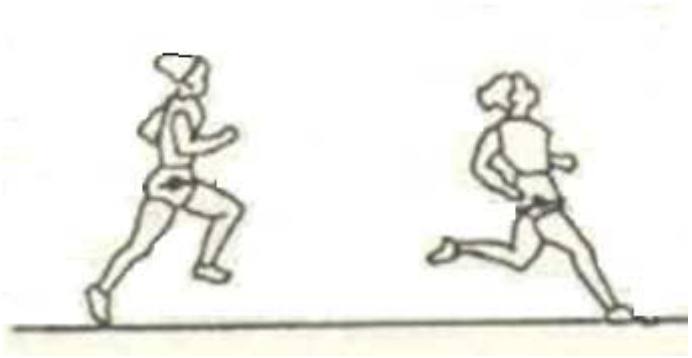
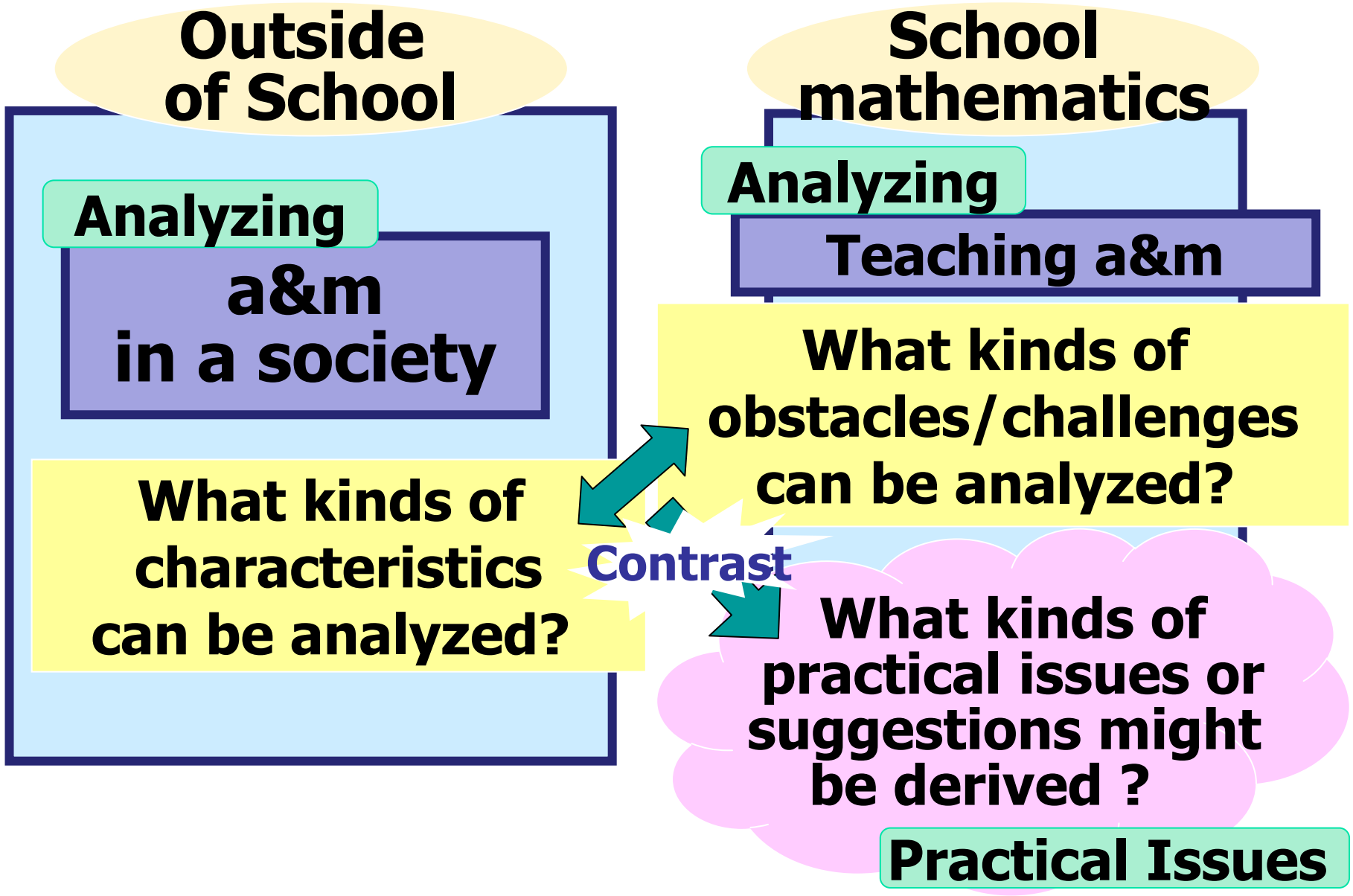


Didactical Reflections on the teaching of mathematical modelling

Suggestions from concepts of "time" and "place"

Toshikazu Ikeda
Yokohama National University, Japan

Didactical Reflections



Focus

Outside of School

Analyzing

a&m in a society

Any mathematical model was build by someone.

Niss(2008)

School mathematics

Practical Issues

What kinds of practical issues or suggestions might be derived by analyzing "Place" and "Time"?

When and Where is the model built?

"Place" and "Time"

Three Issues

Problem situations which people are interested in

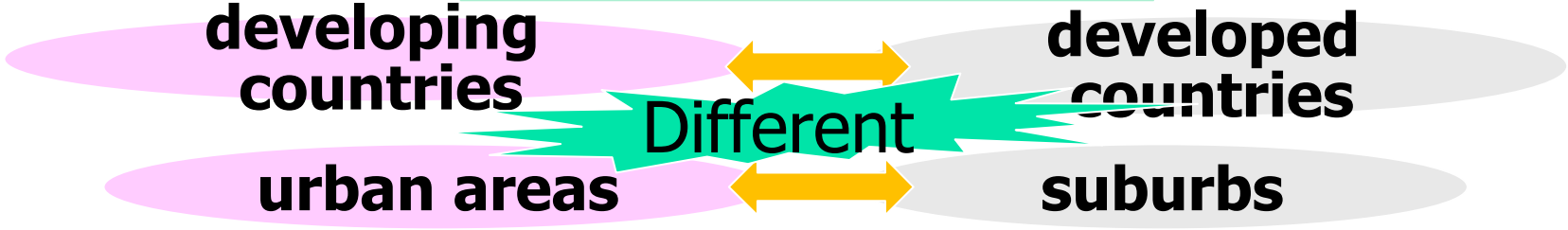
Purposes for using mathematics in a society

Existence of mathematical models, methods, etc. embedded in a society

Place

where people are living (country, area, etc.)

Problem Situation



Time

Problem situations are different in past society and present society

Constructing a figure to measure the length or angle

Select an appropriate modelling task so that students can make sense of a problem situation

What is an appropriate modelling task?

By Galbraith (2007)

(T1) Consistency with avowed purpose

(T2) Introducing real world modelling tasks

(a) the importance of using models based on experience

Further Questions

Does the problem situation concern the surroundings of students at present, or in the future?

Is it concerned with most students or a few students?

Future

Is it concerned with the situation confronted as citizens, as individuals or in their profession/vocation?

What is an appropriate modelling task?

By Galbraith (2007)

(T1) Consistency with avowed purpose

(T2) Introducing real world modelling tasks

(b) motivationnce of using models based on experience

Two points

To clarify the reason why someone had to solve the problem

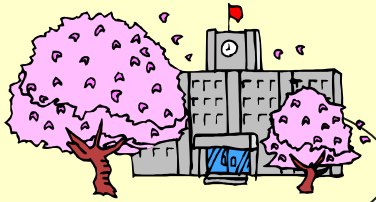
To set the appropriate situation so that students can accept the problem posed by someone as their own problem

(b) motivation

To clarify the reason why someone had to solve the problem

Forecasting when cherry trees will bloom

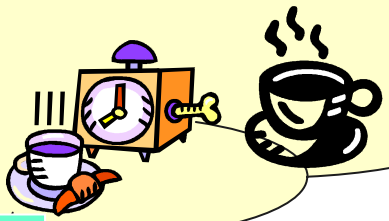
When cherry trees will bloom ?



Important to know the time in a dairy life

Forecast the cooling rate of coffee

How does the temperature decrease as time passes?
Is it proportional or not?



Not important to know in a dairy life

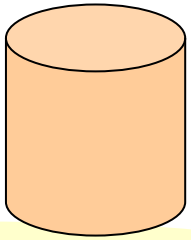
Necessary to stimulate scientific curiosity

(b) **motivation**

To set the appropriate situation so that students can accept the problem posed by someone as their own problem

Observing or analyzing the phenomenon or action

What shapes of cans are used in a supermarket?
Let's examine them this weekend.



Most cans are cylinders, though some are not cylinders

What are the relationships between the shapes and contents of cans?

Some shapes are affected by the can's contents, while the other types are not affected by the can's contents.

Why are the shapes of cans which are not affected by the contents are generally cylinders?

Cost of aluminum

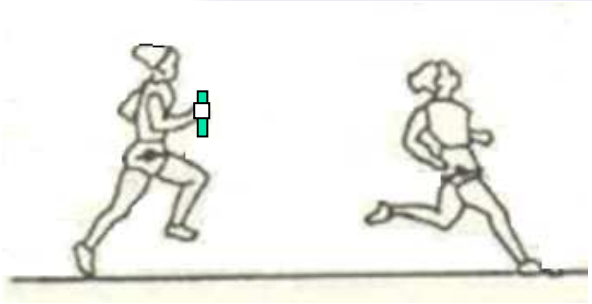
Stability

(b) **motivation**

To set the appropriate situation so that students can accept the problem posed by someone as their own problem

Observing or analyzing the phenomenon or action

How can we win in a relay in school sports? (Osawa,2004)



It is important to consider the order of runners, how to pass the baton, etc

Focusing on the baton pass

When does the next runner begin to run to get the baton from the previous runner, for the shortest baton pass time?

Three Issues

Problem situations which people are interested in

Purposes for using mathematics in a society

Existence of mathematical models, methods, etc. embedded in a society

Place

where people are working on

purposes to use mathematics

By Niss

understand **action** **design**

(P1) in order to *understand* (represent, explain, predict) parts of the world

(P2) in order to subject parts of the world to some kind of *action* (including making decisions, solving problems)

(P3) in order to *design* parts or aspects of the extra-mathematical world (creating or shaping artifacts, i.e. objects, systems, structures).

Place

where people are working on

purposes to use mathematics

By Niss

understand **action** **design**

What kinds of educational goals are emphasized?

Foundation of science

Vocational preparation

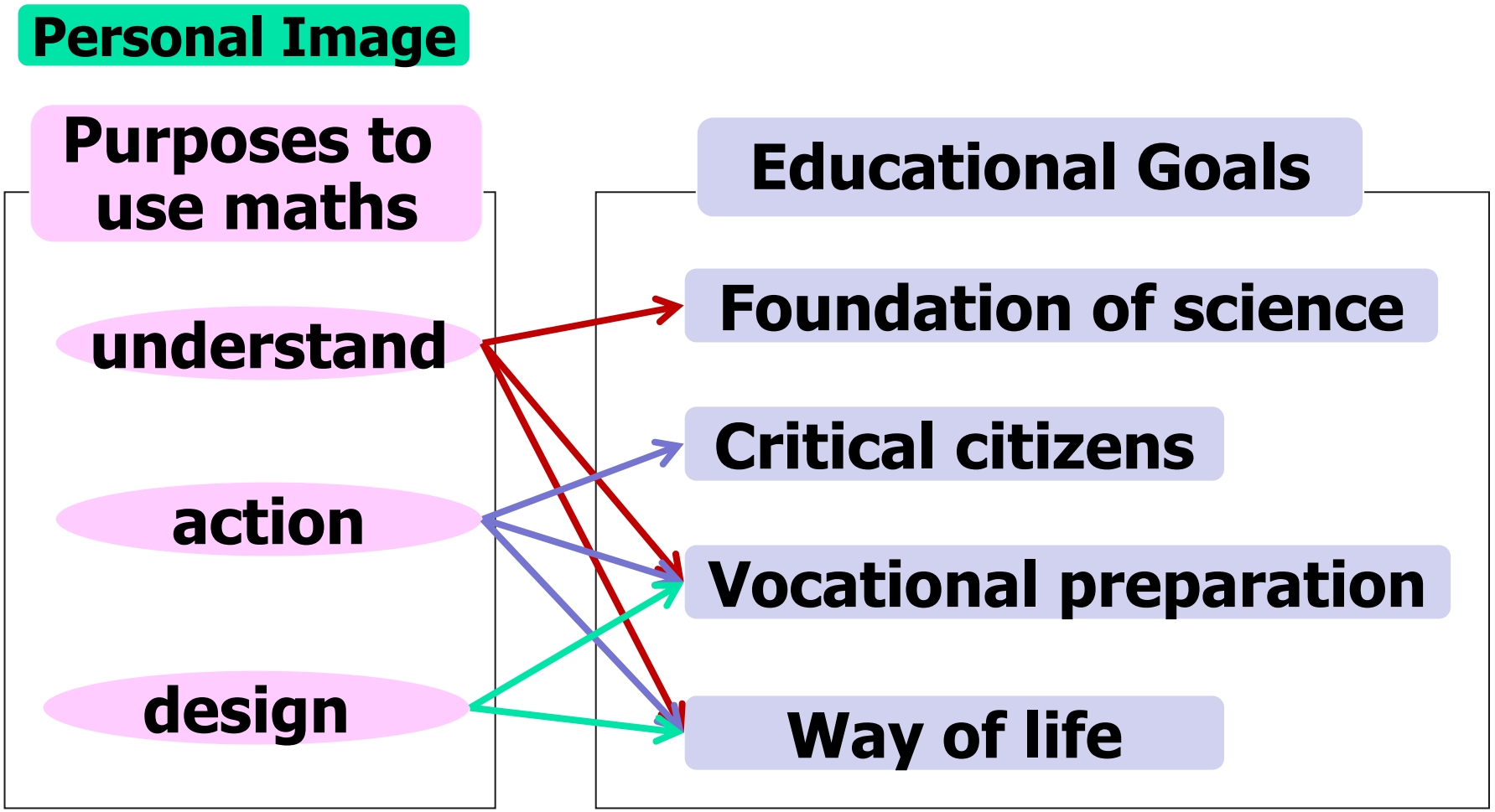
Critical citizens

Way of life

What relations between goals and three purposes?

What relations between three purposes and goals ?

Further analysis is expected



Place

where people are working on

purposes to use mathematics — By Niss

understand **action** **design**

A particular diagram of modelling process is often used to let students understand roughly what modelling is.

Modelling process depends on the purpose or area of other disciplines

understand

Real world situation

Problem

Model 1

Validation

Contrasting the model with the real world phenomena

action　　design

Real world situation

Problem

Model 1 ⟷ Model 2 ⟷ Model 3

Merits and demerits are discussed among models

How can we introduce what is modelling?

Place

where people are working on

purposes to use mathematics — By Niss

understand **action** **design**

Useful when we teach the usefulness of mathematics to students

Balanced approach

Reflect and find out the purposes to use mathematics in a variety of real world situations

How can we assess students' appreciation about usefulness of mathematics?

Example

Before /After modelling teaching

How is mathematics useful when we see real world situations from a variety of viewpoints?

Criteria 1

From only students' personal perspectives
Not from social perspectives

Criteria 2

From social perspectives
Not clear, prejudiced or only special cases

Criteria 3

From social perspectives
Clear and synthetic

understand **action** **design**

Lessons: 100min×9times

9th grade

Example

Before

We can acquire mathematical thinking and judging from maths, however, most people don't use maths in a real life. So, it is no meaning to consider how to use maths in a real life in school.

Criteria 2

After

Maths is useful to set the criteria or theory in a real world situation so that everyone can admit. Maths is useful to consider before doing something. We can predict the solution without doing actually by using maths.

Criteria 3

Three Issues

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Time

The quantities and qualities of mathematical models, methods, concepts, etc. embedded in daily life or society is different.

In the past

The particular mathematical methods which we used as a matter of fact were searched for.

Two teaching approaches

Analyzing mathematical structures or models of existing real life products or phenomenon.

Reflector of a bicycle

Different systems of interest

Finding the focus of an earthquake

Constructing a mathematical model

Do you know the reflector? What is the role?

It is safe for the rider!! It reflects light brightly.

Is it true? Let's examine!

Experiment & Observation

When we conduct an experiment in a dark room using an object from daily life like a penlight, it seems that the bicycle reflector reflects light in the direction exactly opposite to which it came from.

What kind of structure does it have?

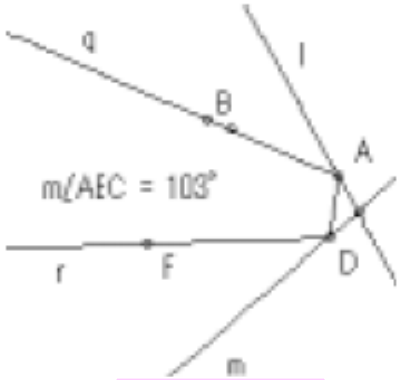
Observation

The angles with which each mirror is constructed are right angles

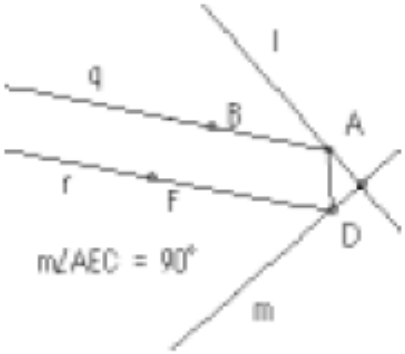
Why?

simple case

Two-dimensional situation



A>90°



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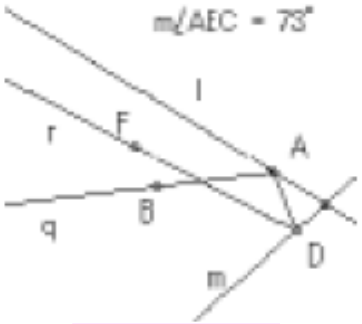


A<90°

Teaching flow is quite different from general modelling process!!

Teaching Flow

1. To clarify why and for whom the object or system has been developed.
2. To find out the characteristics of the object or system by observing and analyzing it.
3. Considering the intention why the object is used in a dairy life, the mathematical structure is investigated.
4. Appreciating the wisdom of ancestors.
   By analyzing implicit assumptions, further modifications are considered.

Modelling process by Pollak (1997)

(1) We identify something we want to know, do, or understand.
(2) We select "objects" that seem important in the real-world question and study the relations among them.
(3) We decide what we will examine and what we will ignore about the objects and their interrelations.
(4) We translate this idealized version into mathematical terms, and obtain a mathematical formulation of it.
(5) We identify the field(s) of mathematics that are needed, and bring to bear the instincts and knowledge of those fields.
(6) We use mathematical methods and insight, and get results.
(7) We translate back to the original field and obtain a theory of the idealized question.
(8) Now comes the reality back. Are the results practical, the answers reasonable, the consequences acceptable?
  (a) If yes, the real world problem solving has been successful.
  (b) If no, we go back to the beginning.

Analytical Approach

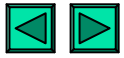
The formulated problems couched in verbal terms are also regarded as matters which someone has developed in the past.

To clarify why and for whom

Taking enough time so that students can interpret why and how the problem situation was generated

It is the teacher's role to consider which approach is appropriate for students, by taking account of both the educational goals and students' surroundings.

Analytical Approach | Constructive Approach



Three Issues

Problem situations which people are interested in

Purposes for using mathematics in a society

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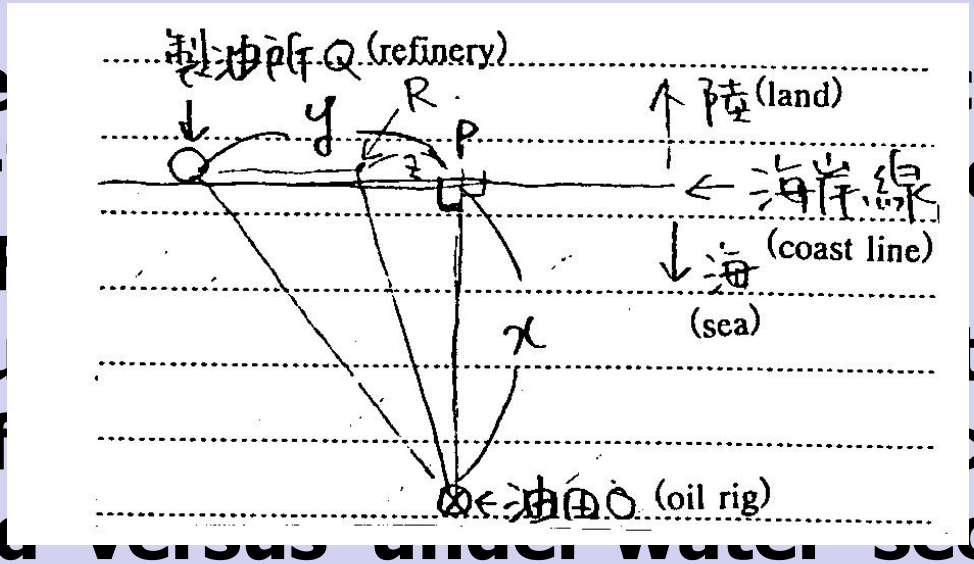
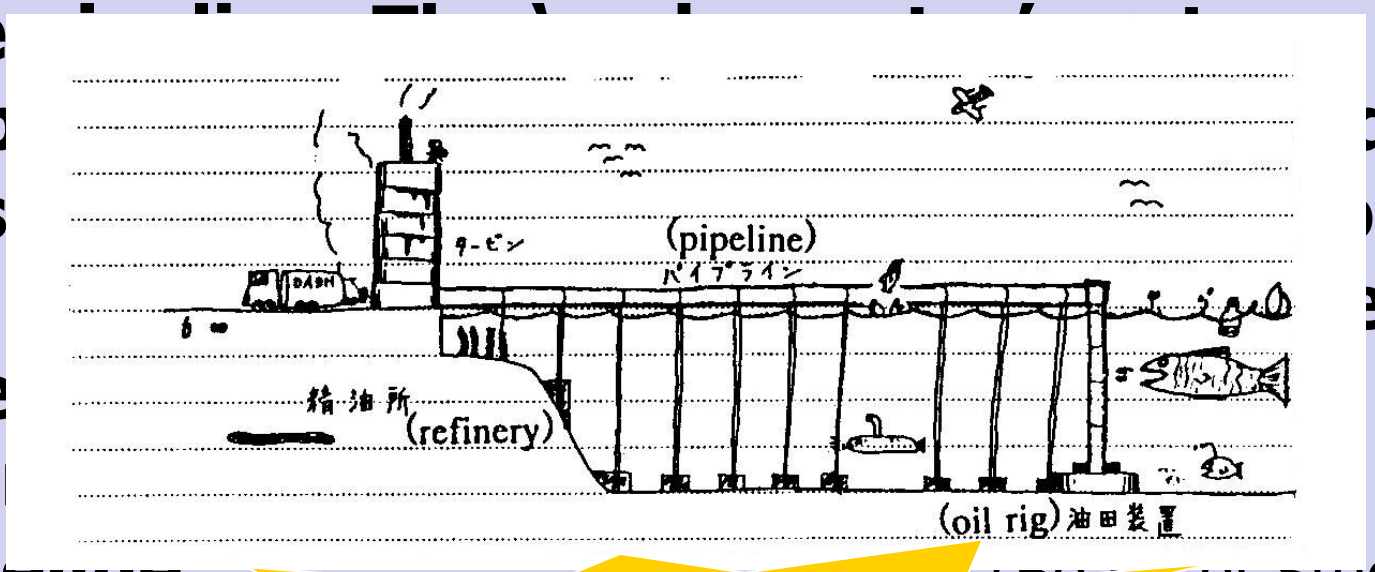
Place

A pipe … connecting an oil r… ery on the coast. … of constru… to account the diff… tion for 'on land' versus 'under water' sections of the … be exp… d' cos… f 'on … e che… co… pipeline.





… Studies, 1997

Not make sense

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OFFENDING COMMAND: --nostringval--

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