Promoting university students' inquiry-based learning through use of questioning:

Review of previous research and description of new research in Japan

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Self-introduction
Yoshi OYAMA

1. Specialized in cognitive and educational psychology
2. In charge of student-teachers' training; Current interest especially on developing students to ask high quality questions.

University education in Japan

- The majority of university classes still relies on use of the lecture method, and students are generally passive in their learning
- Higher education has been changing in response to needs, and adopting alternative ways of teaching
- Examples: Use of reciprocal learning and 'flipped classroom' approaches, to promote the development of crucial 21st century skills in students
- <u>Inquiry-based learning is one direction, and developing students' questioning skills is crucial toward this</u>

Outline

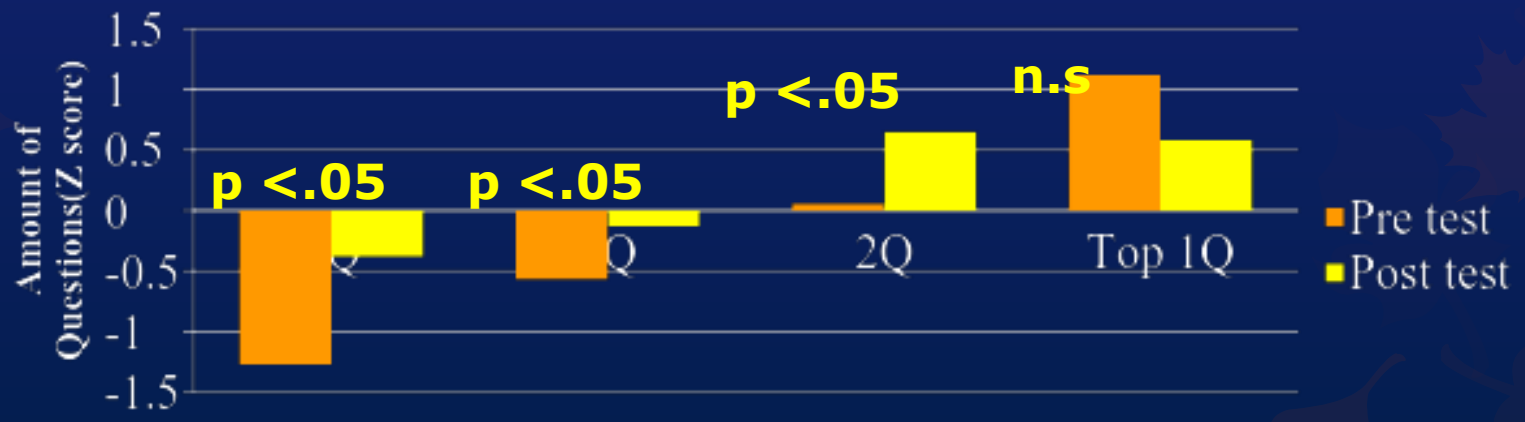
1. Brief review of questioning research in Japan
2. Cognitive variables that influence question generation (Study1)
3. Analysis of the long-term effect of providing “question stems” (Study2)
4. Effect of “evaluation” on promoting question generation (Study3)

Brief review of questioning research in Japan

Training questioning skills through group presentations (Michita, 2011)

Participants: 173 undergraduate students

1） Group (about 8 people) presentation on lecture topic once during the semester
2） Other groups generate questions on the presentation
3） Members of presenting group answer the questions
4） At the end of the class, all of the students fill in a response sheet
5） Instructor picks up a few questions from the sheets and answers them.



Number of questions generated and the attitude toward questioning changed in a more positive manner compared to the lecture method

3 steps approach to assist pupils' question generation (Ikuta & Maruno, 2005)

Prompt "Feeling of unknown"

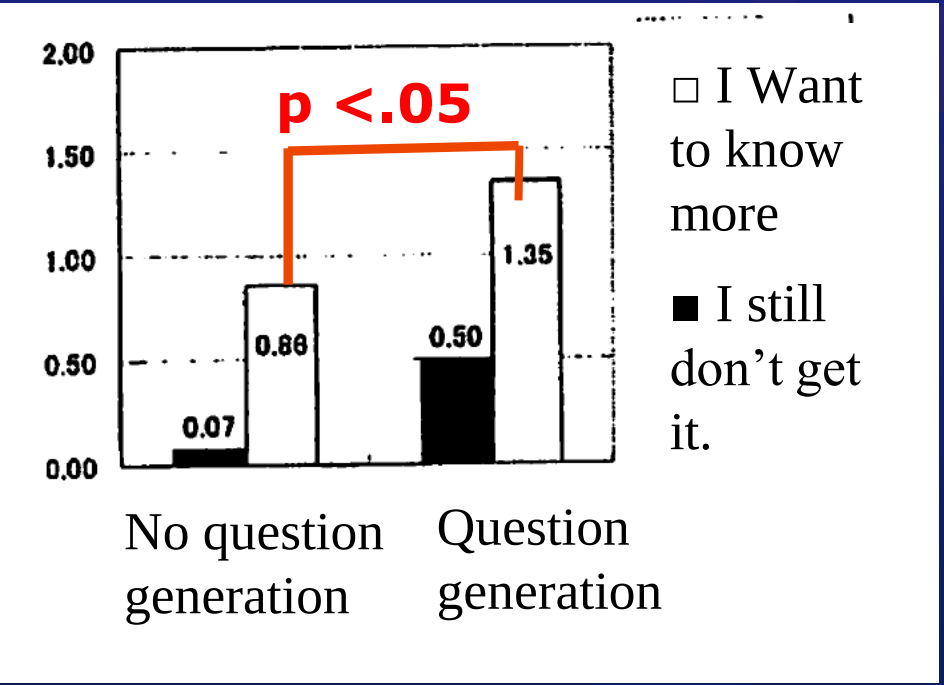
The teacher supports pupils to compare the things they know and the information in the text or from what other people say in the class

Question generation

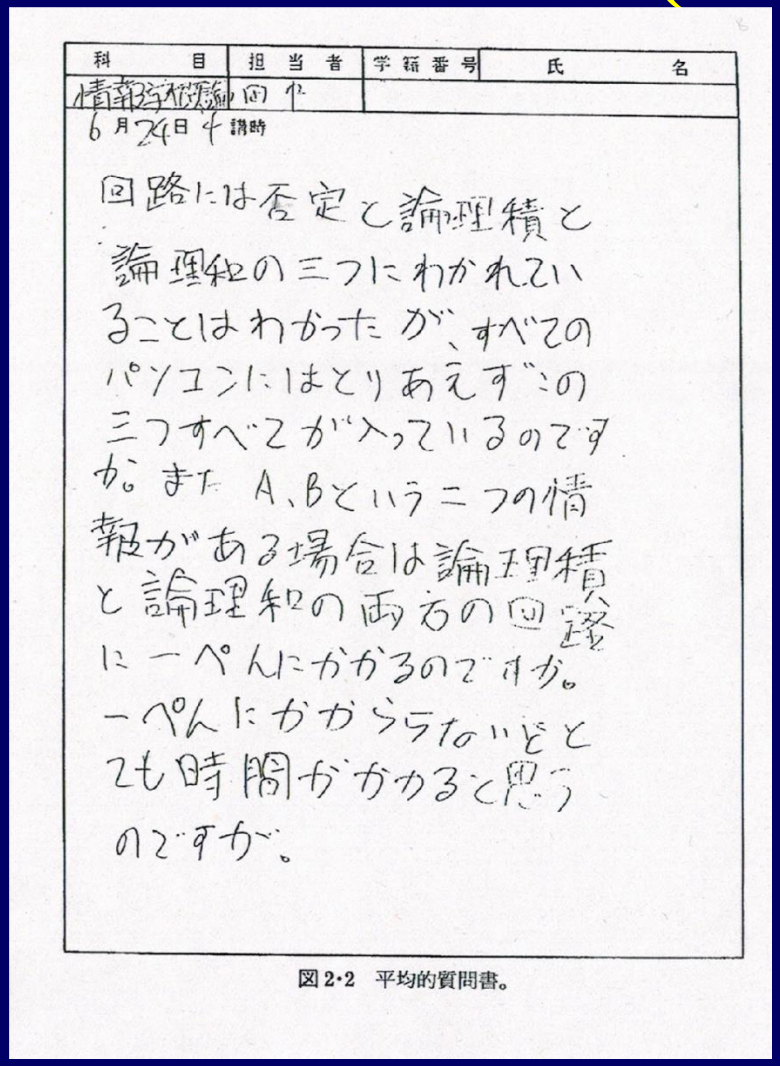
The teacher provides pupils with "Question Stems" to support their question generation

Questions Presentation

The teacher assists pupils with verbalization of questions in front of their classmates.



“Question card method” for university education (Tanaka, 1999)



科目	担当者	学籍番号	氏名
情報学概論	田中		

6月24日 4講時

回路には否定と論理積と論理和の三つにわかれていることはわかったが、すべてのパソコンにはとりあえずこの三つすべてが入っているのですか。またA、Bという二つの情報がある場合は論理積と論理和の両方の回路に一ぺんにかかるのですか。一ぺんにかからないとても時間がかかると思うのですが。

図 2・2　平均的質問書。

- The course grade that students received was based only on the question cards students turned in after every lecture.
- Not based on the data: however, the instructor’s opinion was that “through question generation, students thinking skills improved and they gradually became better at seeing things from multiple perspectives.”

Details of Tanaka's "Question card method"

1. Students write questions on the lecture topics and background explanation of why he/she generated the question(s).

2. After the lecture, the instructor collects the cards, reads all of the students' questions, and rates the appropriateness from 0 to 1. No matter how many questions are generated, "0" is given to questions unrelated to the lecture topic, "0.5" is given to questions without background explanation, and "1" is given to appropriate questions with background explanation.

3. The instructor responds to some of the students' questions during the following lecture.

Study 1

1. Cognitive variables influence question generation (Study 1)

Study 1 clarified which cognitive variables influence question generation, and a training program would target those variables in Study 2 to promote students' question generation.

Method:

The participants: 96 undergraduate students (in psychology). A questionnaire booklet containing the research items was distributed at the end of one lecture session.

Measurements:

- Meta-Cognitive Skills

Japanese version of Metacognitive Awareness Scale (based on Schraw and Dennison's, 1994, scale)

- Beliefs About Questioning

(1 = "strongly disagree", to 6 = "strongly agree")

<u>Cognitive cost of question generation</u>

"It is sometimes tough for me to make questions."

<u>Easiness of question verbalization</u>

"It is easy for me to verbalize what I am perplexed about".

<u>Method for generating questions unknown</u>

I do not know how to generate an appropriate question.

Question Generation Task

Japanese version of a short passage describing either “Clouds” or “Dissolved Oxygen”, based on Costa’s (1997) study (cited in Otero & Graesser, 2001).

Clouds

Most of the people believe that clouds are made of water vapor. But this can not be so because in this case clouds would be transparent and we would not see them. Water contained in a cloud is found as minute droplets that scatter light and give clouds their characteristic white color. These droplets fall down very slowly because of air friction and the turbulence existing in clouds. When there is enough water vapor for the water droplets to increase in size, their falling speed increases. They capture other droplets found in their path as they fall, and continue growing.

Dissolved Oxygen

Some gases, like oxygen, nitrogen, carbon dioxide, or ammonia, are soluble in liquids. The solubility of oxygen in water allows fish to breathe. When the quantity of oxygen dissolved in water decreases because of a polluting process, fish die because of asphyxia. This happens in spite of living in water, H_2O, that contains oxygen. The reason is the incapability of fish to break the water molecule, where the oxygen atom is linked to hydrogen atoms through strong bonds.

Result

Based on King's (1995) study, the generated questions were categorized by two raters as either "factual" or "thought-provoking". The inter-rater agreement was considered satisfactory (Cohen's kappa coefficient = .94).

Example questions about the Cloud passage:

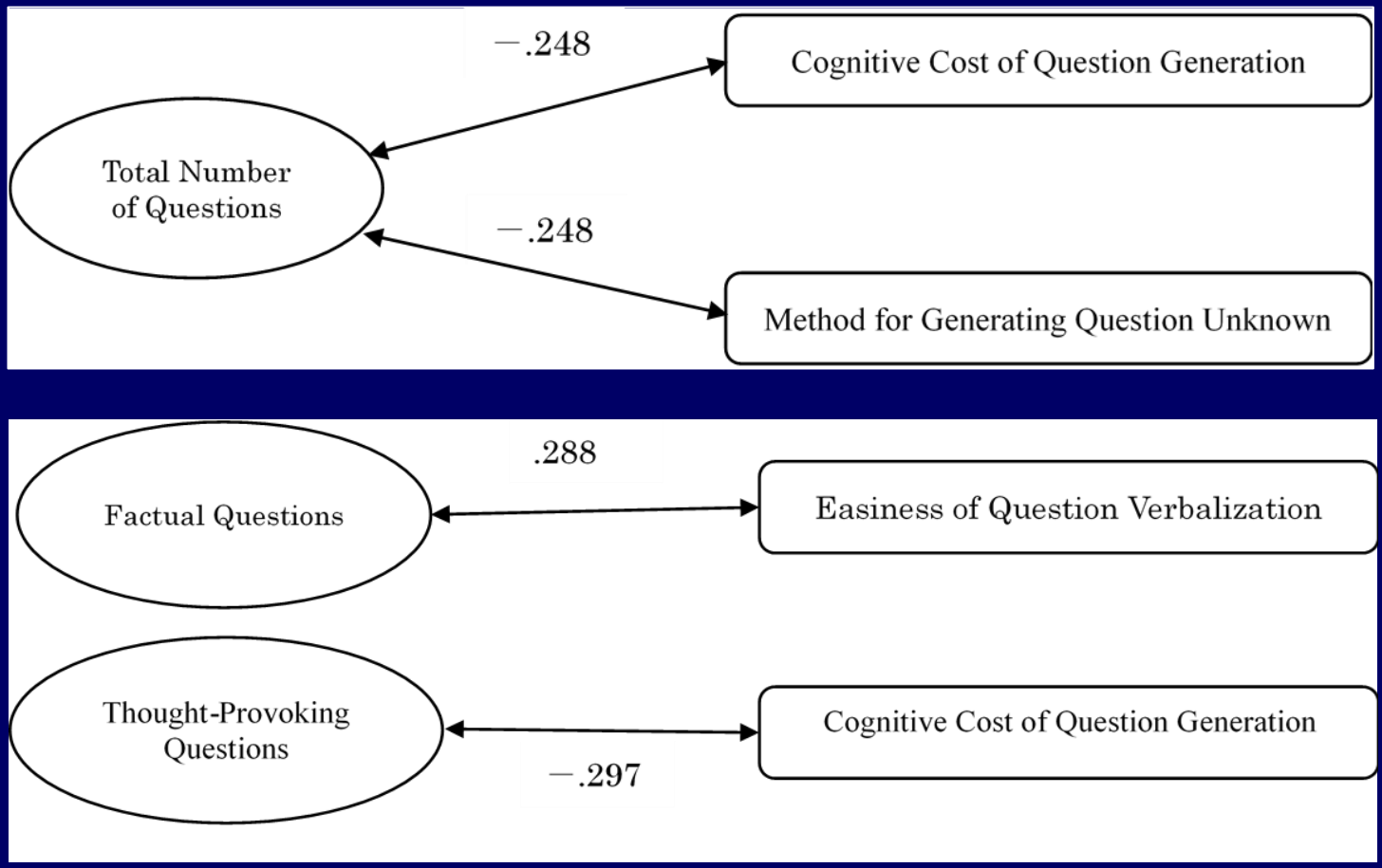
- Factual Question

What are the effects of friction and current in the air?

- Thought-Provoking Question

Why do clouds looks white?

Result



Correlational analysis revealed that “Cognitive cost of question generation“ and "Method for generating questions unknown” hinder learners from generating questions.

Discussion

Based on the result of the study 1, learners would not generate questions because “high cognitive cost” of question generation“ and they do not know how to generate their questions.

Therefore, in study 2, the instructor provide “question stem” to lessen learners’ cognitive cost, and show them how to generate questions to exame learner’s questioning behavior.

Study 2

Study 2

In King (1995)'s study, the participants' number of questions increased with the question stem provision. However, is it truly effective even after the training session ends?

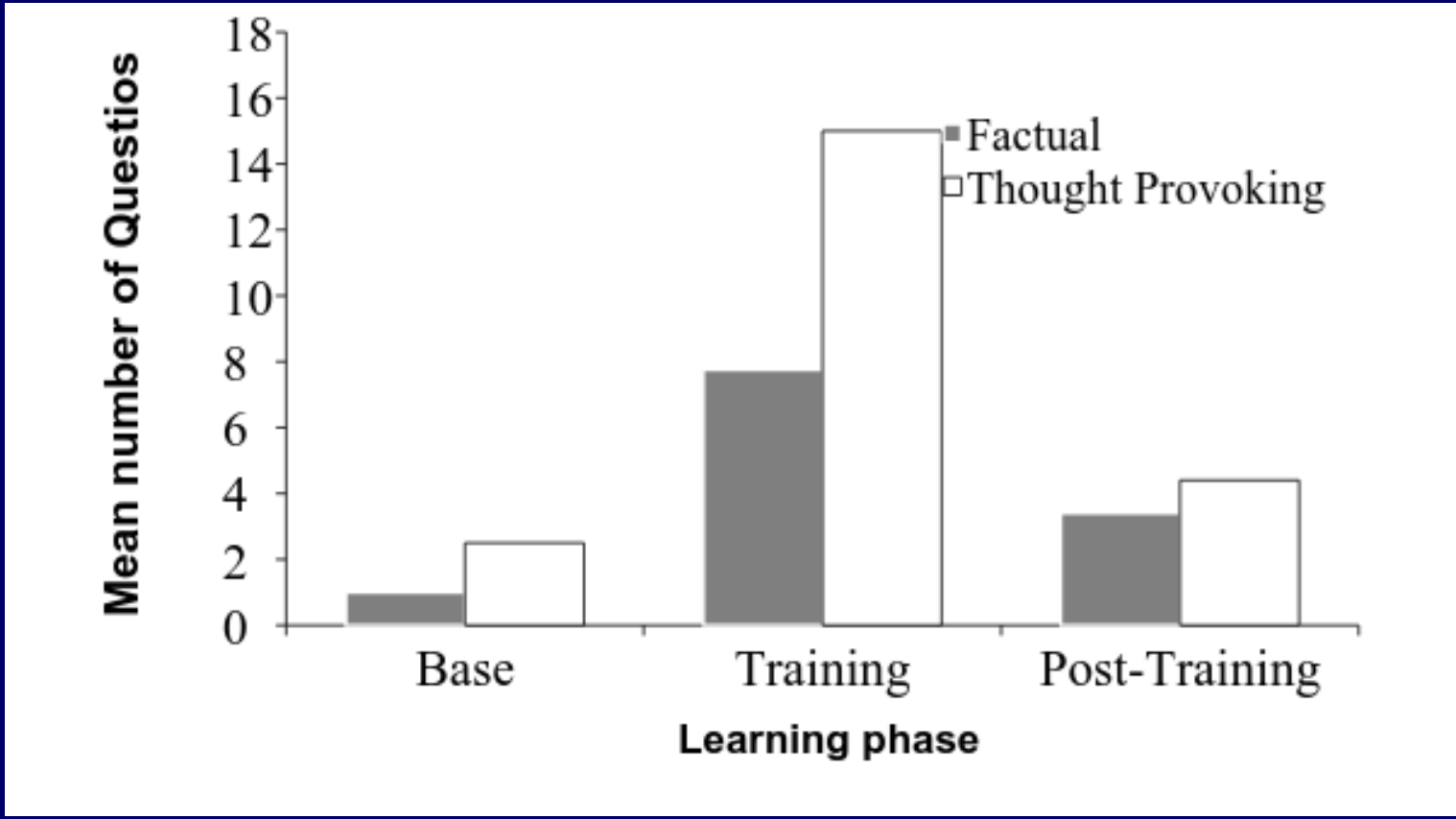
Participants: 61 undergraduate students

Baseline (5 lectures)	Training (5 lectures)	Post-training (5 lectures)
Baseline: no training in generating questions	Training: the participants were given a "question matrix" to generate questions	Post-training: "question matrix" was not distributed to the participants, and the instructor did not ask or verbally encourage the participants to generate questions

Training: Participants were given a “question matrix” to generate questions

Why	**Relation / Influence**	**Advantage/ Disadvantage**
e.g. "Why are people demotivated?"	e.g. “How is Freud’s idea related to Jung's?”	e.g. "What's the main advantage of the client centered therapy?"
Similarity / Difference	**What if**	**In the first place**
e.g. "What are the similarities and differences of the classical and operant conditioning?	e.g. "What if a child has no parents, would he/she fail to form attachment to others?	e.g. " Do intelligence scales measure intelligence in the first place?"

Study 2: Results



The training effect for both factual and thought-provoking question generation was limited to the training phase.

Study 2: Discussion

- Study 1 revealed that cognitive variables such as "Method for generating questions unknown" hinder learners from generating questions.
- Study 2, therefore, provided leaners with method (the "questioning stem") to generate questions.
- However, provision of questioning stems was only effective in the training phase. Long term effect was not observed in Study 2.
- Then, how can we promote university students' inquiry-based learning through use of questioning?

Study 3

Study 3

Effect of "evaluation" on promoting question generation

- Previous studies (e.g., Murayama, 2003) reported that teacher evaluation changes leaners' learning strategy use. Also, Pedrosa-de-Jesus & Watts (2012) suggested to include "evaluation" in the questioning program, CARE.

<u>Hypothesis</u>

The number of questions would increase and students' questioning behavior would continue for inquiry-based learning IF question generation is a part of the course "evaluation" and term papers are based on the questions students generated.

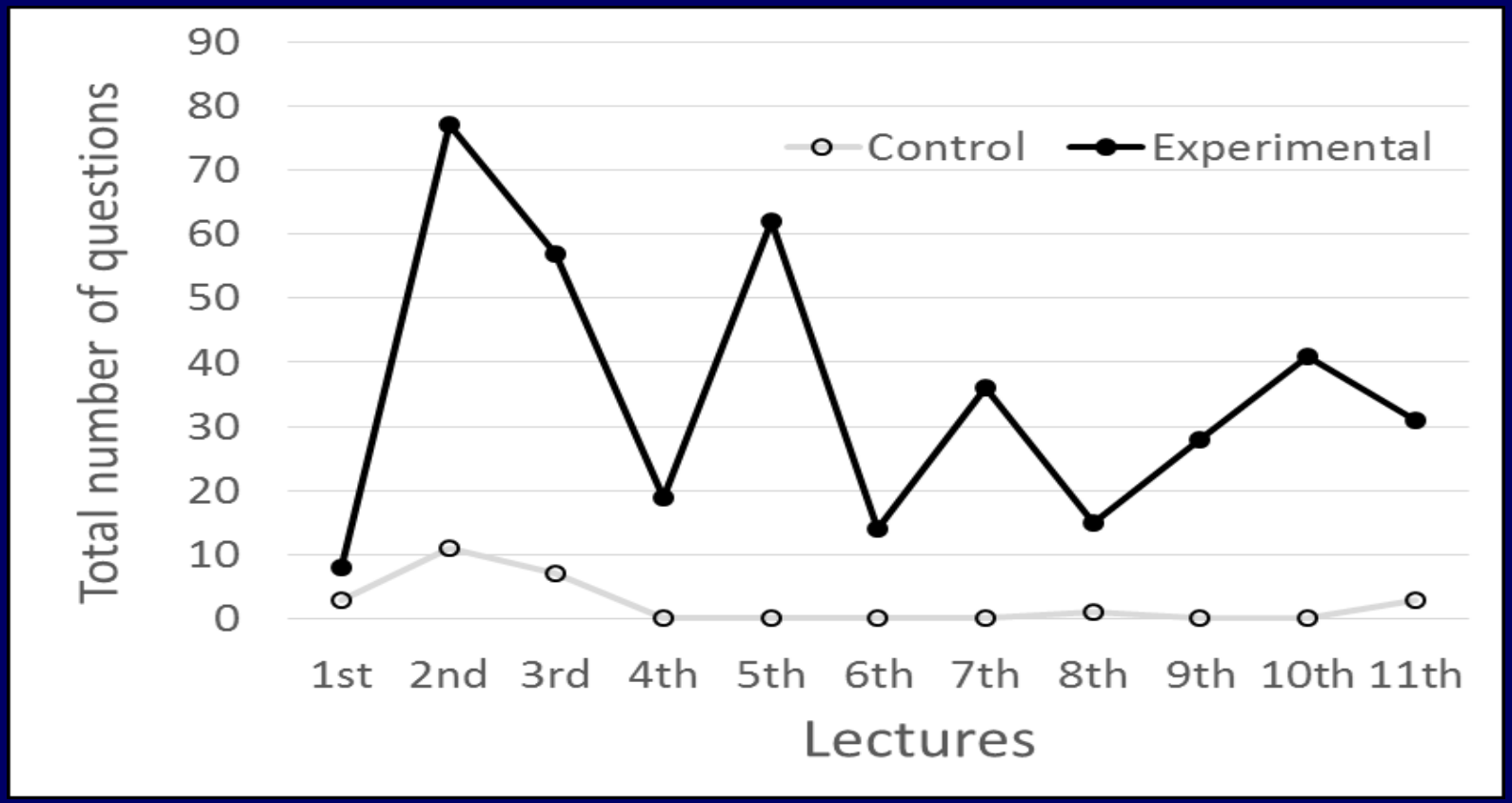
Study 3: Method

Control Class (91 students)	Experimental Class (90 students)

Generate questions concerning the materials covered in each lecture （for both classes)

Required to take two quizzes (at the 4th and 8th class sessions) during the semester.	Required to turn in two reports based on questions they generated in the class (4th and 8th class sessions), In each lecture, their question generation was a part of the course grade (5% of total) .

Study 3: Results



The results showed that the differences in numbers of questions generated by the control and experimental groups were statistically significant for all lectures except the first one.

Study 3:Result

Example of students' report topics:

- Why pupils lose motivation in learning.
- How to teach unforgettable lesson based on theories on human memory.
- Role of punishment in behavior change.
- Dark side of the Pygmalion effect.
- Prevention of students' "Learned Helplessness".

Study 3: Results

In addition...

in the experimental class

The instructor announced a third report for extra credit, to assess students' spontenous inquiry-based learning behavior.

Some students might have done that for the mere purpose of obtaining extra credit, and it was not truly voluntarily. However, in the last lecture of the experimental class,

<u>13 students out of 90 turned in the 3rd paper (14% submission rate).</u>

General Discussion

Study 1 revealed that "cognitive cost of question generation" and "easiness of question verbalization" are factors that affect question generation.

Study 2 examined the long-term effect of providing question stems to help students "verbalize their questions". However, the effect was limited to the training phase only.

Study 3 examined the effect of "evaluation" on question generation and, though it is not truly spontaneous, students generated more questions and improved on their inquiry-based learning by asking more questions about what they were learning.

General Discussion

For students who produced well-researched reports, the instructor asked them to present the contents of their report in front of the class so that they could serve as role models for inquiry-based learning.

Students' responses suggested that, compared to a "lectures & quizzes" class, they enjoyed generating questions and writing their reports better.

However, in the future, ways to promote students' "spontaneous inquiry-based learning (without teacher's evaluation)" need to be developed.