Introducing **Problem Based Learning** as Final Year Projects

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Adoption of PBL in Chemistry's Laboratory Classes

First Introduction to Chemistry's Lab Courses

2002 – 2003 (2nd Term) – as a trial run
Half of a regular 2nd year lab course (equivalent to 1-unit)

Full Implementation into the Undergraduate Curriculum

Since 2008 – 2009 (2 Terms, 4-units)
As final year compulsory projects

Final year Laboratory classes before 2008

Students were required to take 3 lab sessions
Lab classes: experiments with lab manuals

What is Problem-based Learning:

Problem-based Learning (PBL)

A student-centered instructional strategy in which students collaboratively solve problems and reflect on their experiences.

Characteristics of PBL:

- Learning is driven by challenging, open-ended, research problems.
- Students generally work in collaborative groups.
- Teachers take on the role as “facilitators” of learning.

The Basics of the Arrangements of PBL in Dept of Chemistry

Each group is composed of:

1 Project proposer/consultant (professor / instructor)
1 Laboratory supervisor (instructor)
1 Group leader (teaching assistant)
4 Students

In PBL, students are encouraged to take responsibility for their group and organize and direct the learning process, with the support from the group leaders and instructors.

Objectives / Learning Outcomes

Professional Learning Outcomes

- Acquire scientific research skills.
- Enhance students' ability in conducting scientific investigations independently.
- Acquire advanced chemistry knowledge and skills on specific areas.
- Familiar with the use of chemical literature and databases.
- Learning how to apply their chemistry knowledge in actual investigative works.

Generic Learning Outcomes

- Enhance problem-solving skills.
- Professional presentation skills – professional scientific oral presentations and written reports.
- Communication and team-work skills.
- Acquire skills on project management and team management.

Outline of the Major Teaching & Learning Activities/Requirements

Objective of the course design – a close replication of the actual scientific research environment

Lab-based research work:	6 – 8 hrs / week	
Oral project presentation:	1st semester:	2 oral progress reports
	2nd semester:	1 oral progress report 1 final oral presentation
Written project reports:	1st semester:	1 written progress report
	2nd semester:	1 final project report
Brief meeting (students and group leader):		Once every week
Brief meeting (students, TA and instructor):		Once every month

Assessment Scheme

(a) Lab performance (30%) - individual

(b) Monthly meeting with instructors (10%) - individual

(c) Oral progress presentations (10%) - group

(d) Written progress report (10%) - group

(e) Final oral presentation (15%) - group

(f) Written project report (25%) - group

(g) Peer's assessment (+/- 10% of the total sum of items (c) – (f))

Topics in 2010 - 2011

(1) Light Controlled Surface Hydrophobicity
(2) Nanomaterials for Near-Infrared-Induced Photocatalysis
(3) Synthesis, Characterization and Reactivity of Cp_2ZrCl_2
(4) Asymmetric Epoxidation of Alkenes with Chiral Ketones Derived from Arabinose
(5) Synthesis of Biological Study of Platinum Compounds as Anti-Tumor Agent
(6) Asymmetric Michael Addition Catalyzed by Amino Acids
(7) HMF (5-hydroxymethylfurfural) in Foods
(8) Synthesis of Metallocorroles
(9) Synthesis and Biological Activity of Antifungal Peptides
(10) Extraction Conditions for Artemisia Annua
(11) Organogelators – Synthesis and Property Studies
(12) Preparation and Spectroscopic Study of CdTe Quantum Dots
(13) Amine-borane for Hydrogen Storage
(14) Obtaining Fuels from Sustainable Resources
(15) Preparation and Characterization of Biodegradable Polymers

Evaluation Results of 2009 - 2010

Comparison of PBL and Regular Lab Classes (Students' View)

	PBL better	About the same	Regular lab better
Appreciating the complexity of actual chemistry problems	81%	8%	12%
Acquiring skills for searching the chemical literature	88%	8%	4%
Planning experimental work	69%	19%	12%
Learning practical lab techniques	38%	35%	27%
Understand the relations between different areas of chemistry	58%	15%	15%
Learning the basic principles of different areas of chemistry	19%	15%	50%
Developing skills for effective and efficient team work	85%	4%	4%
Developing presentation skills	92%	8%	0%
Developing project planning and management skills	88%	8%	4%
Developing greater interest in learning chemistry	35%	27%	8%

Evaluation Results of 2009 - 2010

Course Effectiveness (Students' View)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I become more motivated to engage in self-learning for chemistry	20%	32%	36%	8%	0%
I become more skillful / efficient in self-learning for chemistry	12%	40%	28%	16%	0%
I feel more confident about carrying out chemistry-related research independently	4%	56%	32%	8%	0%
My interest in working on chemistry-related projects were increased	8%	40%	28%	20%	4%
My PBL group leader was very helpful throughout the project	36%	48%	12%	0%	4%
The supports provided were sufficient	24%	36%	20%	16%	4%
I think the PBL course has been well designed and organized	8%	52%	28%	12%	0%
PBL is an effective way for learning chemistry	8%	56%	28%	4%	0%
Overall, I enjoy the PBL experience	12%	52%	28%	0%	8%

Evaluation Results of 2009 - 2010

Some Remarkable Free Comments from Students

Things that Students LIKE MOST about PBL:

Better than teaching lab that PBL can be more flexible
Just like the real research, but PBL is much easier of course
Better preparation if working in lab in the future.

Challenging and fun

I really gain experience in this PBL by actual practice.
This gives chances for us to know there are plenty of minor things that we have to pay attention to; and also a place for us to tackle our problems encountered.
These are important knowledge that cannot be taught in lectures, while they are often encountered once we have to work.

The process of collaborating with team members and exploring the world of science

Evaluation Results of 2009 - 2010

Some Remarkable Free Comments from Students

Things that Students DISLIKE MOST about PBL:

Perhaps the grouping would be a difficult job.
In case of having unfriendly partners, if the other 3 are already closely related, they may probably bully another one, either giving high work-load, or ignorance, or giving an extreme low participation in peer assessment. This would create extreme unfairness.

Some groups are treated too harsh

Some of the topics are exceptionally time-consuming, even during the very step of the synthetic route

There were too many oral progress reports, better to cut half of them.

Supported by Teaching Development Grant (2009 – 2012)

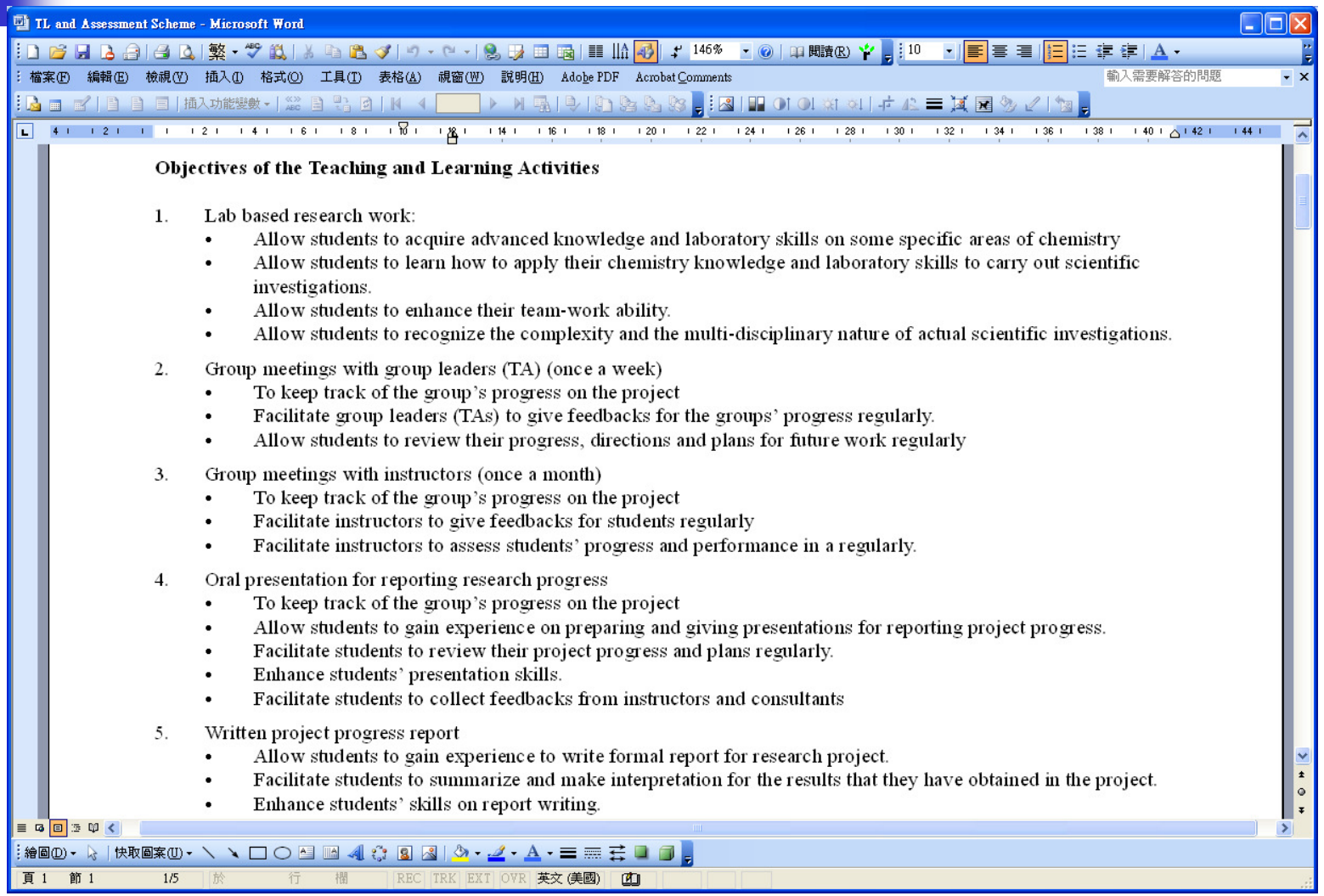
Development of the Problem-based Learning Model for Transitioning Undergraduate Students from Classroom to Research

Key areas of development:

- Define the key professional and generic learning outcomes that are crucial to undergraduate graduates, with inputs from teachers and students.
- Design relevant teaching and learning activities and teaching materials to students to attains these learning outcomes
- Devise assessment scheme in response to the defined learning outcomes
- Develop protocols for guiding teachers, teaching assistants and students to design, plan and work through the projects.
- Develop a web-based platform to support the implementation of T&L activities and course logistics.
- Conduct surveys to evaluate the T&L effectiveness
- Arrange workshops to introduce the PBL model to other departments/faculties

Protocol for Facilitating the Course Management (Example)

Objectives of Each T&L Activity



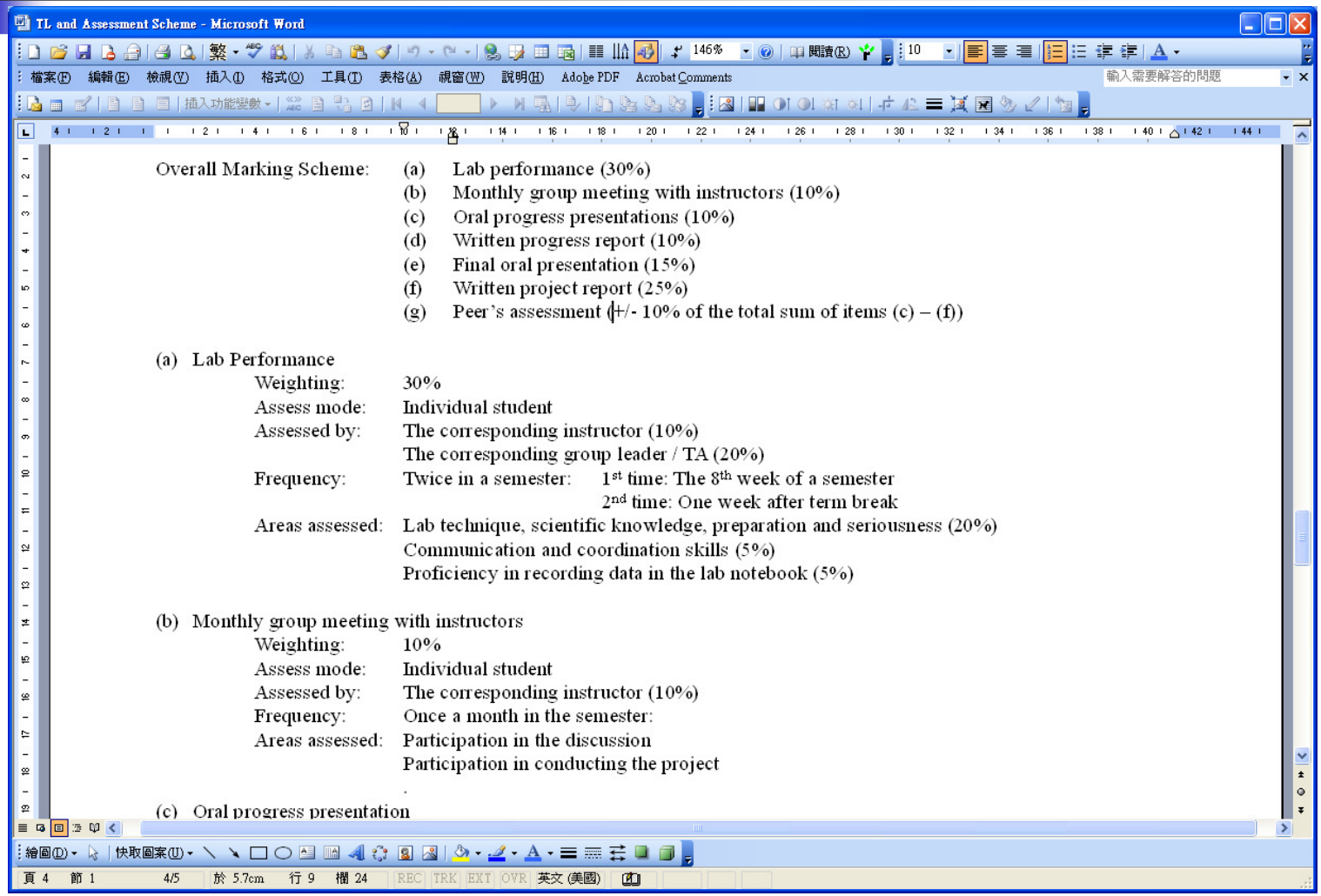
TL and Assessment Scheme - Microsoft Word

Objectives of the Teaching and Learning Activities

1. Lab based research work:
   - Allow students to acquire advanced knowledge and laboratory skills on some specific areas of chemistry
   - Allow students to learn how to apply their chemistry knowledge and laboratory skills to carry out scientific investigations.
   - Allow students to enhance their team-work ability.
   - Allow students to recognize the complexity and the multi-disciplinary nature of actual scientific investigations.
2. Group meetings with group leaders (TA) (once a week)
   - To keep track of the group's progress on the project
   - Facilitate group leaders (TAs) to give feedbacks for the groups' progress regularly.
   - Allow students to review their progress, directions and plans for future work regularly
3. Group meetings with instructors (once a month)
   - To keep track of the group's progress on the project
   - Facilitate instructors to give feedbacks for students regularly
   - Facilitate instructors to assess students' progress and performance in a regularly.
4. Oral presentation for reporting research progress
   - To keep track of the group's progress on the project
   - Allow students to gain experience on preparing and giving presentations for reporting project progress.
   - Facilitate students to review their project progress and plans regularly.
   - Enhance students' presentation skills.
   - Facilitate students to collect feedbacks from instructors and consultants
5. Written project progress report
   - Allow students to gain experience to write formal report for research project.
   - Facilitate students to summarize and make interpretation for the results that they have obtained in the project.
   - Enhance students' skills on report writing.

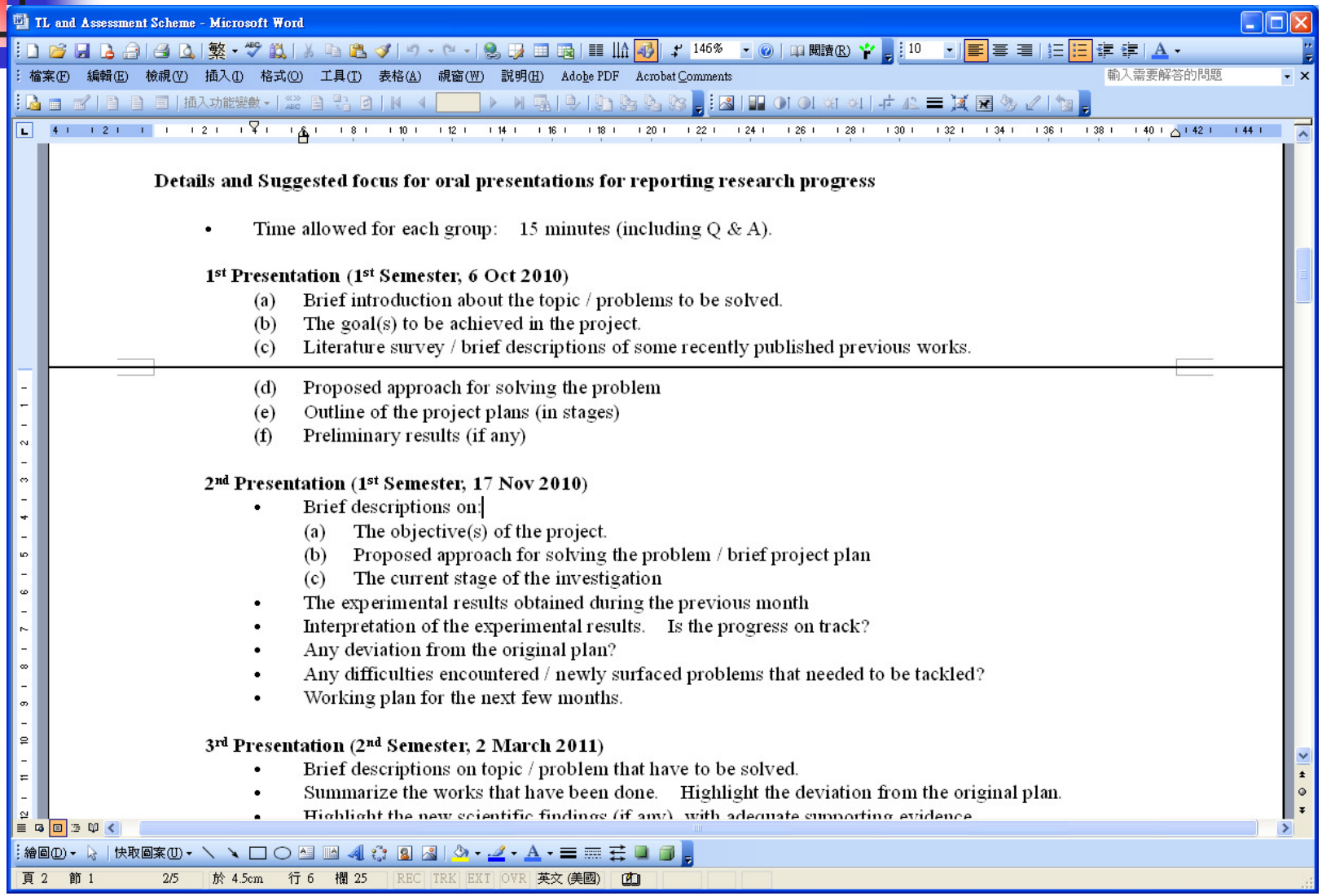
Protocol for Facilitating the Course Management (Example)

Detailed Assessment Scheme



Protocol for Facilitating the Course Management (Example)

Guidelines for Preparing the Presentations

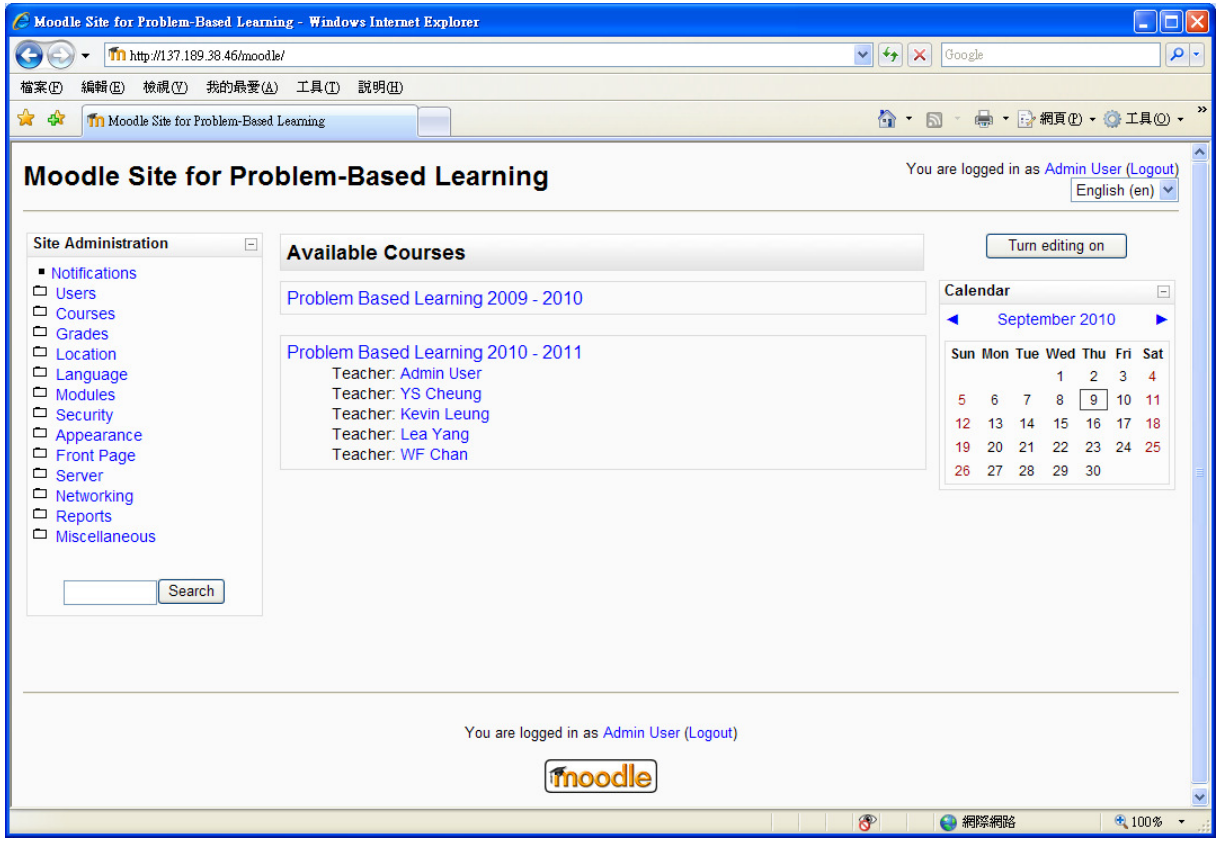


Web-based Platform Developed with Moodle

http://pbl.chem.cuhk.edu.hk/moodle

Why moodle?

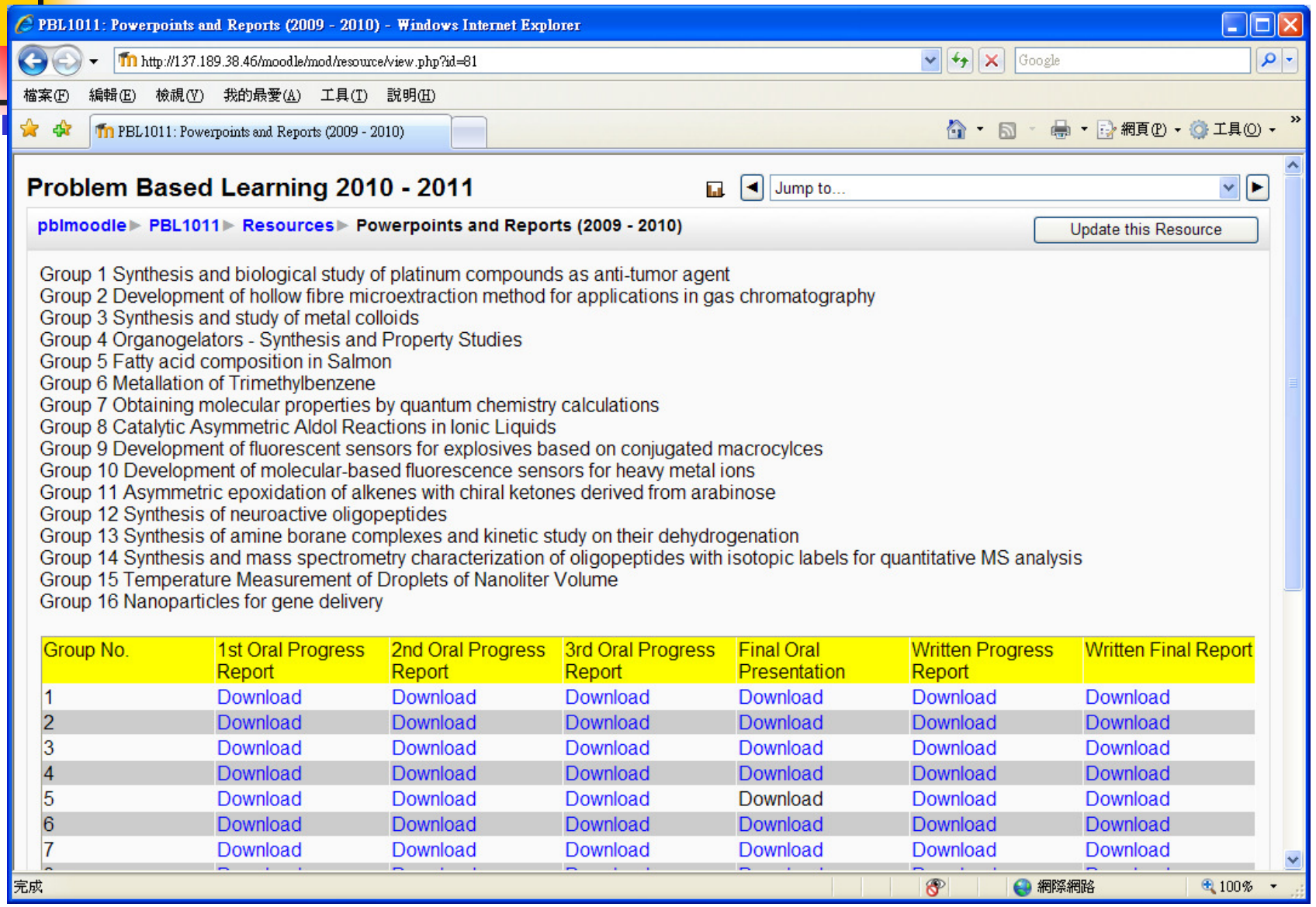
- Open source *(free to use)*
- Flexible and expandable *(lots of add-on modules available)*



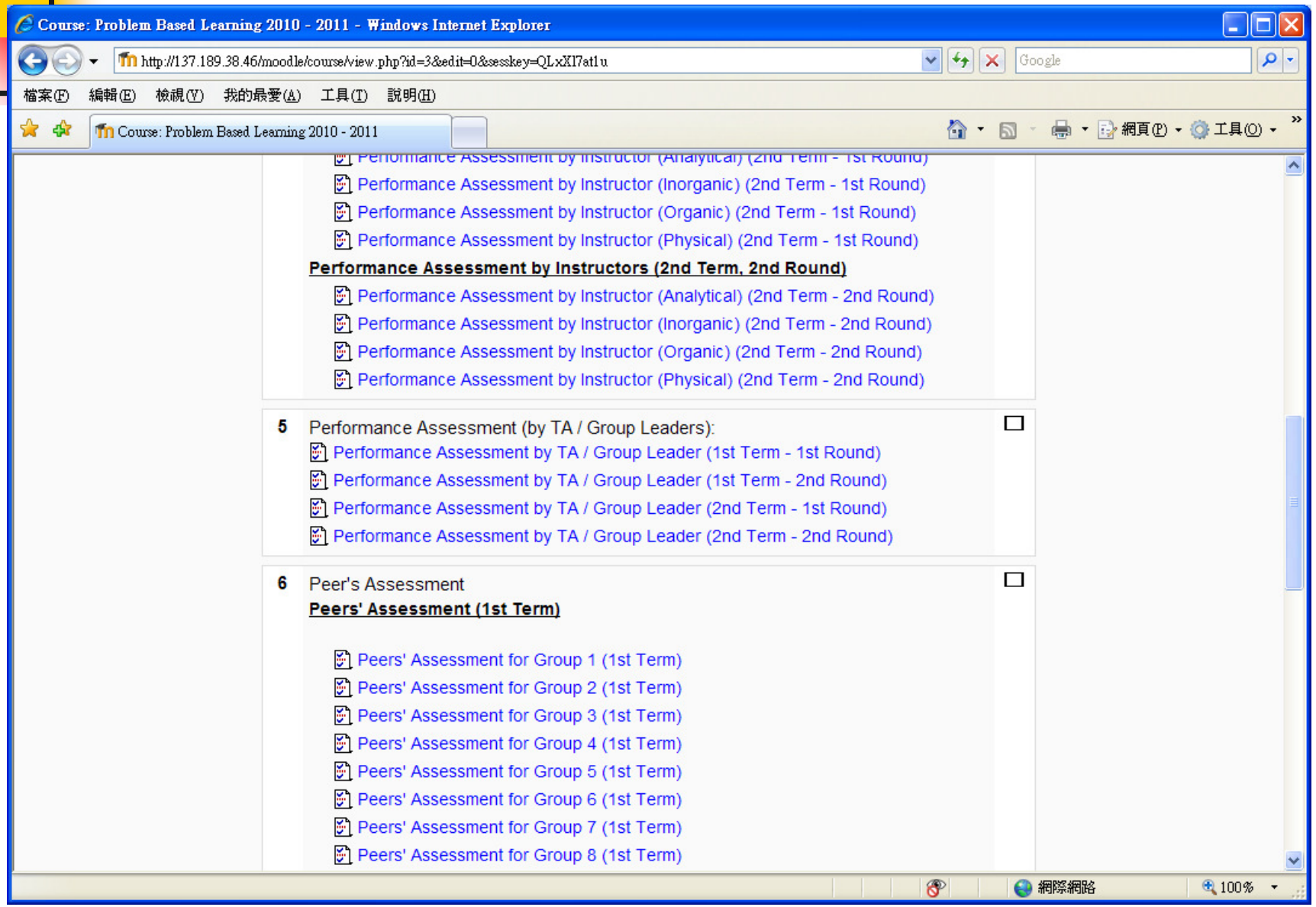
What are now Implemented on the Moodle site?

- General information/instruction about the course
- Previous presentations' powerpoints and reports
- Supporting resources for self-learning
- Platform for collecting the assessment data
- Platform for conducting course survey

Previous Presentations' Powerpoints and Reports on the Moodle site?



Using the Moodle Site to Collect Assessment Data



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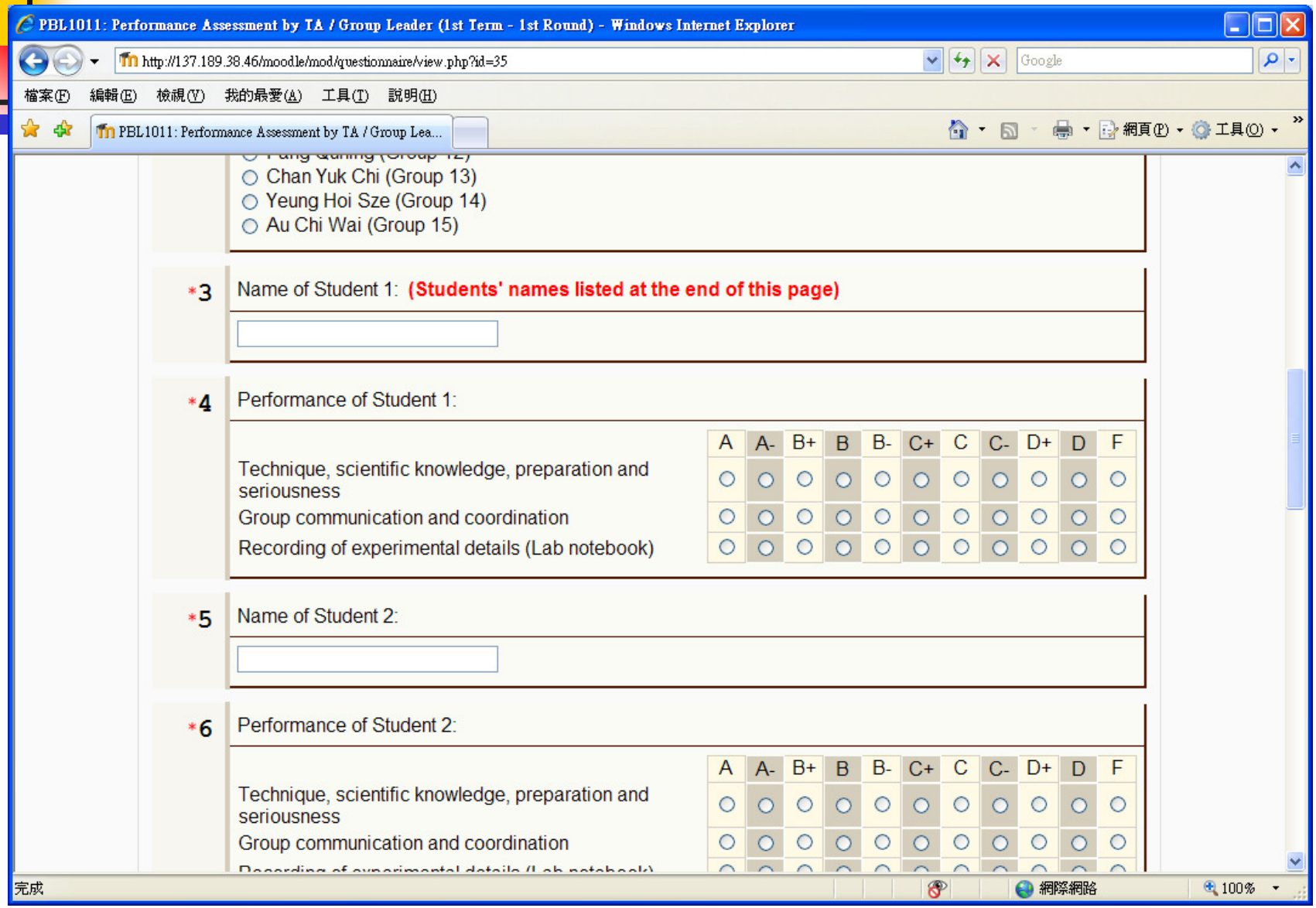

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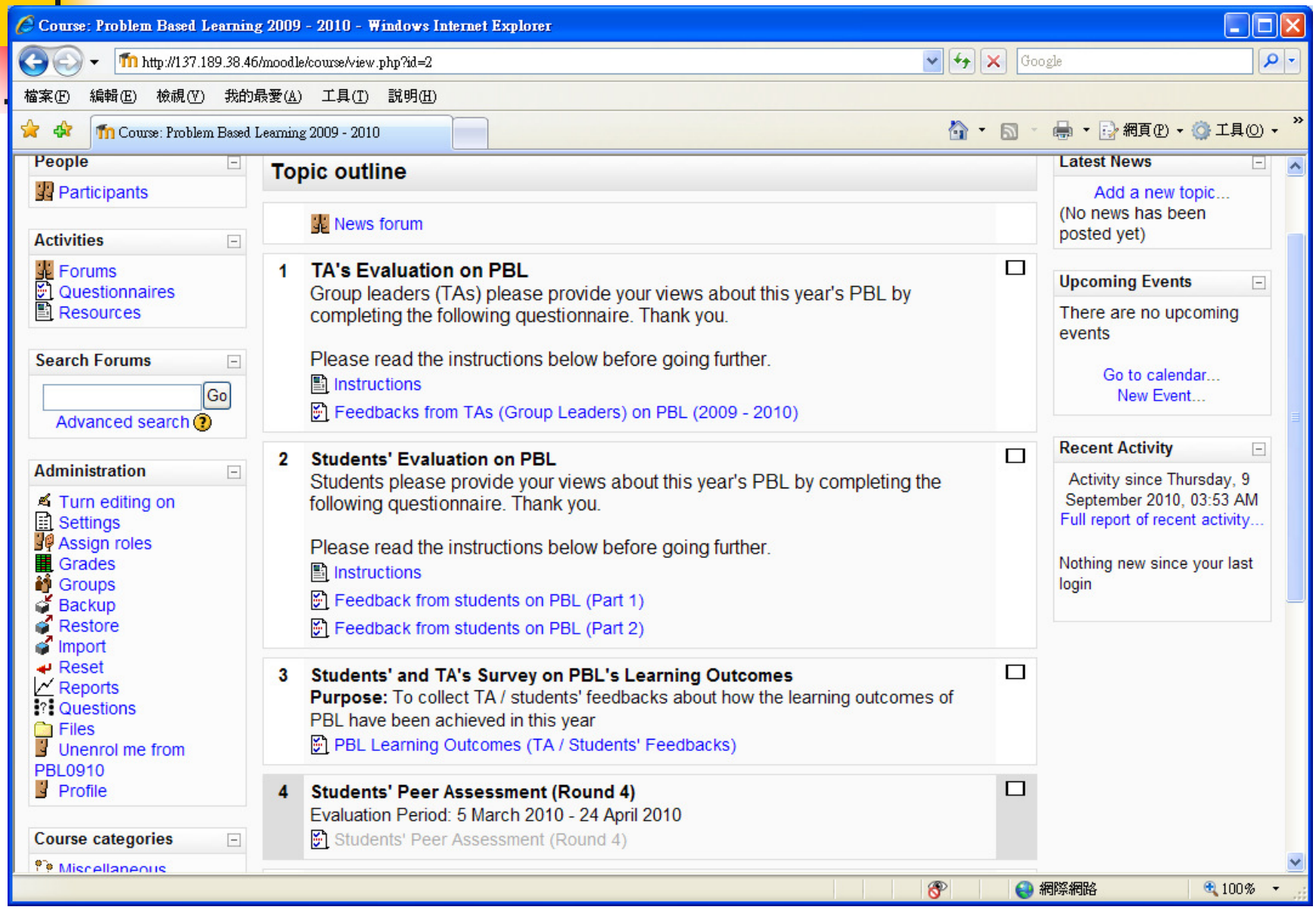

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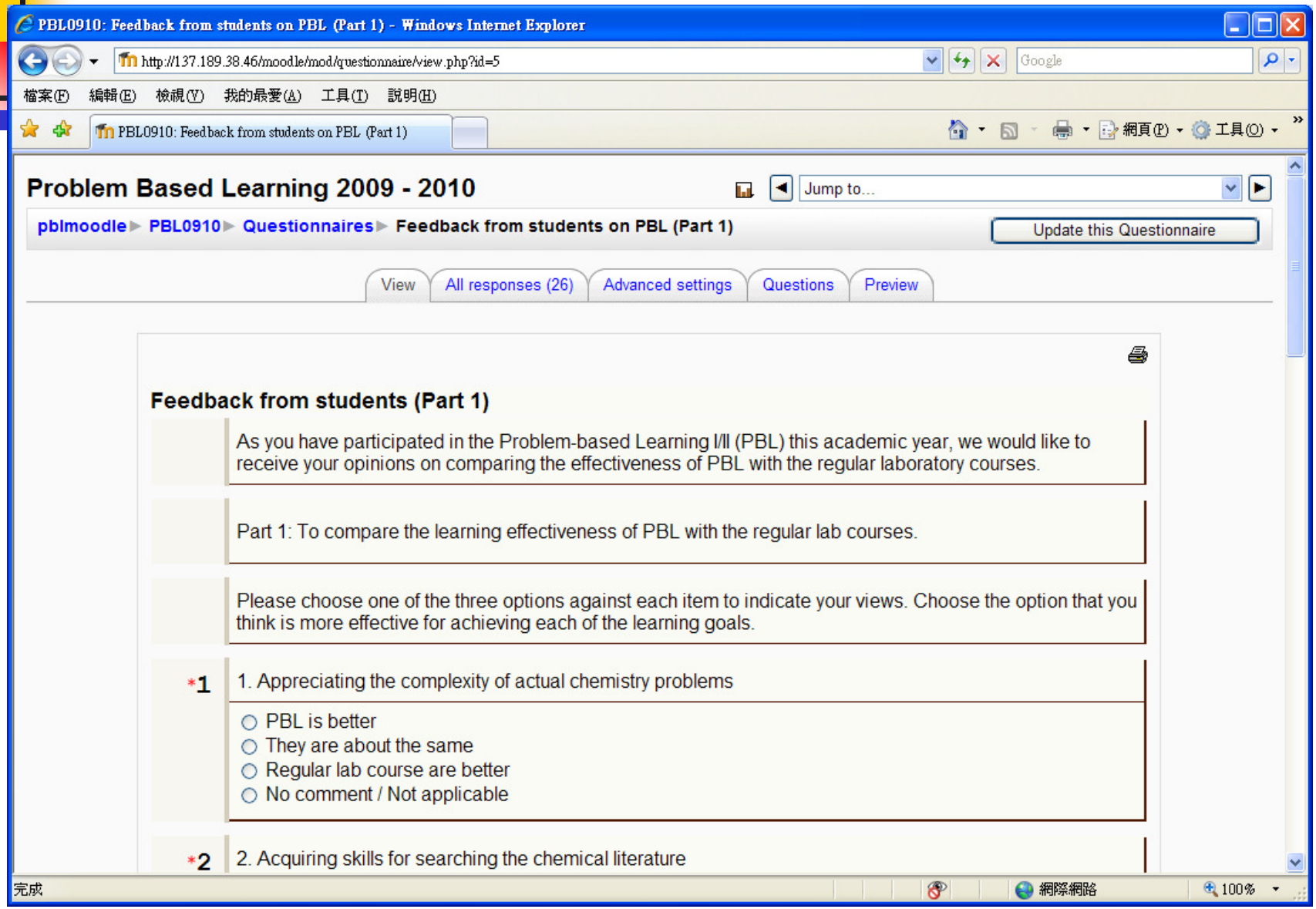

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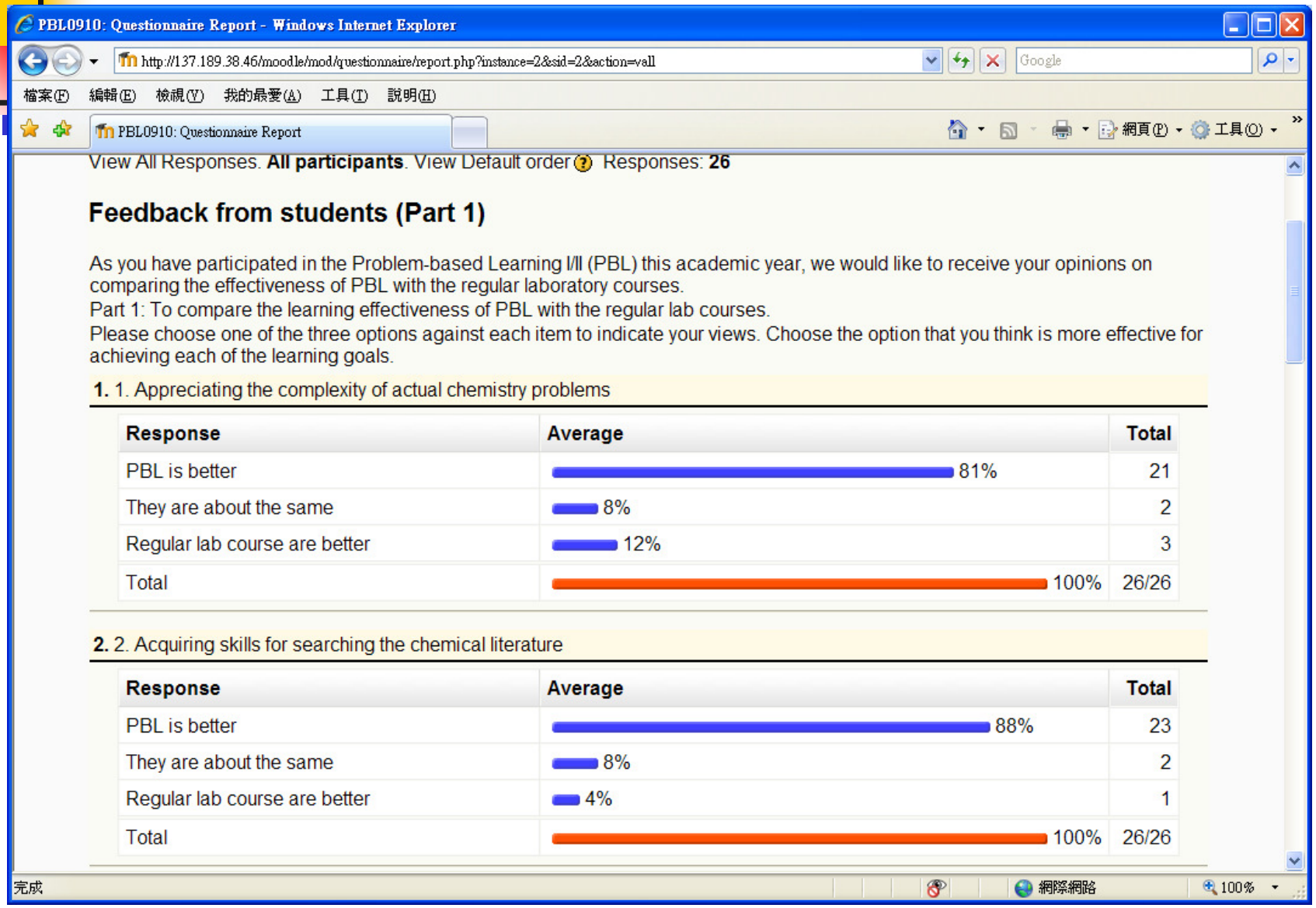

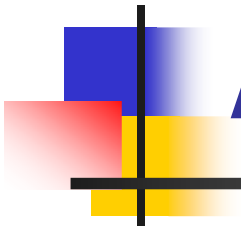

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