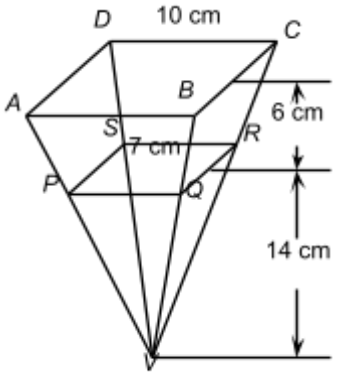
= 336 cm^3

2. 圖中顯示一個平截頭體*ABCDSPQR*。該平截頭體的上底是一個長度為6 cm和闊度為4 cm的長方形，而平截頭體的下底是一個長度為9 cm和闊度為6 cm的長方形。棱錐*VPQRS*和平截頭體*ABCDSPQR*的高分別是8 cm和4 cm。求平截頭體的體積。

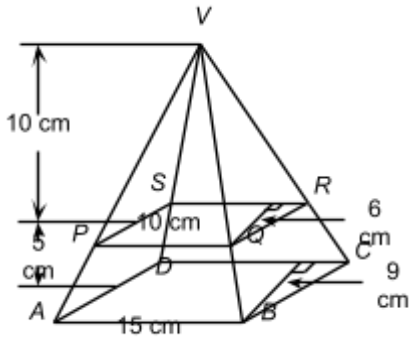


3. 圖中顯示一個倒置直立平截頭體*ABCDSPQR*。該平截頭體的上底和下底分別是邊長為10 cm和

7 cm的正方形。棱錐*VPQRS*和平截頭體*ABCDSPQR*的高分別是14 cm和6 cm。求平截頭體的體積。

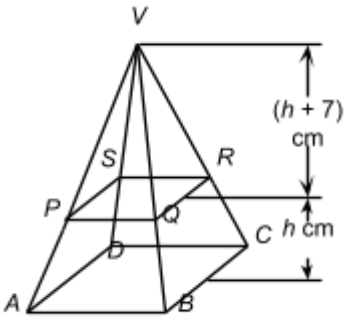


4. 圖中顯示一個直立平截頭體*ABCDSPQR*。該平截頭體的上底是一個底為10 cm和高為6 cm的平行四邊形，而平截頭體的下底是一個底為15 cm和高為9 cm的平行四邊形。棱錐*VPQRS*和平截頭體*ABCDSPQR*的高分別是10 cm和5 cm。求平截頭體的體積。



進階題

5. 圖中顯示一個平截頭體*ABCDSPQR*。該平截頭體的上底和下底的面積分別是256 cm^{2}和576 cm^2。棱錐*VPQRS*和平截頭體*ABCDSPQR*的高分別是$(h + 7)$ cm和h cm。若該平截頭體的體積是 $\frac{8512}{3}$ cm^3，求h的值。



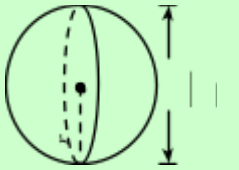
Worksheet 3

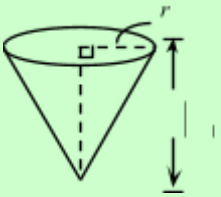
姓名：_____（ ）班別：____ 日期：

課堂工作紙：5.3 球體體積

學習目標：求出球體的體積。

對於一個球體，半徑為r時，

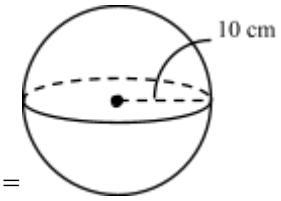
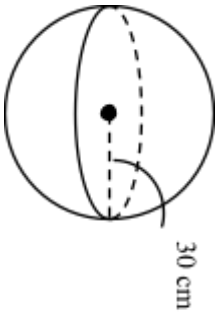
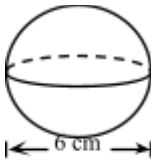
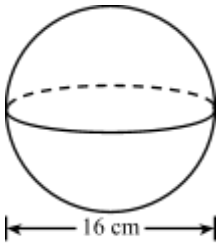
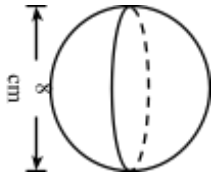
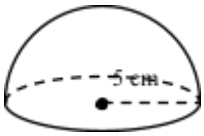
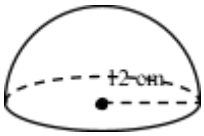
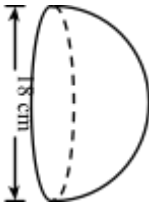




x 2

球體的體積=

以π表示球體的體積。

1(a)  體積 = = cm^3	1(b)  	1(c) 
2(a)  	2(b)  	2(c) 
3(a) 答案準確至三位有效數字。  	3(b)答案準確至三位有效數字。  	3(c)答案準確至三位有效數字。 

4. 某球體的體積是 $\frac{256\pi}{3}$ cm^3。求該球體的半徑。

解:

設該球體的半徑為 _____ cm。

示例

某球體的體積是972 cm^3。求該球體的半徑。

解

設該球體的半徑為r cm。

$\times \times r^3 = 972$

$r^3 = 729$

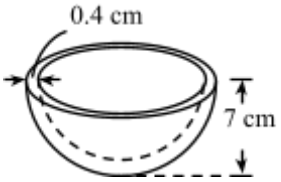
$r = 9$

∴ 該球體的半徑是9 cm。

5. 某球體的體積是288π cm^3。求該球體的半徑。

6. 某半球體的體積是 $\frac{686\pi}{3}$ cm^3。求該半球體的半徑。

5. 右圖是半個被挖去橙肉的橙子。求餘下的體積。(答案以π表示)



進階題

7. 球體A和球體B的半徑分別是7 cm和14 cm。(答案以π表示)
求球體A和球體B的體積比。

3.3 Homework

Homework 1

姓名：_____(　　) 班別：_____ 日期：_____

功課 5.1

對於一個底半徑為 r 和高為 h 的圓錐，

圓錐的體積 $= \frac{1}{3}\pi r^2 h$

1. 以 π 表示下列各圓錐的體積。

(a)

(b)

2. 圖中顯示一個底半徑為 3 cm 和高為 h cm 的直立圓錐。若錐體的體積為 21π cm³。求 h 的值是多少。

3. 圖中顯示一個底半徑為 5 cm 和斜高為 13 cm 的直立圓錐。以 π 表示圓錐的體積。

示例

圖中顯示一個底半徑為 6 cm 和斜高為 10 cm 的直立圓錐。以 π 表示圓錐的體積。

解

設圓錐的高為 h cm。

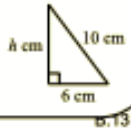
$(h \text{ cm})^2 + (6 \text{ cm})^2 = (10 \text{ cm})^2$ （畢氏定理）

$h = 8$

圓錐的體積

$= \frac{1}{3} \times \pi \times 6^2 \times 8 \text{ cm}^3$

$= 96\pi \text{ cm}^3$



5.13

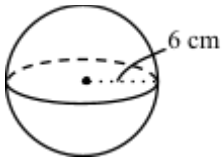
Homework 2

本練習中，除特別指明外，答案以π表示。

球體體積=_____

示範1

圖中顯示一個半徑為6 cm的球體。以π表示球體的體積。

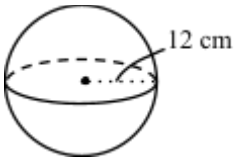


解

球體的體積 $= \frac{4}{3} \times \pi \times 6^3$ cm^3

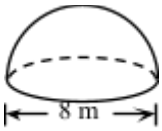
$= 288\pi\ cm^3$

1. 圖中顯示一個半徑為12 cm的球體。以π表示球體的體積。



示範2

圖中顯示一個直徑為8 m的半球體。求半球體的體積。



解

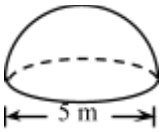
半球體的半徑 $= \frac{1}{2} \times 8$ m

$= 4$ m

半球體的體積 $= \frac{1}{2} \times \frac{4}{3} \times \pi \times 4^3$ m^3

$= 134\ m^3$（準確至三位有效數字）

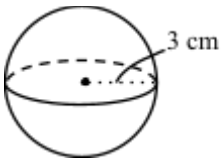
2. 圖中顯示一個直徑為5 m的半球體。求半球體的體積。



球體表面面積=_____

示範3

圖中顯示一個半徑為3 cm的球體。以π表示球體的表面面積。

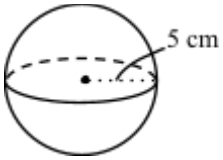


解

球體的表面面積 $= 4 \times \pi \times 3^2\ cm^2$

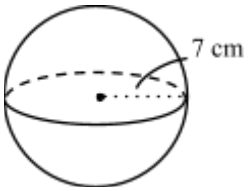
$= 36\pi\ cm^2$

3. 圖中顯示一個半徑為5 cm的球體。以π表示球體的表面面積。

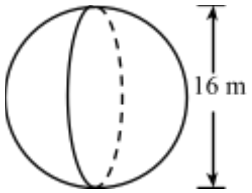


4. 求下列各球體的體積。

(a)

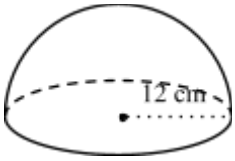


(b)

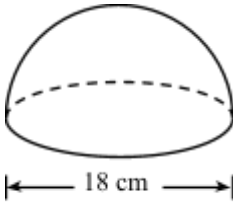


5. 以π表示下列各半球體的體積。

(a)



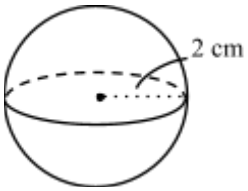
(b)



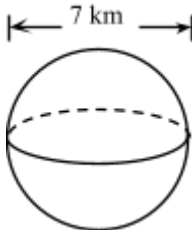
6. 一個球體的體積是972π m^3。求球體的半徑。

8. 求下列各球體的表面面積。

(a)



(b)



3.4 Self-reflection Form

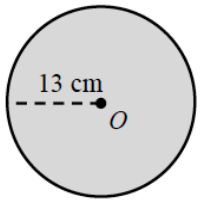
Self-reflection Form 1

學生自評表

姓名:_____班別:3_____(　　)　　課題:圓柱體積　　分數:_____/13分

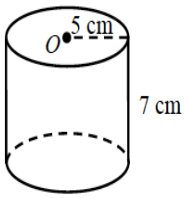
答案以 π表示。

1. 求圓的面積。(2分)

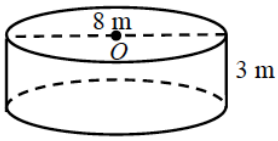


2. 求圓柱體的體積。(6分)

(a)



(b)



3. 右面由一元硬幣疊起的圓柱體中, 硬幣直徑為 2.6 cm, 且高度為 4 cm, 該圓柱體的體積是多少？(5分)

能做到嗎？

- ☐ 認出圓面積和高
- ☐ 寫出圓柱體積公式
- ☐ 正確計算答案

怎樣做得更好:

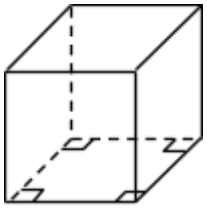
- ☐ 記認圓面積公式
- ☐ 書本練習5.1
- ☐ 其他: _____

Self-reflection Form 2

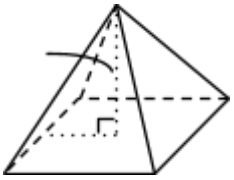
學生自評表

姓名:_____班別:3_____(　　)　　課題:面積與體積　　分數:_____/ 70分

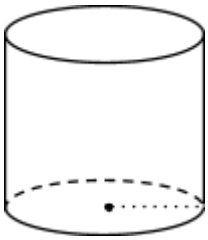
公式



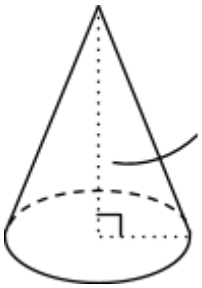
體積　=
表面面積 =



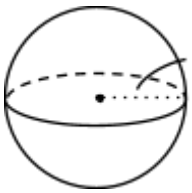
體積　=
表面面積 =



體積　=
表面面積 =



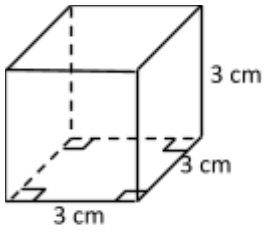
體積　=
表面面積 =



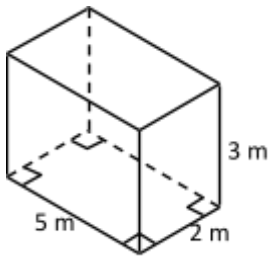
體積　=
表面面積 =

1. 求下列各棱柱的體積。(6分)

(a)

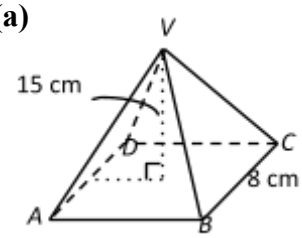


(b)

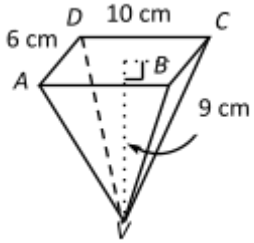


2. 求下列各棱錐的體積。(6分)

(a)

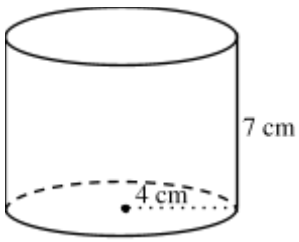


(b)

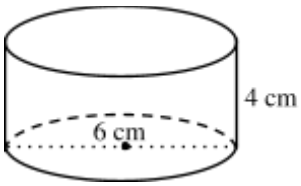


3. 求下列各圓柱的體積。(6分)
(答案以 π 表示。)

(a)

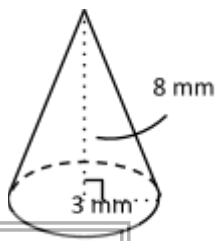


(b)

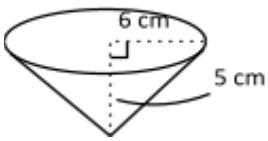


4. 以 π 表示下列各圓錐的體積。(6分)

(a)

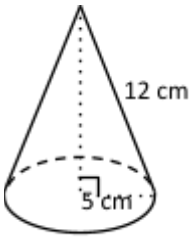


(b)

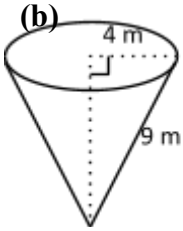


5. 以 π 表示下列各圓錐的曲面面積和總表面面積。(6分)

(a)

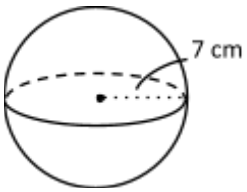


(b)

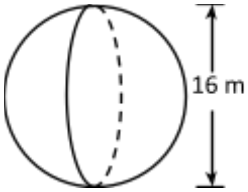


6. 求下列各球體的體積。(6分)

(a)

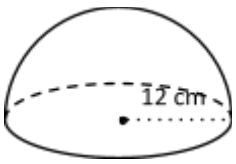


(b)

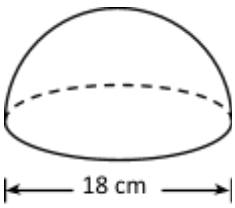


7. 以 π 表示下列各半球體的體積。(6分)

(a)

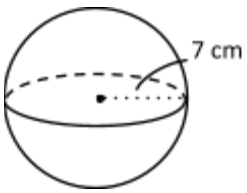


(b)

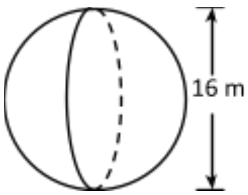


8. 求下列各球體的表面面積。(6分)

(a)

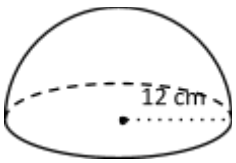


(b)

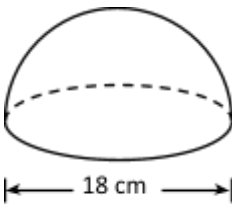


9. 以 π 表示下列各半球體的表面面積。(6分)

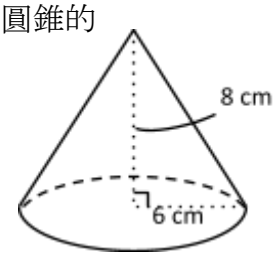
(a)



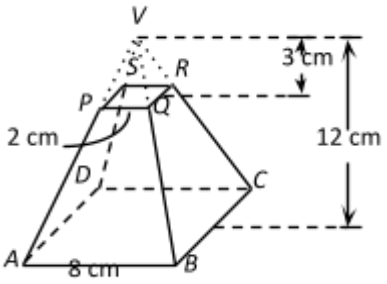
(b)



10. 圖中顯示一個底半徑為6 cm和高為8 cm的直立圓錐。求圓錐的曲面面積。(6分)



11. 圖中顯示一個平截頭體*ABCDSPQR*。該平截頭體的上底和下底分別是邊長為2 cm和8 cm的正方形。棱錐*VPQRS*和棱錐*VABCD*的高分別是3 cm和12 cm。求平截頭體*ABCDSPQR*的體積。(10分)



能做到嗎？	怎樣做得更好:
☐ 分辨球體體積和表面面積公式 ☐ 寫出球體體積公式 ☐ 正確計算平截頭體體積 ☐ 正確計算答案	☐ 記認球體體積和表面面積公式 ☐ 書本練習5.4 ☐ 其他: _____ _____

3.5 Summative Assessment

慕光英文書院
中三級 數學科 統一測驗
第五章：面積及體積

日期：___ – 11 – 2021
班別：F.3____ 姓名：_____( ) 分數：_____/ 50

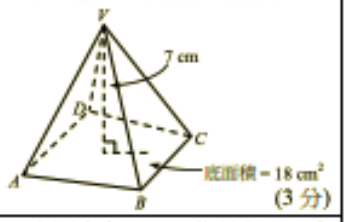
除特別指明外，數值答案以真確值表示或準確至 3 位有效數字。

參考公式

扇	形：	弧　長 = $2\pi r \times \frac{\theta}{360^\circ}$	面	積 = $\pi r^2 \times \frac{\theta}{360^\circ}$
球	體：	表面面積 = $4\pi r^2$	體	積 = $\frac{4}{3}\pi r^3$
圓	柱：	曲面面積 = $2\pi rh$	體	積 = $\pi r^2 h$
圓	錐：	曲面面積 = πrl	體	積 = $\frac{1}{3}\pi r^2 h$
棱	柱：	體　積 = 底面積 × 高		
棱	錐：	體　積 = $\frac{1}{3}$ × 底面積 × 高		

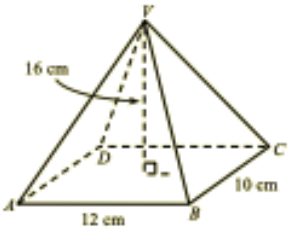
甲部 (35 分)

1. 圖中顯示一個高為 7 cm 的棱錐 *VABCD*，其底是一個面積為 18 cm^2 的四邊形。求棱錐的體積。



(3 分)

2. 圖中顯示一個高為 16 cm 的棱錐 *VABCD*，其底是一個長度為 12 cm 和闊度為 10 cm 的長方形。求棱錐的體積。



(3 分)

3. 以 π 表示以下圓錐的體積。

(3 分)

4. 圖中顯示一個半徑為 6 cm 的球體。

(a) 以 π 表示球體的體積。

(b) 以 π 表示球體的表面面積。

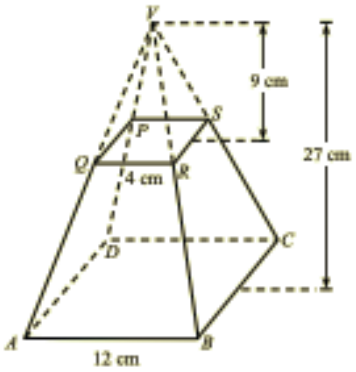
(4 分)

5. 圖中顯示一個平截頭體 *ABCDPQRS*。該平截頭體的上底和下底分別是邊長為 4 cm 和 12 cm 的正方形。棱錐 *VPQRS* 和棱錐 *VABCD* 的高分別是 9 cm 和 27 cm。

(a) 求棱錐 *VPQRS* 的體積。

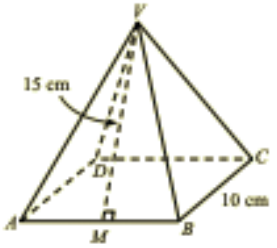
(b) 求棱錐 *VABCD* 的體積。

(c) 求平截頭體的體積。



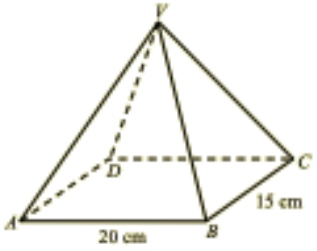
(6 分)

6. 圖中顯示一個直立棱錐 *VABCD*，其底是一個邊長為 10 cm 的正方形。△*VAB* 的高 *VM* 是 15 cm。求棱錐的總表面面積。



(5 分)

7. 圖中顯示一個棱錐 *VABCD*，其底是一個長度為 20 cm 和闊度為 15 cm 的長方形。若棱錐的體積是 2200 cm^3，求棱錐的高。



(5 分)

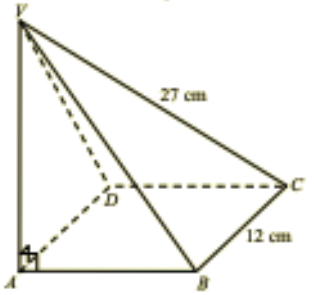
8. 圖中顯示一個底半徑為 10 cm 和斜高為 12.5 cm 的直立圓錐。以 π 表示圓錐的體積。

(6 分)

乙部 (15 分)

9. 圖中顯示一個棱錐 $VABCD$，其底是一個邊長 12 cm 的正方形。$VA \perp AB$，$VA \perp AD$ 和 $VC = 27$ cm。

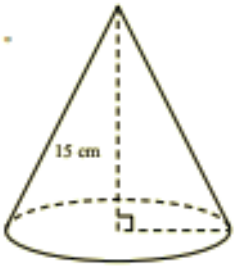
(a) 求 AC。



(b) 求棱錐的高。

(c) 求棱錐的體積

(d) 將棱錐熔化後鑄造成一個高為 15 cm 的實心圓錐。求圓錐的底半徑。

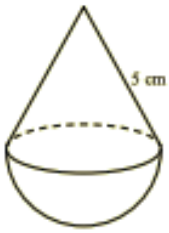


(9 分)

10. 圖中顯示一個半徑為 12 cm 和扇形角為 144° 的扇形。把 OA 和 OB 連接，使扇形屈成一個直立圓錐。

(a) 求圓錐的底半徑。

(b) 現將一半球體與圓錐合併，求該模型的總表面面積。



(6 分)

挑戰題 (5 分)

1. 圖中顯示一個具均勻厚度 0.5 cm 的半球體形的塑膠碗。該碗的外半徑是 6.4 cm。

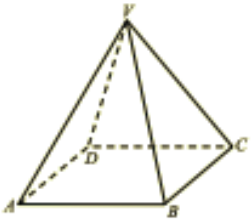
(a) 求該碗的容量。

(b) 求該碗的總表面面積。

(5 分)

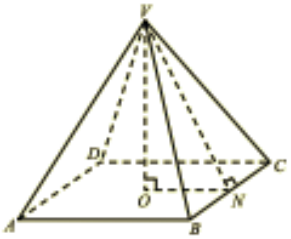
基礎題 (2 分)

1. 參閱下圖，圈出圖中棱錐的底。



VAD/VDC/VBC/VAB/ABCD (1 分)

2. 參閱下圖，圈出圖中棱錐的高。



VO/VN/AD/BC (1 分)

3. 化簡 $\frac{x^3}{x}$。

(1 分)

4. 展開 $3x(2x + 2)$

(2 分)

~ 試卷完 ~

3.6 Marking Scheme

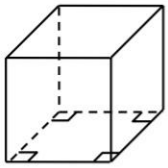
☆ M：代表過程/列式分

A：代表答案分

第 5 章　面積和體積（三）

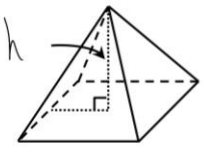
姓名：_____（　　）　　日期：_____

公式



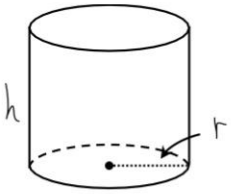
體積 = 長 × 闊 × 高

表面面積 = 所有面的面積相加



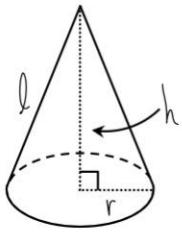
體積 = $\frac{1}{3}$ × 底面積 × 高

表面面積 = 底面積 + 側面面積（三角形）



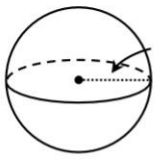
體積 = $\pi r^2 h$

表面面積 = $2\pi r^2 + 2\pi r h$



體積 = $\frac{1}{3}\pi r^2 h$

表面面積 = $\pi r^2 + \pi r l$

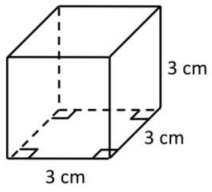


體積 = $\frac{4}{3}\pi r^3$

表面面積 = $4\pi r^2$

1. 求下列各棱柱的**體積**。

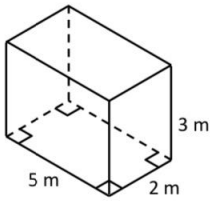
(a)



$V = 3 \times 3 \times 3$ ... 2M

$= 27\ cm^3$ ... 1A

(b)

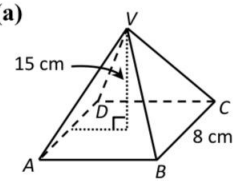


$V = 2 \times 5 \times 3$ ... 2M

$= 30\ cm^3$ ... 1A

2. 求下列各棱錐的**體積**。

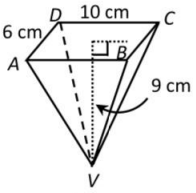
(a)



$V = \frac{1}{3} \times 8 \times 8 \times 15$ ... 2M

$= 320\ cm^3$ ... 1A

(b)



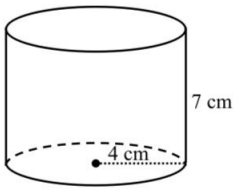
$V = \frac{1}{3} \times 6 \times 10 \times 9$ ... 2M

$= 180\ cm^3$ ... 1A

3. 求下列各圓柱的**體積**。

（答案以 π 表示。）

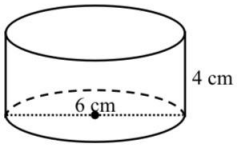
(a)



$V = \pi(4)^2 \times 7$ ... 2M

$= 112\pi\ cm^3$ ... 1A

(b)

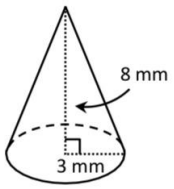


$V = \pi\left(\frac{6}{2}\right)^2 \times 4$ ... 2M

$= 36\pi\ cm^3$ ... 1A

5. 以 π 表示下列各圓錐的**體積**。

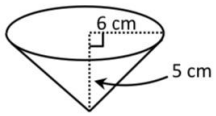
(a)



$V = \frac{1}{3} \times 3^2 \times 8$ ... 2M

$= 24\pi \text{ mm}^3$ ... 1A

(b)

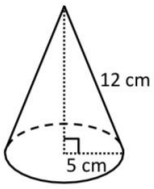


$V = \frac{1}{3}\pi(6)^2 \times 5$ ... 2M

$= 60 \text{ cm}^3$ ... 1A

4. 以 π 表示下列各圓錐的**曲面面積和總表面面積**。

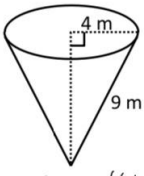
(a)



曲: $\pi(5)(12) = 60\pi \text{ cm}^2$ ... 1A

總: $60\pi + \pi(5)^2 = 85\pi \text{ cm}^2$ ... 1M+1A

(b)

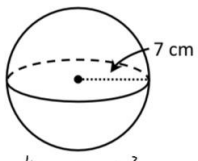


曲: $\pi(4)(9) = 36\pi \text{ m}^2$ ... 1A

總: $36\pi + \pi(4)^2 = 52\pi \text{ m}^2$ ... 1M+1A

4. 求下列各球體的**體積**。

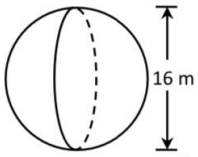
(a)



$V = \frac{4}{3}\pi(7)^3$ ... 2M

$= 457\frac{1}{3}\pi \text{cm}^3$ ... 1A

(b)

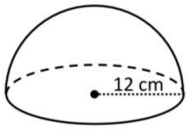


$V = \frac{4}{3}\pi(8)^3$ ... 2M

$= 682\frac{2}{3}\pi \text{ cm}^3$ ... 1A

5. 以 π 表示下列各半球體的**體積**。

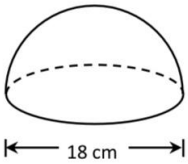
(a)



$V = \frac{1}{2} \times \frac{4}{3} \times \pi(12)^3$ ... 2M

$= 1152\pi \text{ cm}^3$ ... 1A

(b)

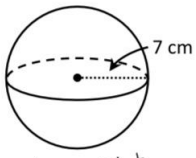


$V = \frac{1}{2} \times \frac{4}{3} \times \pi\left(\frac{18}{2}\right)^3$ ... 2M

$= 486\pi \text{ cm}^3$ ... 1A

4. 求下列各球體的**表面面積**。

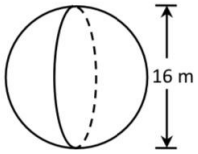
(a)



$A = 4\pi(7)^2$ ... 2M

$= 196\pi \text{ cm}^2$ ... 1A

(b)

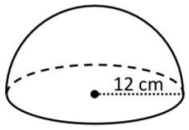


$A = 4\pi\left(\frac{16}{2}\right)^2$ ... 2M

$= 256\pi \text{ cm}^2$ ... 1A

5. 以 π 表示下列各半球體的**表面面積**。

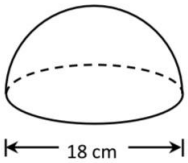
(a)



$A = \pi(12)^2 + \frac{1}{2} \times 4\pi(12)^2$ ... 2M

$= 432\pi \text{ cm}^2$ ... 1A

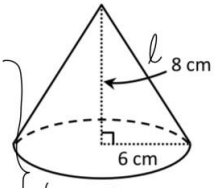
(b)



$A = \pi\left(\frac{18}{2}\right)^2 + \frac{1}{2} \times 4\pi\left(\frac{18}{2}\right)^2$ ... 2M

$= 243\pi \text{ cm}^2$ ... 1A

32. 圖中顯示一個底半徑為 6 cm 和高為 8 cm 的直立圓錐。求圓錐的**曲面面積**。



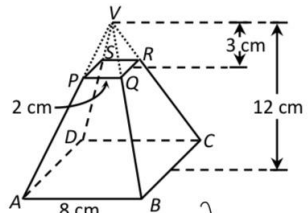
$l = \sqrt{8^2 + 6^2} = 10 \text{ cm}$ ... 2M+1A

曲 $= \pi(6)(10)$ ... 2M

$= 60\pi \text{ cm}^2$ ... 1A

6 Marks

10. 圖中顯示一個平截頭體 *ABCDSPQR*。該平截頭體的上底和下底分別是邊長為 2 cm 和 8 cm 的正方形。棱錐 *VPQRS* 和棱錐 *VABCD* 的高分別是 3 cm 和 12 cm。求**平截頭體** *ABCDSPQR* 的體積。



大錐體體積 $= \frac{1}{3} \times 8 \times 8 \times 12 = 256 \text{ cm}^3$ ... 3M+1A

小錐體體積 $= \frac{1}{3} \times 2 \times 2 \times 3 = 4 \text{ cm}^3$ ... 3M+1A

平截頭體體積 $= 256 - 4 = 252 \text{ cm}^2$ ... 1M+1A

10分.

4. Result of Project

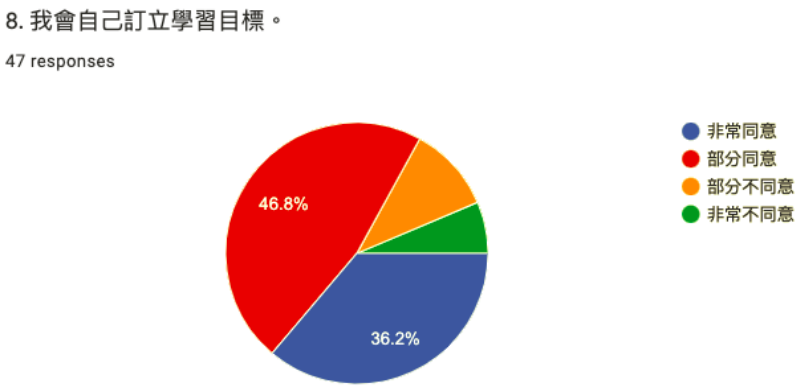
The result of the project will discuss the criteria of self-directed learning, which are goal setting, self-planning, self-monitoring, self-evaluation, and revision.

4.1 Goal setting

It is expected that the students can achieve the ability to master the knowledge of area and volume of solid after the topic. Referring to the pre-test of the teaching materials, students can assess the knowledge they didn't understand, and give a clearer direction for them to set the goal. The heading of the worksheet has a summary of the content, it is clear for them to note the learning objectives of every topic.

From the interview with the coordinator, she agreed that action learning can help students to set their goals. On the other hand, she also points out that the incentive for students to learn after school in the lower banding school is not enough. The students who have higher learning abilities would accept the learning mode of self-directed learning better than those who have lower abilities. There is room for self-directed learning to improve if we would like to implant action learning in school.

From the questionnaires of students, 84% of the students reflected that they will set learning goals after the project. It shows that students have a sense of goal setting.

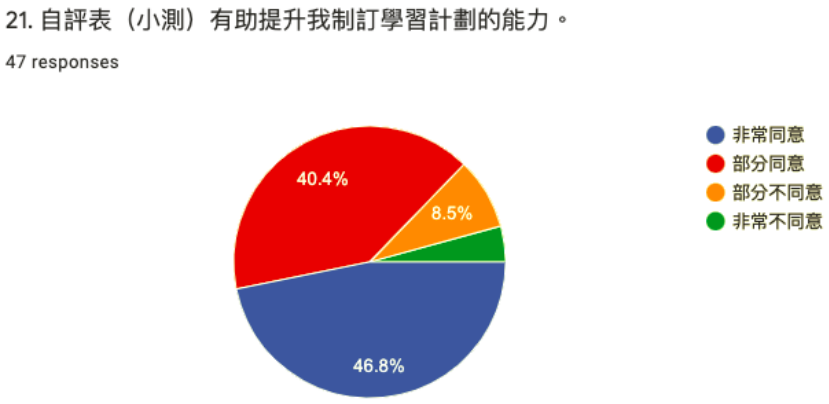


4.2 Self-planning

From the activity of making three pyramids to form a cube and using the orange to find out the formula of surface area, students need to set a goal for the activities, that is the conclusion they would like to draw.

Most of the students in the lesson can do the experiment in groups. The process of peeling off the skin to fill the circle, find the formula of the surface area of the sphere shows that students have the ability to self-planning after the project.

After they finish the self-reflection sheet and the homework, students have a better ability to understand the weakness in their learning, which helps to plan the next subject of teaching content.



4.3 Self-monitoring

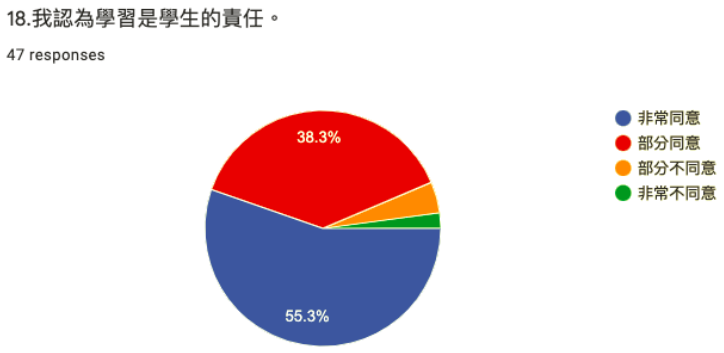
It is expected that the students can master the knowledge of area and volume. Students are aware of the implant of action learning, follow the routine of it.

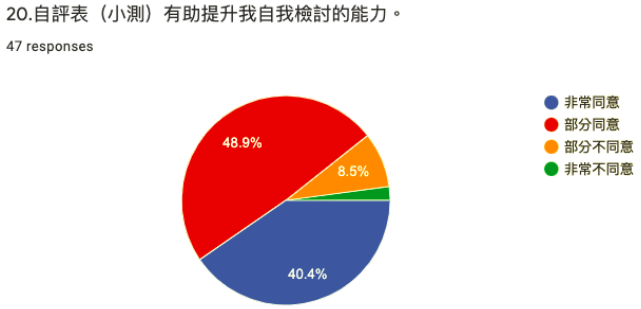
From the interview with students, they reflected that they can observe their improvement clearly from the pre-test and post-test. The after-school exercise can help them summarize the knowledge. That has achieved goal setting and revision of self-directed learning.

The design of the worksheet and homework has a QR code on it, the link providing some supplementary information for students to learn deeply after the lesson. For example, one of them is the proof of transformation from a flat surface to a solid of three dimensions of solid.

Also, during the lesson, some students can complete the worksheet and finish the challenging questions by themselves. Some of the higher ability students can complete the exercises and learn deeply.

From the questionnaires collected from the students, 89.3% of the students reflected that they will revise according to their weaknesses.



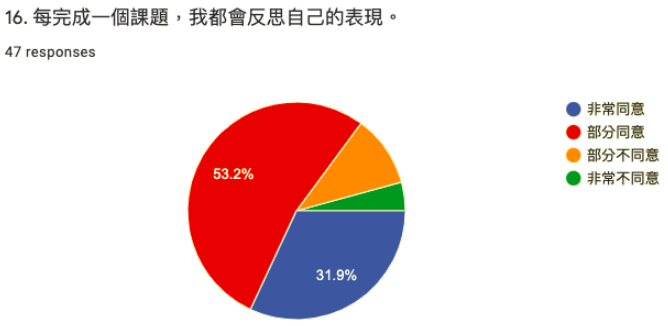


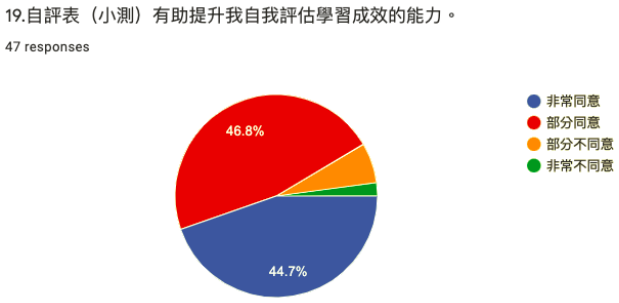
4.4 Self-evaluation

According to appendix 6.1, from the homework and test of the students, we can see that part of the students can calculate the questions of solid correctly, they can analyze the meaning of problem-solving, which achieves the purpose of designing homework.

Referring to the questionnaires collected from the students, 46.8% and 40.8% of students strongly agreed and agreed that they will reflect on their learning. It shows that students have learned to reflect on their own performance according to the self-reflection sheet.

The project guide the students to reflect on their learning process step by step. From the interview with teachers, she pointed out that the combination of quizzes and self-reflection sheets can also help students to revise when they have exams. Promoting action learning at school is good for students and improved their skills and attitudes of students.

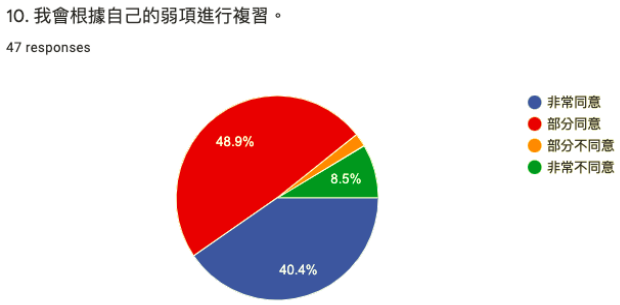




4.5 Revision

From the interview with the teachers, she said that the after-class exercise helps students to form a summary of the whole learning process, it is useful for them to revise and know the focus point of the topic.

From the result of the questionnaires, we can see that 55.3% and 38.3% of students strongly agreed and agreed they have the responsibility for learning. This shows that the sense of responsibility of students had improved.



4.6 Summary of result

Domain of Self-directed learning	Objectives	Activities	Learning Outcomes	Action Learning
4.1 Goal setting	Students can set the goal according to the pre-test	Pre-test	Pre-test gives a clearer direction for students to set goals	Plan
4.2 Self-planning	Independent learning	-Class worksheet -Class activities	Students knows that they should plan before act	Plan
4.3 Self-monitoring	Master the knowledge of the surface area and volume	Homework	Students are able to solve the problem from their homework independently	Act
4.4 Self-evaluation	Students can evaluate their own performance	Reflection sheet	Students are able to reflect on own experience	Reflect
4.5 Revision	-Follow the structure of action learning -Revise the knowledge	Post-test	students can revise according to their strength and weakness	Learn

5. Conclusion

The purpose of this research was to identify effective strategies for student's learning performance. It is expected that the students will improve their self-directed learning through action learning. From the quantitative and qualitative research, we can see that students fulfill the teaching objectives.

In the affective domain, students had achieved self-regulation and deepened their sense of responsibility. The class activity and consolidation exercise assess the ability of students to express and apply the concept in daily life. Throughout the project, students conducted experiments to prove the relationship between prism and pyramid. The activity gives instant and appropriate feedback to promote the mathematical exploration spirit of students.

In the cognitive domain, students had to acknowledge the concept and application of prism, pyramid, and sphere. From the result of students' pretest and their homework and the summative assessment, we can see that students had improved their academic results.

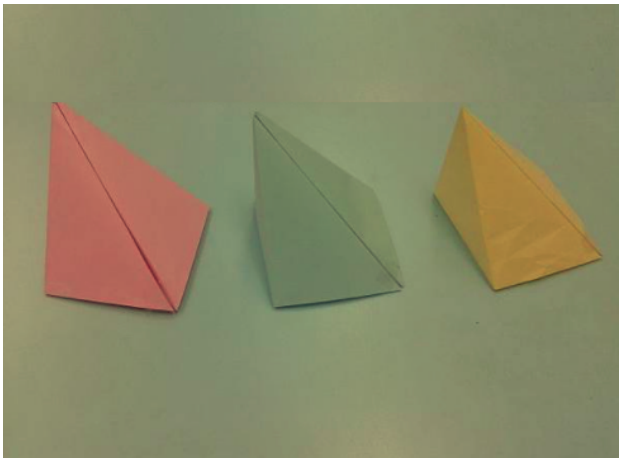
In the psychomotor domain, students had adapted and integrated the skills of planning, including setting learning goals and formulating learning plans. Students had also performed the ability of self-evaluation and reflection based on their performance. The self-reflection sheet helped students build up self-evaluation skills.

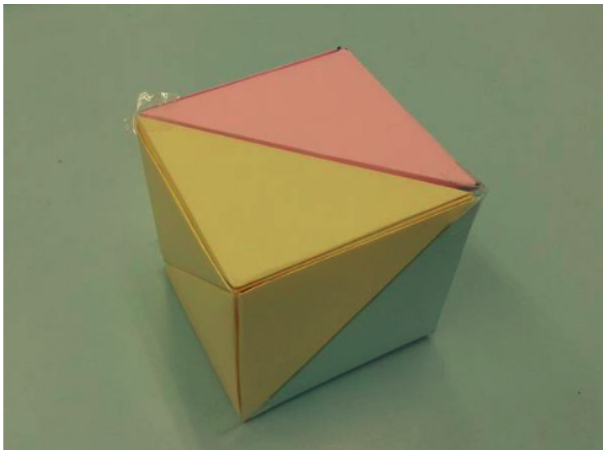
But there are some limitations to the project, the duration of the project is not long enough, since there are only 6 teaching cycles, the time may not be long enough to help students master the ability in an automatic way. Besides, the project group base is not large enough, and the students from the control group and experiment group have different learning abilities.

This project gives a great foundation for scaffolding of class practice learning, guiding the students through the class practice will enhance their learning motivation and sense of achievement. It is hoped that students will apply the action learning in different aspects and enhance their learning motivation, which will achieve self-directed learning.

6. Appendix

6.1 Students' work





圓面積

學習目標：解有關圓面積的問題。

對於一個半徑為 r 的圓，

面積 = πr^2 cm^2

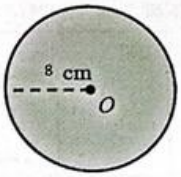
1. 求下列各圓的面積，答案以 π 表示。

(a)

面積 $= \pi r^2$
$= 36\pi\ cm^2$

(b)

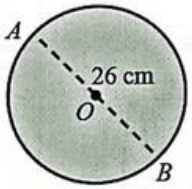
面積 $= \pi r^2$
$= 64\pi\ cm^2$



(c)

$r = \frac{1}{2}R = 13\ cm$

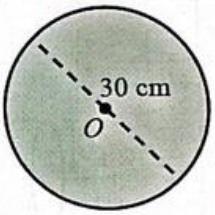
面積 $= \pi r^2$
$= 169\pi\ cm^2$



(d)

$r = \frac{1}{2}R = 15\ cm$

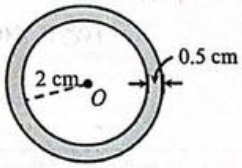
面積 $= \pi r^2$
$= 225\pi\ cm^2$



2. 圖中顯示的圓環由兩個同心圓所組成。外圓的直徑是 5 cm，而圓環的闊度是 0.5 cm。求圓環的面積。

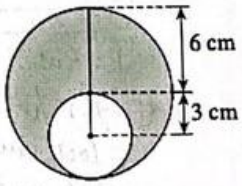
外圓半徑 $= 5\ cm \div 2 = 2.5\ cm$

面積 $= \pi(2.5)^2 - \pi(2)^2$
$= 6.25\pi - 4\pi$
$= 2.25\pi\ cm^2$



3. 求右圖著色部分的面積。

面積 $= \pi(6)^2 - \pi(3)^2$
$= 27\pi\ cm^2$



圓柱體積

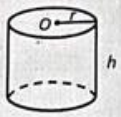
學習目標：解有關圓柱體積的問題。

右圖的圓柱中，

底面積 = πr^2

高 = h

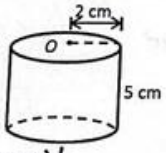
體積 = $\pi r^2 h$ (底面積 x 高)



答案以 π 表示

求下列各圓柱的體積。

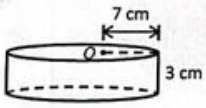
1(a)



體積 $= \pi r^2 h$

$= 20\pi \text{ cm}^3$

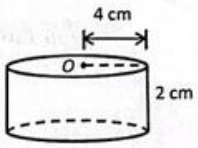
(b)



體積 $= \pi r^2 h$

$= 147\pi \text{ cm}^3$

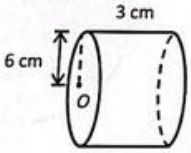
(c)



體積 $= \pi r^2 h$.

$= 32\pi \text{ cm}^3$.

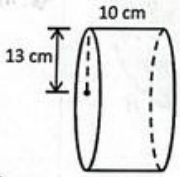
2(a)



體積 $= \pi r^2 h$

$= 108\pi \text{ cm}^3$

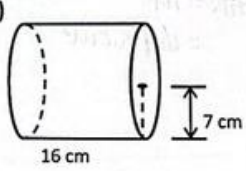
2(b)



體積 $= \pi r^2 h$

$= 169\pi \text{ cm}^3$

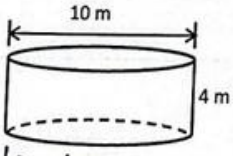
2(c)



體積 $= \pi r^2 h$.

$= 784\pi \text{ cm}^3$.

3(a) 答案準確至三位有效數字



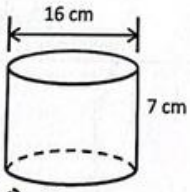
$r = \frac{1}{2}R = 5\text{m}$.

體積 $= \pi r^2 h$

$= 100\pi \text{ cm}^3$

$= 314 \text{ cm}^3$

3(b) 答案準確至三位有效數字



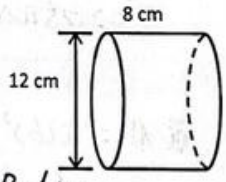
$r = \frac{1}{2}R = 8\text{cm}$

體積 $= \pi r^2 h$

$= 448\pi \text{ cm}^3$

$= 1410 \text{ cm}^3$

3(c) 答案準確至三位有效數字



$r = \frac{1}{2}R = 6\text{cm}$

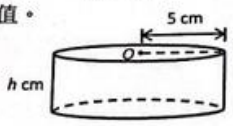
體積 $= \pi r^2 h$

$= 288\pi \text{ cm}^3$

$= 905 \text{ cm}^3$.

4(a)

圖中顯示一個底半徑為 5 cm 和體積為 300π cm^3 的圓柱。求 h 的值。



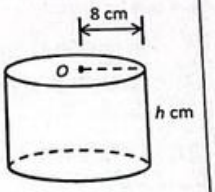
體積 $= \pi r^2 h = 300\pi$

$25h = 300$

$h = 12$.

4(b)

圖中顯示一個底半徑為 8 cm 和體積為 448π cm^3 的圓柱。求 h 的值。



體積 $= \pi r^2 h = 448\pi$

$64h = 448$

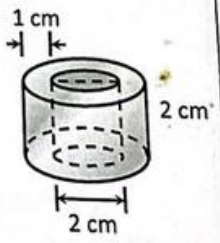
$h = 7$

5. 圖中所示為一條銅管。銅管的內底半徑和外底半徑分別是 13 mm 和 14 mm，而銅管的高是 80 mm。求製造銅管所需的銅的體積。

體積 $= \pi(14)^2 \times 80 - \pi(13)^2 \times 80$

$= 2160\pi\ cm^3$.

6. 圖中所示為一卷中空的紙巾，其中中空部分的底直徑是 2 cm。紙巾的高是 2 cm，而厚度是 1 cm。求紙巾的體積。



體積 $= \pi(2)^2 \times 2 - \pi(1)^2 \times 2$

$= 6\pi\ cm^3$.

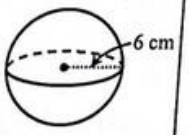
5.3 球體

本練習中，除特別指明外，答案以 π 表示。

球體體積 $= \frac{4}{3}\pi r^3$

示範 1

圖中顯示一個半徑為 6 cm 的球體。以 π 表示球體的體積。

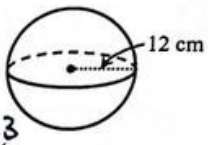


解

球體的體積 $= \frac{4}{3} \times \pi \times 6^3 \text{ cm}^3$

$= 288\pi \text{ cm}^3$

1. 圖中顯示一個半徑為 12 cm 的球體。以 π 表示球體的體積。



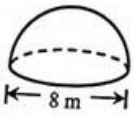
$\frac{4}{3}\pi r^3$

$= \frac{4}{3}\pi \times 12^3 \text{ cm}^3$

$= 2304\pi \text{ cm}^3$

示範 2

圖中顯示一個直徑為 8 m 的半球體。求半球體的體積。



解

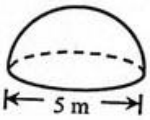
半球體的半徑 $= \frac{1}{2} \times 8 \text{ m}$

$= 4 \text{ m}$

半球體的體積 $= \frac{1}{2} \times \frac{4}{3} \times \pi \times 4^3 \text{ m}^3$

$= 134 \text{ m}^3$（準確至三位有效數字）

2. 圖中顯示一個直徑為 5 m 的半球體。求半球體的體積。



$r = \frac{1}{2}R = 2.5 \text{ m}$

$\frac{1}{2} \times \frac{4}{3}\pi r^3$

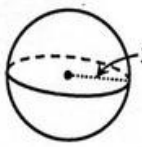
$= \frac{2}{3}\pi \times 2.5^3 \text{ m}^3$

$= 32.7\pi \text{ m}^3$（準確至三位有效數字）

球體表面面積 $= 4\pi r^2$

示範 3

圖中顯示一個半徑為 3 cm 的球體。以 π 表示球體的表面面積。

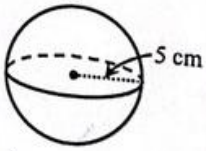


解

球體的表面面積 $= 4 \times \pi \times 3^2 \text{ cm}^2$

$= 36\pi \text{ cm}^2$

3. 圖中顯示一個半徑為 5 cm 的球體。以 π 表示球體的表面面積。



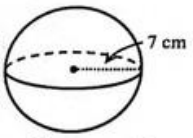
$4\pi r^2$

$= 4\pi \times 5^2 \text{ cm}^2$

$= 100\pi \text{ cm}^2$

4. 求下列各球體的體積。

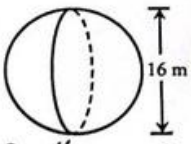
(a)



$\frac{4}{3}\pi r^3 = \frac{4}{3}\pi \times 7^3 cm^3$

$= 457\frac{1}{3}\pi cm^3$

(b)



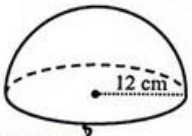
$r = \frac{1}{2}R = 8m$

$\frac{4}{3}\pi r^3 = \frac{4}{3}\pi \times 8^3 m^3$

$= 682\frac{2}{3}\pi m^3$

5. 以 π 表示下列各半球體的體積。

(a)

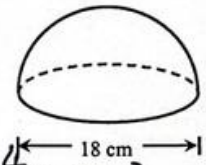


$\frac{1}{2} \times \frac{4}{3} \times \pi \times r^3$

$= \frac{2}{3}\pi \times 12^3 cm^3$

$= 1152\pi cm^3$

(b)



$r = \frac{1}{2}R = 9cm$

$\frac{1}{2} \times \frac{4}{3} \times \pi \times r^3$

$= \frac{2}{3}\pi \times 9^3 cm^3$

$= 486\pi cm^3$

6. 一個球體的體積是 $972\pi m^3$。求球體的半徑。

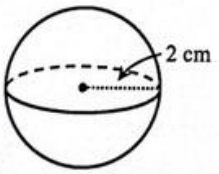
$\frac{4}{3}\pi r^3 = 972\pi m^3$

$\frac{4}{3}r^3 = 972 m^3$

$r = 9m$

8. 求下列各球體的表面面積。

(a)

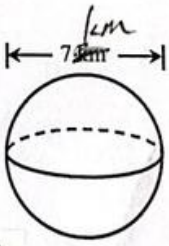


$4\pi r^2$

$= 4\pi \times 2^2 cm^2$

$= 16\pi cm^2$

(b)



$r = \frac{1}{2}R = 3.5km$

$4\pi r^2$

$= 4\pi \times 3.5^2 km^2$

$= 49\pi km^2$

6.2.1 Quantitative Research

Research Questions for students

https://forms.gle/pQsUeMNHw2w36sHV9

6.2.2 Qualitative Research

Research Questions for teacher

Question1: 你認為在學校推行自主學習的可行性高嗎？

答:“自主學習講求學生主動學習，他們想將課餘時間投放在自己喜歡的事情上。想要達到學生課後自己主動學更多，需要為學生提供誘因，而在學校推動學生自主學習最直接的方法就是能夠為學生提升考試成果，才能推動學生在課後學習更多。尤其是對於我們的學生來說，不納入考試範圍和成績的內容，他們都不會有動力去完成，但是這樣有違自主學習的初衷。所以我覺得自主學習在不同banding和不同能力的學生身上會出現很不同的效果，明顯地，學習能力較高的學生更適合自主學習。”

Question 2:你認為學生能從自評表上學到什麼？

答:“我很贊同每個課題之後都應該給予學生一個小測驗，這樣有助學生總結和反思自己在那些方面做得好和未能掌握。在考試前，有些學生不能自己找到考試重點，而平時的工作紙和小測能幫助他們溫習.....”

Question 3 : 請問你認為推動行動學習的成效如何？

答:“推動行動學習可以幫助學生反思和計劃下一步學習，我們的學生大多數時間只是完成老師的功課，很少會花時間去研究適合自己的學習方法。推動行動學習一定程度上可以幫助學生去反思自己的學習強弱，當學生懂得反思自己的行為，可以令他們持續進步。”

Research Question for students

1. 你認為課堂活動對你有幫助嗎？請解釋。
2. 你認為反思表的作用是什麼？
3. 你認為反思教學可以幫到你嗎？請解釋。

6.3 Citation

1. Abdullah, M.H. 2001. Self-directed learning. *ERIC digest*. Bloomington, IN: Indiana University, ERIC Clearinghouse on Reading, English and Communication.

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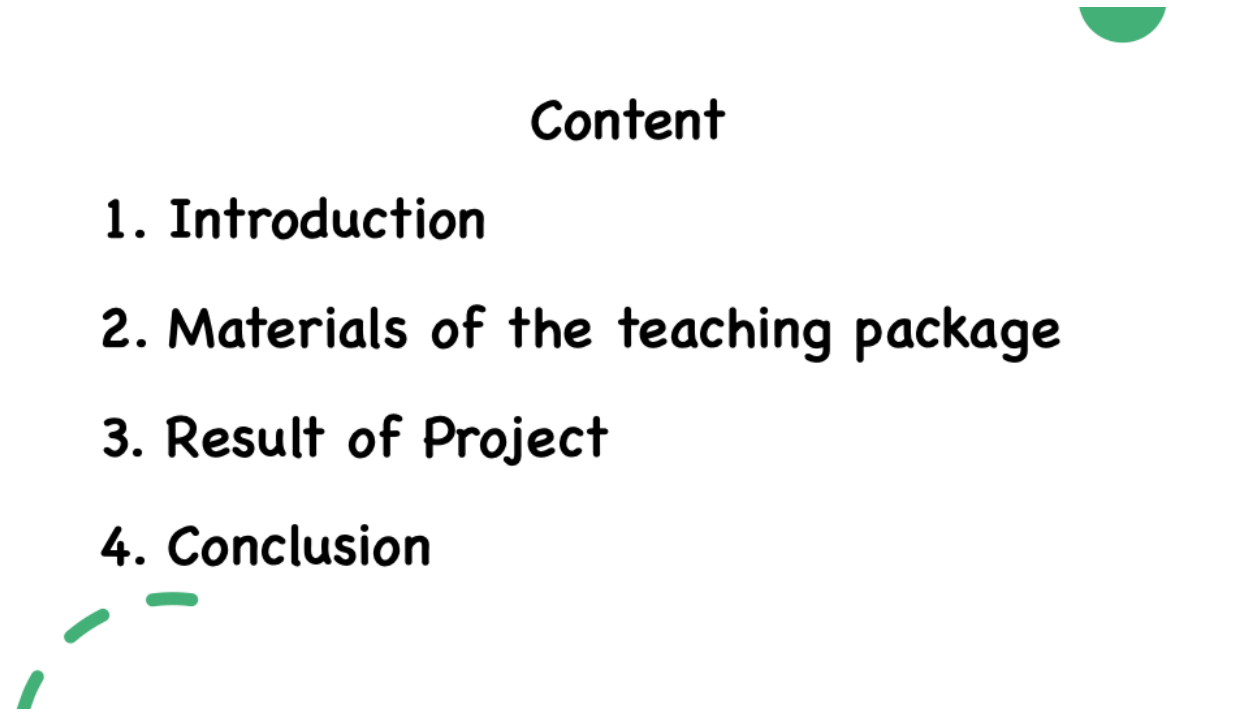
7. Powerpoint

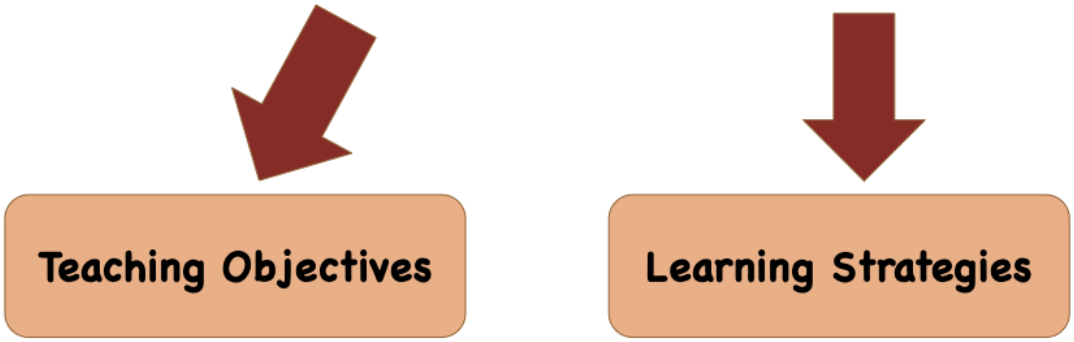


1. Introduction

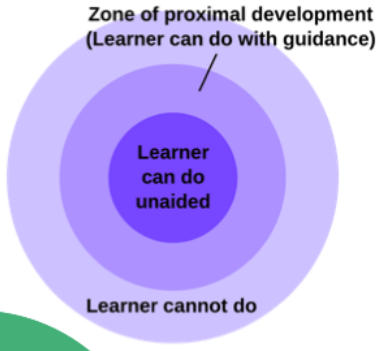
- 1.1 Design of the project
- 1.2 Action Learning (Method)
- 1.3 Self-directed learning (Teaching Objectives)
- 1.4 Research Method

1.1 Design of the project

*Enhance students' **Self-directed Learning** through **Action Learning***



1.1 Design of the project



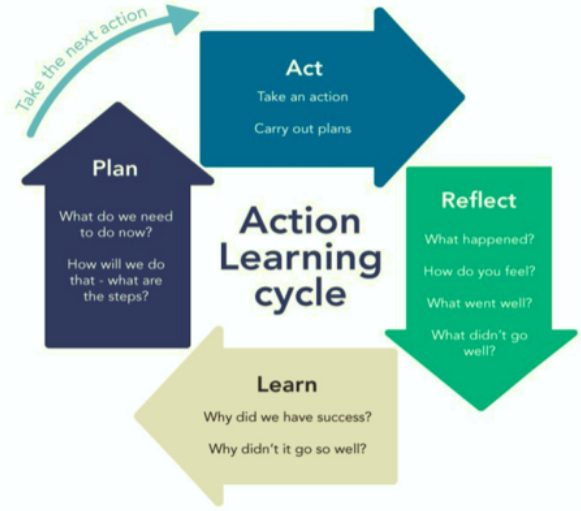
Follow the structure of the **Action Learning**

Scaffolding (giving guidance)

- Alleviate the learning difficulties of students
- From teaching' guiding development to the zone of learner can do unaided

1.2 Action Learning (Learning Strategies)

Learners **study their own actions and experiences** to improve performance(Welskop, 2013).



1.3 Self-directed learning (Teaching Objective)

- 5 key components (Goal setting, Self-planning, Self-monitoring, Self-evaluation and Revision)
- students could take individual responsibility for their own learning (Brockett & Hiemstra, 1991)

1.4 Methodology

Mixed Research Method

- Qualitative study: Interview with teacher and students
- Quantitative study: Questionnaires for students

Qualitative and quantitative data from:

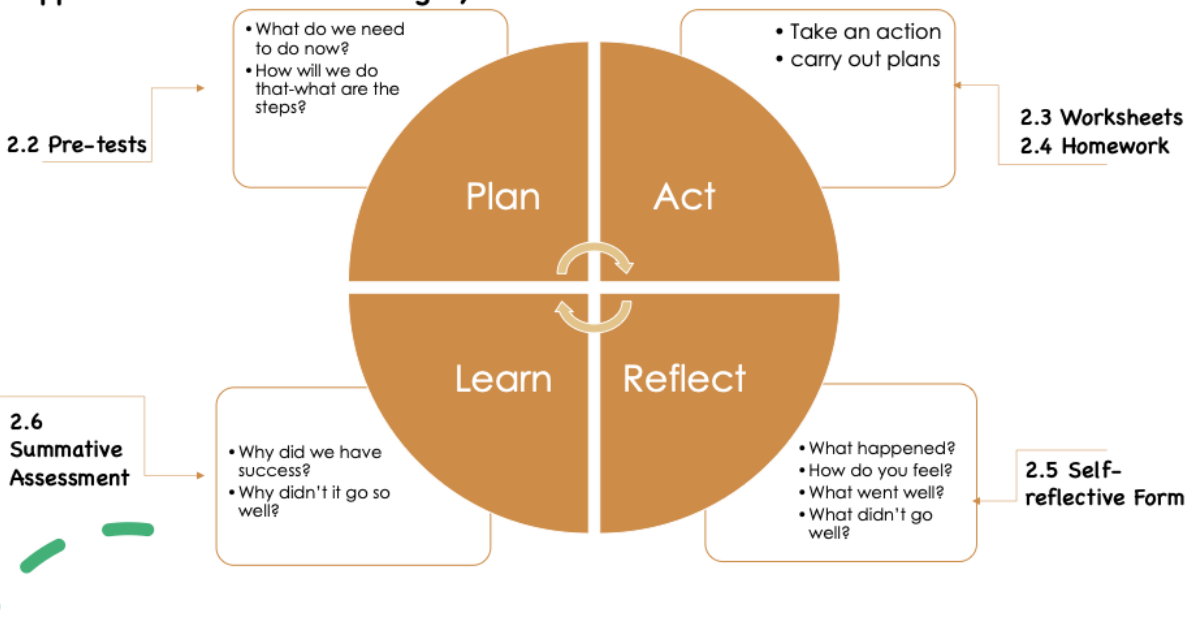
- Supporting teacher
- Teacher as a researcher

2. Materials of the teaching package

Topic: Form 3 Mathematics (Area and Volume)

- 2.1 Lesson Plans
- 2.2 Pre-tests
- 2.3 Worksheets
- 2.4 Homework
- 2.5 Self-reflective Form
- 2.6 Summative Assessment

Application of action learning cycle



2.1 Lesson Plan

2.1 Volume of cylinder

知識
-學生能聯繫面積和體積的關係(4, 5)
-學生能辨識圓柱體的組成部分：半徑、底、高(5, 9)
-學生能分析應用題題意，正確透過體積逆向求高(6, 9)

情意
-學生能應用圓柱體體積的概念適當運用於日常生活中(3, 7)
-學生能透過自評表建立自我評核能力(6, 8)

技能
-學生能通過繪圖分辨圓柱體的組成部分(4, 5)
-學生能運用公式求圓柱體體積(6)
-學生能運用公式和題目資料解答應用題(6, 7, 9)

九種共同能力：
1. 協作能力
2. 溝通能力
3. 創造力
4. 批判能力
5. 運用資訊科技能力
6. 運算能力
7. 解決問題能力
8. 自我管理能力
9. 研習能力

課題: 面積與體積（圓柱體體積）
節數:一節(40分鐘)

學生背景:
大部分學生能力中等。整體學習氣氛良好,且樂意回答問題。

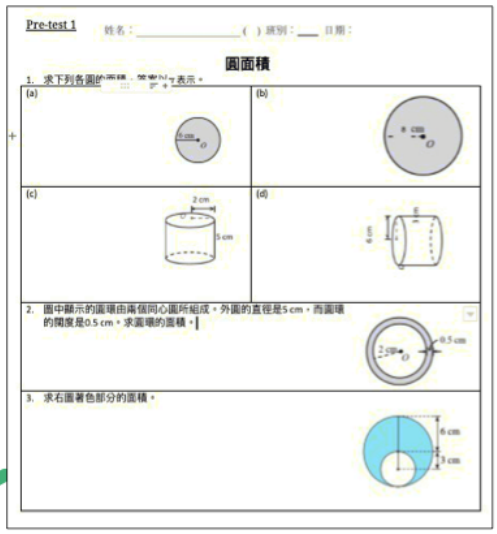
前置知識：
1. 學生能運用公式求圓的面積
2. 學生能處理與圓相關的應用題

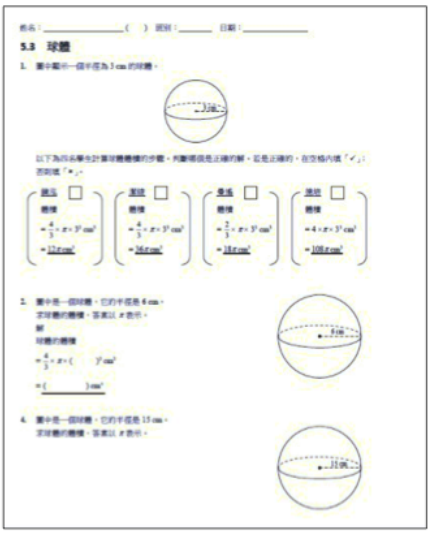
教學資源:
1. 前測題目
2. 工作紙
3. iPad
4. 自評表

教學過程

時間(分鐘)	內容	學生活動	目的	資源
10:05-10:10 5分鐘	前測	-完成前測題目	-檢視已有知識	-前測工作紙
10:10-10:15 5分鐘	-問學生一元硬幣的形狀 -用一元硬幣引入圓面積 -填寫公式 -試做1a	-回答問題 -寫公式 -跟隨老師解題	-重溫圓面積公式 -直接代公式求圓面積	工作紙概念部分 一元硬幣
10:15-10:18 3分鐘	-學生試做1b,1c -計算一元硬幣面積 -講解答案	-嘗試解題 -對答案	-重溫圓面積公式 -用直徑求出圓面積	工作紙1b,1c
10:18-10:21 3分鐘	-將一元硬幣搭起，展示一個圓柱，問學生怎樣得到圓柱體積 -在黑板上畫出圓柱，要求學生將上底的圓畫上斜線	-回答問題 -跟隨老師解題 -畫面 -填寫圓柱公式	-建立圓柱概念 -帶出圓柱體積公式	工作紙概念部分 十個一元硬幣
10:21-10:26 5分鐘	老師示範1a，2a	-跟隨老師解題 -回答問題	-讓學生熟悉格式 -示範用半徑和高找出圓柱體積 -示範用直徑和高找出圓柱體積	工作紙1a2a
10:26-10:30 4分鐘	學生試做1b，2b	-做練習	-用半徑和高找出圓柱體積 -學生用直徑和高找出圓柱體積	工作紙1b2b
10:30-10:33 3分鐘	示範4a （已知圓體積求高）	-跟隨老師解題 -回答問題	學會用公式逆向求高	工作紙4a
10:33-10:37 4分鐘	學生試做4b 講解答案	-做練習		工作紙4b
總結 10:37-10:40 3分鐘	-總結重點 -交代家課	-聆聽 -記筆記 -抄下家課	總結課堂重點	自評表

2.2 Pre-test (Plan)





2.3 Worksheet (Act)

圓柱體積

學習目標：解有關圓柱體積的問題。

右圓的圓柱中，
底面積 = _____
高 = _____
體積 = _____ (底面積 x 高)

答案以 π 表示

求下列各圓柱的體積。

1(a) 2 cm, 5 cm

(b) 7 cm, 3 cm

(c) 4 cm, 2 cm

2(a) 6 cm, 9 cm

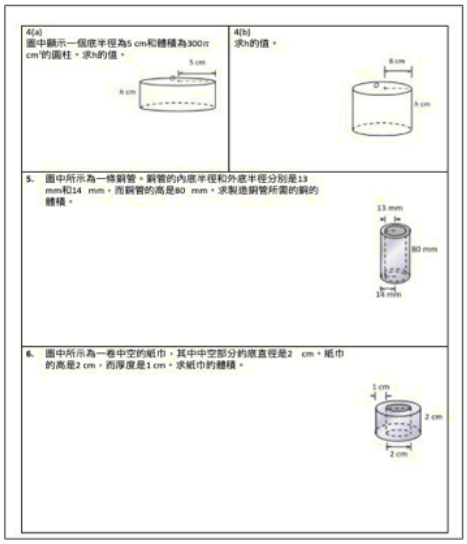
2(b) 15 cm, 10 cm

2(c) 5 cm, 9 cm

3(a) 答案準確至三位有效數字 10 m, 4 m

3(b) 答案準確至三位有效數字 16 cm, 7 cm

3(c) 答案準確至三位有效數字 5 m, 12 m



4(a)
圓中顯示一個底半徑為5 cm和體積為300π cm³的圓柱。求h的值。

5 cm, h cm

4(b)
求h的值。

8 cm, h cm

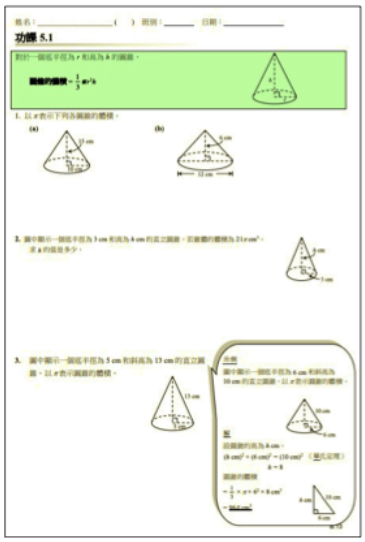
5. 圓中所示為一條鋼管。鋼管的內底半徑和外底半徑分別是13 mm和14 mm，而鋼管的高是80 mm。求製造鋼管所需的鋼的體積。

13 mm, 14 mm, 80 mm

6. 圓中所示為一卷中空的紙巾，其中中空部分的底直徑是2 cm。紙巾的高是2 cm，而厚度是1 cm。求紙巾的體積。

1 cm, 2 cm, 2 cm

2.4 Homework (Act)



姓名：_____ (　) 班別：_____ 日期：_____

功課 5.1

對於一個底半徑為 r 和高為 h 的圓錐，

圓錐的體積 $= \frac{1}{3}\pi r^2 h$

1. 以 π 表示下列各圓錐的體積。

(a) 3 m, 4 m

(b) 5 cm, 12 cm

2. 圓中顯示一個底半徑為 3 cm 和高為 4 cm 的直立圓錐。若圓錐的體積為 21π cm³，求 h 的值是多少。

4 cm, 3 cm

3. 圓中顯示一個底半徑為 5 cm 和斜高為 13 cm 的直立圓錐。以 π 表示圓錐的體積。

13 cm, 5 cm

例題

圓中顯示一個底半徑為 6 cm 和高為 10 cm 的直立圓錐。以 π 表示圓錐的體積。

解

圓錐的高為 8 cm。

$(6\text{ cm})^2 + (8\text{ cm})^2 = (10\text{ cm})^2$ （畢氏定理）

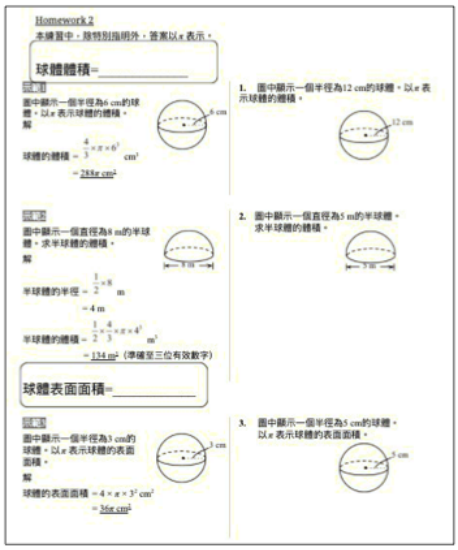
$64 = 64$

圓錐的體積

$= \frac{1}{3} \times \pi \times 6^2 \times 8\text{ cm}^3$

$= 96\pi\text{ cm}^3$

10 cm, 8 cm, 6 cm



Homework 2

本練習中，除特別指明外，答案以 π 表示。

球體體積=_____

例題

圓中顯示一個半徑為6 cm的球體。以 π 表示球體的體積。

解

球體的體積 $= \frac{4}{3} \times \pi \times 6^3\text{ cm}^3$

$= 288\pi\text{ cm}^3$

6 cm

1. 圓中顯示一個半徑為12 cm的球體。以 π 表示球體的體積。

12 cm

例題

圓中顯示一個直徑為8 m的半球體。求半球體的體積。

解

半球體的半徑 $= \frac{1}{2} \times 8\text{ m}$

$= 4\text{ m}$

半球體的體積 $= \frac{1}{2} \times \frac{4}{3} \times \pi \times 4^3\text{ m}^3$

$= 134\text{ m}^3$（準確至三位有效數字）

8 m

2. 圓中顯示一個直徑為5 m的半球體。求半球體的體積。

5 m

球體表面面積=_____

例題

圓中顯示一個半徑為3 cm的球體。以 π 表示球體的表面面積。

解

球體的表面面積 $= 4 \times \pi \times 3^2\text{ cm}^2$

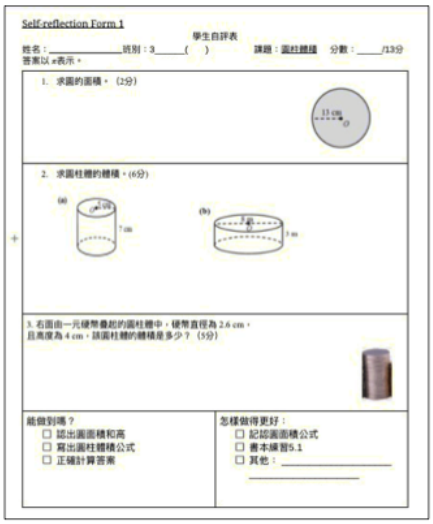
$= 36\pi\text{ cm}^2$

3 cm

3. 圓中顯示一個半徑為5 cm的球體。以 π 表示球體的表面面積。

5 cm

2.5 Self-reflection Form (Reflect)



Self-reflection Form 1

學生自評表

姓名：_____ 班別：3_____(　) 課題：圓柱體積 分數：_____/13分

答案以 π 表示。

1. 求圓的面積。(2分)

2. 求圓柱體的體積。(6分)

(a)

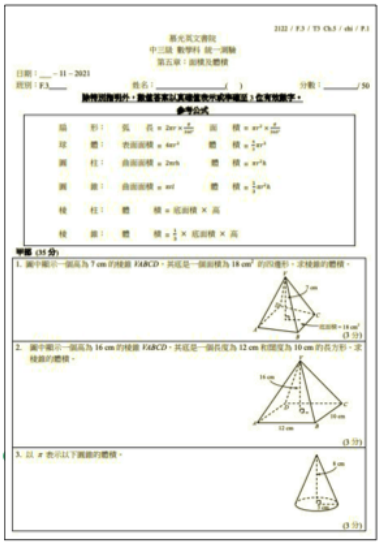
(b)

3. 右圖由一元硬幣疊起的圓柱體中，硬幣直徑為 2.6 cm，
且高度為 4 cm，該圓柱體的體積是多少？(5分)

能做到嗎？
- ☐ 認出圓面積和高
- ☐ 寫出圓柱體積公式
- ☐ 正確計算答案

怎樣做得更好：
- ☐ 記認圓面積公式
- ☐ 書本練習5.1
- ☐ 其他：_____

2.6 Summative Assessment (Learn)



2122 / F.3 / T3 Ch.5 / chi / P.1

基光英文書院

中三級 數學科 統一測驗

第五章：面積及體積

日期：__ – 11 – 2021

班別：F.3____ 姓名：_____(　) 分數：_____/ 50

除特別指明外，需要答案以其確至有半或半或兩位小數字。

參考公式

扇形：	弧長 $= 2\pi r \times \frac{\theta}{360}$	面積	$= \pi r^2 \times \frac{\theta}{360}$
球體：	表面面積 $= 4\pi r^2$	體積	$= \frac{4}{3}\pi r^3$
圓柱：	曲面面積 $= 2\pi rh$	體積	$= \pi r^2 h$
圓錐：	曲面面積 $= \pi rl$	體積	$= \frac{1}{3}\pi r^2 h$
棱柱：	體積	$=$ 底面積 $\times$ 高	
棱錐：	體積	$= \frac{1}{3} \times$ 底面積 $\times$ 高	

甲部 (35 分)

1. 圖中顯示一個高為 7 cm 的棱錐 $VABCD$，其底是一個面積為 18 cm² 的四邊形，求棱錐的體積。

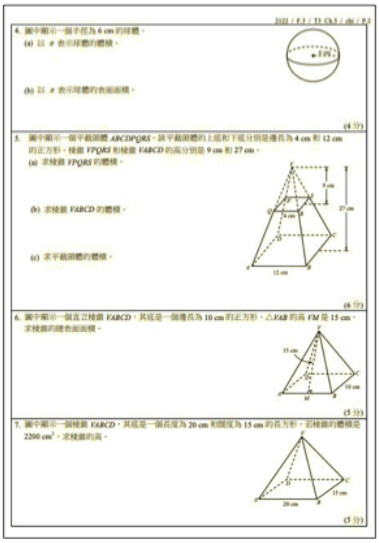
(3 分)

2. 圖中顯示一個高為 16 cm 的棱錐 $VABCD$，其底是一個長度為 12 cm 和闊度為 10 cm 的長方形，求棱錐的體積。

(3 分)

3. 以 π 表示以下圓錐的體積。

(3 分)



2122 / F.3 / T3 Ch.5 / chi / P.2

4. 圖中顯示一個半徑為 6 cm 的球體。

(a) 以 π 表示球體的體積。

(b) 以 π 表示球體的表面面積。

(4 分)

5. 圖中顯示一個平截頭體 $ABCDPQRS$，該平截頭體的上底和下底分別是邊長為 4 cm 和 12 cm 的正方形，棱錐 $VPQRS$ 和棱錐 $VABCD$ 的高分別是 9 cm 和 27 cm。

(a) 求棱錐 $VPQRS$ 的體積。

(b) 求棱錐 $VABCD$ 的體積。

(c) 求平截頭體的體積。

(6 分)

6. 圖中顯示一個直立棱錐 $VABCD$，其底是一個邊長為 10 cm 的正方形，$\triangle VAB$ 的高 VM 是 15 cm，求棱錐的總表面積。

(5 分)

7. 圖中顯示一個棱錐 $VABCD$，其底是一個長度為 20 cm 和闊度為 15 cm 的長方形，若棱錐的體積是 2200 cm³，求棱錐的高。

(5 分)

3. Result of Project

3.1 Goal setting

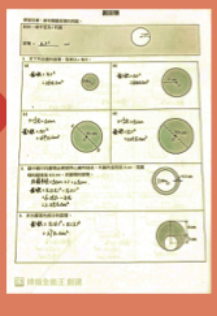
3.2 Self-planning

3.3 Self-monitoring

3.4 Self-evaluation

3.5 Revision

3.1 Goal setting (initial stage)



Pre-test

-helps students identify their learning difficulties

-helps students to set their learning goals

-examine students' prior knowledge

Usage of pre-test

-helps teacher identify the learning needs

-clarify the misconception of students

➡ It shows that students have develop goal setting

Action learning

3.2 Self-planning

Experiment

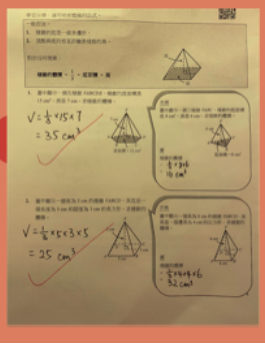
-Set a goal for the activities, which is the conclusion they would like to draw.

Self-reflection sheet

-helps to plan the next subject of teaching content.

➡ It shows that students have a sense of self-planning.

3.3 Self-monitoring



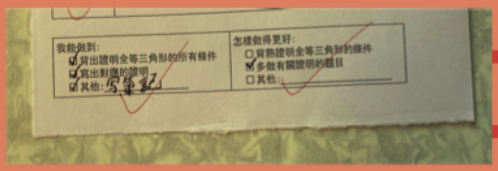
Graded Consolidation Worksheet
-Students can finish the challenging question based on their ability

Teacher as a researcher
-students showed they will keep on tracking on the performance of their own studies
-using highlight pen and double-checking

Teacher from the school
-students will review the concept before the lesson or during the recess

➡ It shows that students have develop self-monitoring.

3.4 Self-evaluation



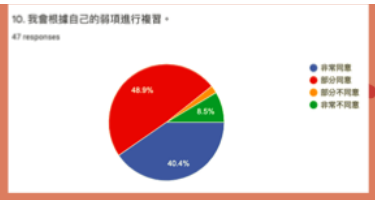
Homework
-Calculate the questions of solid correctly, they can analyze the meaning of problem-solving

Interview with students
-some students can complete the worksheet and finish the challenging questions by themselves

Questionnaires
-31.9% and 53.2% of students strongly agreed and agreed that they will reflect on their learning.

➡ It shows that students have develop self-evaluation.

3.5 Revision



Learning journey book
-students collect their worksheet, homework and self-reflection sheet to form a learning journey book
-students will revise their homework, quiz and self-reflection sheet by themselves
-students review their worksheet during recess

Interview with students
-the method of revision has changed from rely on teachers to take up the responsibility

Observation
-students revise after school with their classmates

➡ It shows that students take up their responsibility on learning.

3. Result of Project

Domain of Self-directed learning	Objectives	Action Learning	Activities Which aims at	Learning Outcomes(from students' questionnaires and supporting document)
3.1 Goal setting (1 page	Students can set the goal according to the pre-test	Plan	Pre-test	students are abled to set goals
3.2 Self-planning	Independent learning	Plan	-Class worksheet -Class activities	Students are abled to that they should plan before act
3.3 Self-monitoring	Master the knowledge of the surface area and volume	Act	Homework	Students are abled to solve the problem from their homework independently
3.4 Self-evaluation	Students can evaluate their own performance	Reflect	Reflection sheet	Students are abled to reflect on own experience
3.5 Revision	-Revise the knowledge	Learn	Post-test	students can revise according to their strength and weakness

4. Conclusion

1. Enhance students' **Self-directed Learning** through **Action Learning**
2. The project had gone through the 5 stages of action learning, as students building up foundation of self-directed learning
3. The purpose of the project leads to student-oriented learning
4. Promote scaffolding to junior secondary students, it is expected that they could master the skills of self-directed learning and be able to achieve life-long learning

Q & A

Enhance students' Self-directed Learning through Action Learning

WONG Lee s1125070
Professor：Dr Ng Cheuk Wing
2021-2022 Capstone Project – The Education University of Hong Kong

Introduction

According to the Education Bureau[1] , the learning mode in the Mathematics classroom was teacher-oriented, and there was insufficient opportunities for students to explore more. This project applied strategies of action learning like planning and reflecting to

What is **Self-directed Learning** ?

- students could take personal responsibility for their own learning (Brockett & Hiemstra, 1991)
- helps students identify their own learning needs
- choosing the most suited learning strategies
- 5 key components (Goal setting, Self-planning, Self-monitoring, Self-evaluation and Revision)

Methods and Materials

Action Learning

Action learning is an educational process where the participants study their own actions and experiences to improve performance(Welskop, 2013).

Taylor, J., Marais, D. and Kaplan, A. (1997)

Method

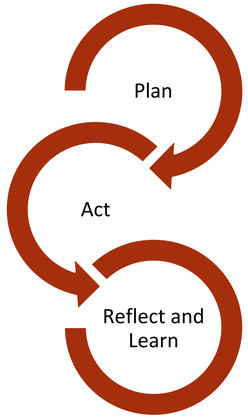
- Qualitative study: Interview with teacher and student
- Quantitative study: Questionnaires for students

Rubrics

Pre-test: identify learning objectives and the key points

Post-test: find out the weakness and strengths on learning

Materials	
Before Lesson	Pre-test
During Lesson	Experimental proof, graded consolidation worksheet
After Lesson	Post-test and self-evaluation form



Flow

Pre-test
1. Students need to complete a test about the volume of sphere
2. Check the answer and marked by themselves

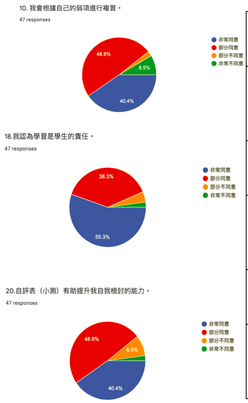
Experimental Proof
1. Students proof the formula through experiment

Interaction with peers and teacher
2. Sharing the findings and discuss the error
3. Exercise to deepen learning

Post-test
1. evaluate the learning
2. compare with pre-test

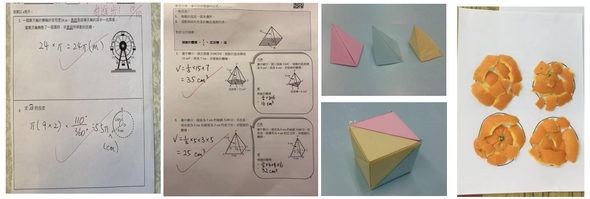
Self-reflection sheet
3. find out the strength and weakness of learning

Results

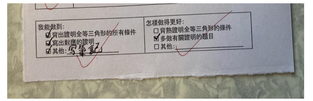


Domain of Self-directed learning	Objectives	Activities	Learning Outcomes
Goal setting	Students can set the goal according to the pre-test	Pre-test	Pre-test gives a clearer direction for students to set goals
Self-planning	Independent learning	-Class worksheet -Class activities	Students knows that they should plan before act
Self-monitoring	Master the knowledge of the surface area and volume	Homework	Students are able to solve the problem from their homework independently
Self-evaluation	Students can evaluate their own performance	Reflection sheet	Students are able to reflect on own experience
Revision	-Follow the structure of action learning -Revise the knowledge	Post-test	students can revise according to their strength and weakness

Students' Work



Students' feedback



Discussion

Learning Difficulties

-some students were not familiar with reflection
-some students didn't have the habits of doing homework
-some students showed difficulties in understanding and doing word problems

Effectiveness

-catering for learning differences
-some students reflected on their weakness accurately
-improvement of students' academic performance

Conclusion

Action Learning can

- identify effective strategies for student's learning performance
- achieved self-regulation and deepened their sense of responsibility
- build up ability of students to express and apply the concept in daily life

Be able to achieve self-directed learning as project expectation

-adapted and integrated the skills of planning
-setting and access personal growth
-develop personal learning style

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香港教育大學

The Education University of Hong Kong

Enhance students' Self-directed Learning through Action Learning

CAPSTONE PROJECT

Reflection

WONG Lee

Professor： Dr. Ng Cheuk Wing

April 2022

1. Introduction

The purpose of the project is enhancing students' self-directed learning through action learning. The discussion will cover the materials of the teaching package and the research method applied in the project. In this reflective essay, I will review the project in-depth and comprehensively with the support of literature. After that, I would like to identify the issue of the project, and make improvement of the issues I addressed in the previous part. In the end of the article, some limitations and implication of the project will be discussed.

2. Review of the project

The project applied diverse teaching strategies to helping students with individual differences in learning. The project adopted the structure of action learning, scaffolding and giving quality feedbacks to help students achieved self-directed learning. The following reviews the quality of the process and outcomes with supporting documents.

The application of action learning cycle[1] enhance the self-directed learning of students effectively. The pre-test in the stage of planning helps teacher identify the learning needs of the students, and work as an initial stage to help students setting their goal. The experiment and the self-reflection develop the sense of self-planning. The reason of adapting action learning cycle is the reflection part is the linkage of past action and more effective future action. As a teacher as a researcher, students showed that they can monitor their own learning in the lessons. Such as they would using highlight pen during the lesson to mark down the key point and the students who

[1] McGill, I., & Beaty, L. (2016). Action learning: A practitioner's guide. Routledge.

always careless in their calculation will check their work twice.

Scaffolding[2] as a teaching strategy from Lev Vygotsky and developed from his concept of the zone of proximal development (ZPD). The activities provided in scaffolding instruction are just beyond the level of what the learner can do alone (Olson & Pratt, 2000). Achieving self-directed learning through the four steps of action learning is a process that requires time and guidance. Applying the strategies of scaffolding, simplify the task of action learning to make the process more manageable and achievable. Using self-reflection sheet as an example, the questions helps students to reflect on their own performance and provide some direction for them, reduce frustration. During stage of reflection, the questions were not only about right and wrong, or closed-ended questions. The design of the questions triggers students' thinking and encourage them to think more about their own behaviors.

According to the Rogers' five feedback types, giving feedbacks to the students effectively can enhance their learning motivation and helps them improve their studies. The feedback given to students are evaluative, positive and constructive, for example, I would appreciate what they did well and pointed out where they fall short directly or indirectly. The feedback given to students was accurate and adapted to suit individual students' learning needs. I hope students could feel that teachers are caring about them and we are pleasure to support to them in their studies. I showed appreciate to their effort, when giving supportive feedback, it helps them to build confidence. For example, I would say, 'You are really creative in using different method to solve the problem, but there is some problem in your calculation.'. From

[2] Benson, B. K. (1997). Scaffolding. English Journal, 86(7), 126.

the feedback of teacher, a positive learning atmosphere was created and strengthen students' learning motivation by building up a good relationship with students.

Summary of review of the Project

Teaching Strategies	Objective	Result
Action Learning	Students can study their experience and actions to improve their performance.	Student find learning methods to enhance their weakness
Scaffolding	From teaching' guiding development to the zone of learner can do unaided.	Students showed they can reflect on own performance on their work.
Giving quality feedbacks (Reflect stage of Action Learning)	Help students develop self-assessment ability and gradually replace external feedback with internal feedback.	Students correct their work by themselves after the feedbacks from teachers.

3. Issues of the project to be addressed

3.1 Planning of the self-directed learning

First, during the procedure of the group project, planning of the project is not enough. The design of the project begins with the planning stage, as an initial stage after the pre-test. The pre-test helps students to identify their learning difficulties and examine their prior knowledges. But there's lacks of detailed records, in the end the project, students may forget the learning targets they set from the beginning. It lowers the effectiveness of reflection in the end of the topics.

3.2 The variety of the assessment method

Second, the variety of assessment method is not enough. The project adopted after class worksheet and examination as the summative assessment, but it may bring anxiety to the students who have poor performance under pressure. The students with lower learning ability usually don't capable with strong learning motivations, test and targets can provide an intention as performance indicator for them to study. But the temporary intension does not relate with feelings and emotions, which means it doesn't facilitate students' learning interest. This kind of situation stopped student to learn self-directed and actively after the lesson.

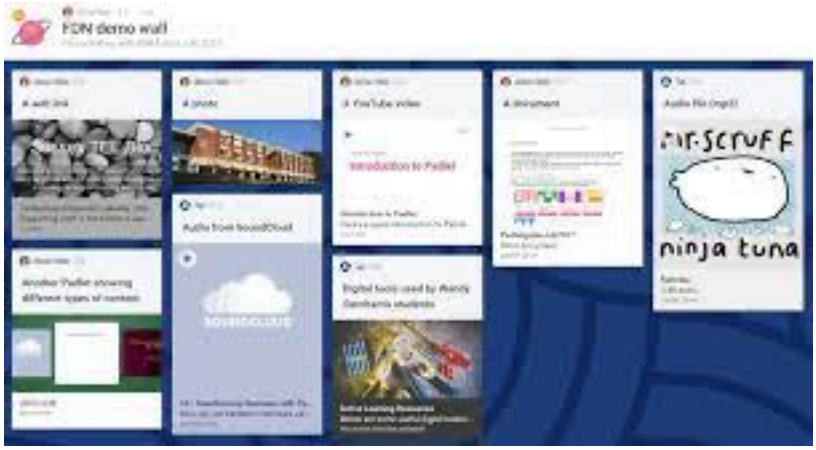
4. Improvement

4.1 Improving the planning stage of action learning through group based learning

Promoting collaborative learning[3] give s students a clearer learning objectives and helps students to set their learning goals. Collaborative learning lowers the anxiety that the students need to work induvial and who may have poor performance under pressure and fear of failure. Action learning[4] is based on the relationship between reflection and action, when students fails to plan their study detailed and concisely, the reflection of their study would be vague and frustrated. When the initial stage of goal setting in self-directed learning is not visible, teachers couldn't give feedback on their goal setting accordingly.

Making powerful decisions is greatly enhanced by working with others[5]. During my teaching process, most of the teaching was individual tasks, the learning progress was lake of collaborative learning. A group or a team can help the students to understand his/ her situation and helped them to explore the issues, which helps students to learn from the judgement of others. Also, a team can give support and bring continuous awareness on their current situation. The members of the group will improve their performance through the process of questioning each other's work and giving support. For example, after the pretest, a few simple questions can be post on Padlet, and divide students into groups, setting their learning goals. After the pretest, students could set their learning goals and planning the next action.

[3] Rutherford, S. M. (2014). Collaborative learning: Theory, strategies and educational benefits. Nova.
[4] Rigg, C., & Trehan, K. (2004). Reflections on working with critical action learning. Action Learning: Research and Practice, 1(2), 149-165.
[5] Kotter, J. P. (1995). Leading change: Why transformation efforts fail.



Sample of using Padlet in the lesson

Padlet create an positive learning atmosphere. The benefits of using Padlet are a lot, students can see each other's work and give comments to others. It demonstrates the work of others, giving a positive reinforcement for students to complete their work and learn from others. Padlet creates a room of monitoring and discussion of ideas. When the team shared a project, that they worked together and have a common goal, they would undertake some actions to meet the targets. The function of a group project enabling the performance of individuals in a team. The discussion in a group focuses on the issues and challenges of teammate's, the teammate is expected to be listened and finding the solutions.

4.2 Diverse assessment methods

The project should adapt various assessment methods instead of using summative assessment only. To solve the challenges mentioned above, the further action can be giving diversified homework and promote students self-planned learning[6]. During the project, students have pre-test, quizzes, homework and summative assessment, these kinds of tasks can help students review their studies and give a lot of exercise and

[6] Tough, A. (1993). Self-planned learning and major personal change. Routledge, New York, USA, 31

references for them to revise their studies. The project failing to assess the learning ability of students comprehensively, it focuses on the requirements of basic competencies, which leads to the scope of assessment is too narrow.

The difficulty of learning assignment can be adjusted based on the learning ability or learning style of students, in order to achieve different learning outcomes. There are four types of students—adaptive, diffuse, convergent, and assimilative(Chiu & Ho, 2009). Teachers can provide appropriate learning materials or design appropriate learning activities according to students' learning style. For example, divide the students into different groups, and assigned the tasks based on their personality. After the lesson of surface area of sphere, we may allowing adaptive students to discuss schoolwork problems and report in groups, allowing convergent students try to connect the problem solving with real life, allowing diffused students finding the possibility of applying surface area in real life, allowing assimilating students to summarize the core concepts of the topic. Teacher as a researcher should be aware of the responses and behaviors on the lesson, giving oral comment, instead of quizzes.

The conceptual model and corresponding definition of self-directed learning, one of the component is self-planned learning (Tough, 1979). Self-planned learning means students plan their learning before acting, for example, they set learning targets and expected learning outcomes. With the clear learning target, students can reflected on their action in a more directed way. Without the process of planning, students may miss a great deal of potential learning, it could resulted in slow development and ill-informed action.

Action learning research is a form of self-reflective, in order to improve the students' understanding of learning process and the situation when these practices are carried out(Carr and Kemmis,1986). Which means students should recognize the steps of action learning and understand what to do in each step, in order to achieve self-directed learning. If we expected the students achieve self-directed learning form the steps of action learning, including act, reflect, learn and plan. We should apply scaffolding, guiding the students from the zone of proximal development to the zone of learner can do unaided. Building up the concept of action learning giving opportunities for students achieve self-directed learning by themselves.

To better improve the reflection, we should adding questions related to reflect on how does the success happened. For example, 'What did you do, so that you can improve the performance of learning?' as one of the questions in the interview with students. From the perspective of teacher as a researcher, I observed that some of the students using highlight pen and write the summary by themselves. It helps them to remark the key concepts and approached of solutions. To reflect on the learning strategies students used in their study leads to successful, helps to influence their action of learning in the future.

Summary of issues to be addressed and solutions

Issues	Consequences	Solution	Expected outcome
Planning stage of the project is not enough	Students forget the learning targets they set from the beginning	Forming groups and using Padlet	Students reflect on their learning more effectively
The design do not cater for students with all learning needs	Cannot assess the ability of students comprehensively	Using diverse assessment method and apply self-planned learning	Provide quality feedbacks and help students develop into their own evaluators

5. Limitations and implications

According to the report from the Hong Kong Examinations and Assessment Authority, the number of students who satisfying the general entrance requirements for local four-year undergraduate programs is larger than the number of students enrolled by the undergraduate programs. That means all the students wants to get a higher result in their examination. Under the syllabus of Education Bureau, students are more focuses on how to getting a higher grade of examinations, teachers in school emphasis on how to helps their students get a higher grade. In such a strong competitive atmosphere, students who wants to learn the content that will appear in the exam paper. They are not interested in 'why', and the history of the knowledge. To achieve self-directed learning, students are required to complete the five stages of self-directed learning by themselves and keep on self-monitoring. But the goals and the learning target are mostly focus on the learning content, less appreciate on students' attitudes and their improvements.

According to the discussion of Legislative Council in 2012, it pointed out that the number of secondary students brings difficulties of promote small class lecture in secondary school. From my teaching experience, there are huge learning difference in a class since the students are divided into different classes according to their ability of languages. The process of action learning can welly adopted by the students who have higher learning abilities, but the students with lower learning ability was barely complete their work, not to say spending time on self-reflection. The learning motivation of students are not strong enough to study after the lessons, the homework assigned by the teachers is considered as the punishment of the students, and some students need detention if they didn't finish their homework. Therefore, students resist to explore more and self-learning without the help from teachers.

6. Conclusion

The purpose of the project is helping students achieve self-directed learning in Mathematics lessons. But more importantly, it is hoped that students can gain and master relevant skills from self-directed learning, and extend it to other subjects and even helps them to build up a positive attitudes in life-long learning. School is a stage of building foundation before individuals get into society, the knowledge teaches in school may not be applicated in their future. But the attitude and skills of self-directed learning provides a structure for individual to reflect on own behaviors and improve the performance.

After the 6 weeks project conducted in the schools, the learning performance of students had improved from the cognitive domain, affective domain and psychomotor domain. Students showed a positive learning attitude of adapting self-directed learning, the students showed that they have notice the weakness of their study, and they have applying different methods to help with their learning. Throughout the teaching in school, guiding students steps by steps to go through the four steps of Action Learning, including plan, act, reflect and learn gives a clear instruction for students to follow. It brings sense of satisfaction when students are able to carry out the four steps by themselves and the effective of self-directed learning is improved. From the feedbacks of students, they have developed a sense of study on their own actions and experience, which benefits them in life-long learning.

7. Appendix

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