



Using Context from PISA Task in Problem Generation and Reformulation Teachers' Experience in Problem Posing Activities

Tatag Yuli Eko Siswono
Universitas Negeri Surabaya

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Outline

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2. Teachers' Mathematical Problem Solving
3. Designing Teachers' Professional Development
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INDONESIA ON PISA MATHEMATICS RESULTS

- Issue on Mathematical Literacy in Indonesia



Year	Rank	Number of Participants	Mean Score	OECD Average Mean Score
2003	38	40	360	500
2006	50	57	391	498
2009	68	74	371	496
2012	64	65	375	494
2015	63	69	386	490
2018?	62	70	386	



INDONESIA ON PISA MATHEMATICS RESULTS

- Indonesian Responses toward PISA results: Research on PISA mathematics
 - a) Assessing students' mathematical literacy
 - b) Designing learning activities improving student's mathematical literacy---RME-based lesson, problem-based lesson
 - c) Teacher training/education for mathematical literacy
 - d) Designing PISA-like mathematics task

Student teacher/prospective teacher completing final project



School teacher



Teachers' Mathematical Problem-solving

Mathematical Problem-solving Knowledge for teaching (Chapman, 2015)

Type of knowledge	Knowledge
Problem solving content knowledge	Mathematical problem solving proficiency
	Mathematical problems
	Mathematical problem solving
Pedagogical problem solving knowledge	Students as mathematical problem solvers
	Instructional practices for problem solving
Affective factors and beliefs	

a) Designing PISA-like mathematics task

Problem posing





Mathematical Problem Posing

- Problem reformulation:

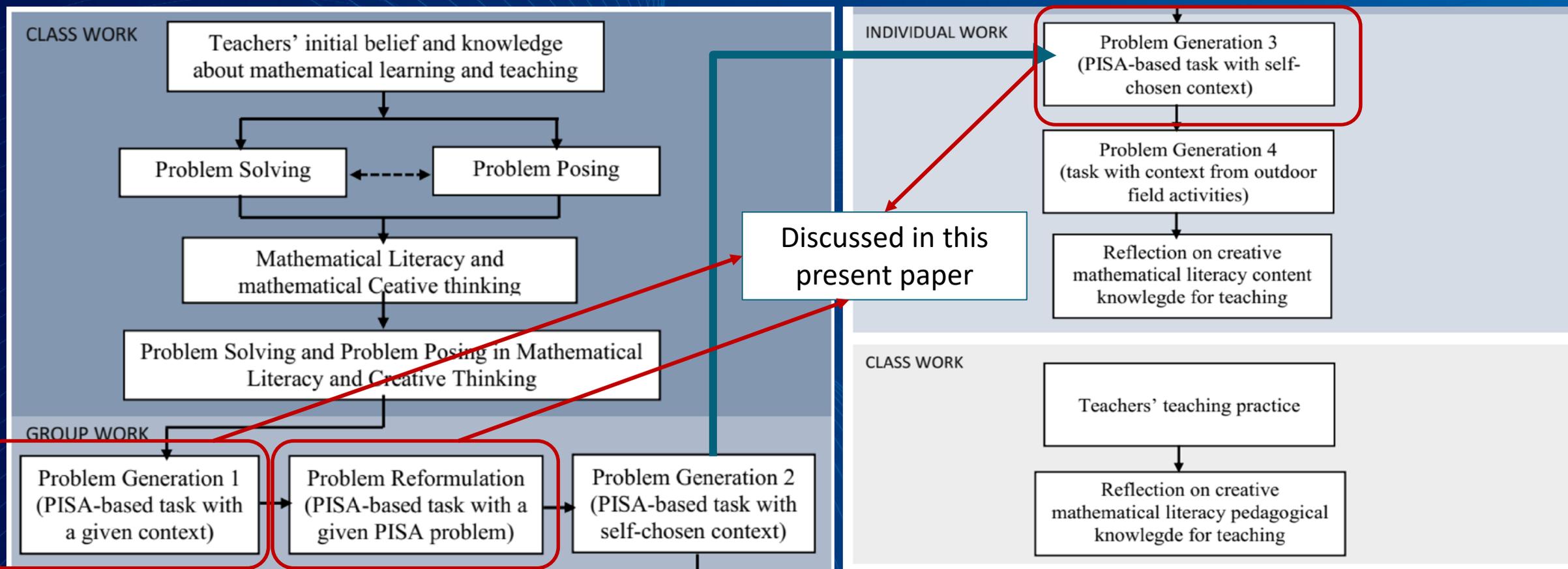
The problem posed by teachers can be categorized into seven groups:

- (1) switch the given and the wanted,
- (2) change the context,
- (3) change the given,
- (4) change the wanted,
- (5) extension,
- (6) add information,
- (7) re-word.

Problem Generation:

- (1) non-mathematical statement or mathematical statement but not a plausible problem,
- (2) plausible problem without sufficient information,
- (3) single-step plausible problem with sufficient information,
- (4) multi-step plausible problem with sufficient information.

The Teacher Professional Development



Learning Sequences within the development process of TPD

The Professional Training

SLIDE 8



Participants	Venue	Time
40 middle school teachers	Mojokerto city, East Java Province	Mei 2015
30 middle school teachers	Jember city, East Java Province	January 2016
20 primary school teachers	Surabaya city, East Java Province	July 2017
12 middle school teacher	Sidoarjo city, East Java Province	2019

Our projects

- Primary school teachers' beliefs and knowledge about mathematical problem-solving and their performance on problem-solving task
- Searching for Authentic Context in Designing PISA-like Mathematics Problem: From Indoor to Outdoor Field Experience
- Teachers' views and experiences on mathematical literacy and context-based task
- An Innovative Training Model for Supporting In-service Teachers' Understanding on Problem-solving Knowledge for Teaching

This Present Study

- 40 teachers from Jember city were involved in the program.
- Five days teacher training using the TPD



Aim of paper



- report the **experiences** of a group of **secondary mathematics teachers** in designing context-based mathematics problems within a program intervention which use **problem-solving** and **problem-posing** activities in deepening understanding on PISA-like mathematics problem



Problem posing as tool of learning to pose PISA-like math problem

- Problem posing helps teachers understand mathematics content knowledge (Toluk-Ucar (2009)).
- thinking habits within problem posing not only enhanced problem-solving skills, but also helped to reinforce and enrich basic mathematical concepts (Kwek, 2015).
- Regarding knowledge of context, problem posing ability is not only influenced by mathematics content knowledge that teachers have, but also it is influenced by their contextual knowledge (Chapman, 2010)
- Problem posers should appropriately combine problem contexts with key concepts and structures in solutions along with constraints and requirements in the task. Thus, knowledge of context and mathematics content knowledge are recognized to have strong relationship with problem posing abilities. (Chapman, 2010)
- Knowledge about how to connect mathematics to real life (contextual knowledge) has played an important role in the development of problem posing in professional development [De Corte, 2000)

Research Method

- **The Instrument: Problem-posing task (Problem generation)**

Translation:

You will be paid 2,000 rupiah per copy for 240 copies of the first newspaper that you have successfully sold in one week, plus 4,000 rupiahs for each additional copy that you have successfully sold

Paid high in no time! Sell People's Voice newspapers and get your base payment of 600,000 per week, plus an extra payment of 500 rupiah per newspaper sold

Paiman decided to apply for job to be a newspaper seller. Thus, he would like to choose one of the companies, i.e. Indo Pos or People Voice

Please see the above information. Then make as many context-based tasks as possible within 25 minutes



Research Method

- **The Instrument: Problem-posing task (problem reformulation)**

Problem Reformulation Activity

FAULTY PLAYERS

The Electrix and Tronics Company make video and audio players. At the end of the daily production runs, the players of those two companies are tested and those with faults are removed and sent for repair. The tables below compare the average number of players of each type that are made per day, and the average percentage of faulty players per day, for the two companies.

Company	Average number of video players made per day	Average percentage of faulty players per day
Electrix Company	2000	5%
Tronics Company	7000	4%

Company	Average number of audio players made per day	Average percentage of faulty players per day
Electrix Company	6000	3%
Tronics Company	1000	2%

Which of the two companies, Electrix Company or Tronics Company, has the lower overall percentage of faulty players? Show your calculations using the data in the tables above.

Please answer the problem in five minutes. Then make as many as mathematics context-based problem as possible by using the problem posing technique discussed earlier (20 minutes)



Results

- Problem Generation: In total, the number of items produced by the teacher participants in this activity is **235 items** ($M=5.87$, $SD=2.86$) (3-12 items)
- Problem reformulation: The teacher participants designed as many as **216 items of tasks** in this activity ($M=5.4$, $SD=3.51$) (2-14 items)



Results: Problem Generation

- Non-mathematical statement or mathematical statement but not a plausible problem (n=16 (7%))
 1. Write a mathematical sentence about payment that Paiman will obtain if he successfully sells newspapers from Indo Pos and People Voice
 2. If $f(x)=200x+500$, find $f(10)=...$
 3. Make a bar chart representing the amount of payment Paiman will get from People Voice and IndoPos
 4. If Paiman wants to get rich quick, which one of the two companies should he choose to sell newspapers. Give your reason
 5. Paiman select to work at People Voice. What can you say about his personality?

Results: Problem Generation

- **Plausible problem without sufficient information (n=12 (5%))**

Make a line chart describing the relationship between the number of sold newspapers and the amount of payment received by each of newspaper company.

- **Single-step plausible problem with sufficient information (n=172 (73%))**

- If Paiman can sell both the two newspapers, 300 newspapers of IndoPos and 140 newspapers of People Voice, how much will he get?
- how much someone can receive from Indopos if he sells 240 newspapers in one week?
- How much someone can receive from IndoPos if he only sells 200 copies?
- How much someone can receive from the People Voice if he only sells 100 copies of the newspaper in one week?



Results: Problem Generation

- Multi-step plausible problem with sufficient information (n=35 (15%))
 - If Paiman wants to get extra payment as much as the base payment in one week, how many newspapers of People Voice should he sell?
 - For how many newspapers need to be sold in order that the payment obtained by a seller for IndoPos and People Voice is the same?

Results: Problem Reformulation

- Change the given ($n=15$ (7%))

The Electrix and Tronics Company make video and audio players. At the end of the daily production runs, the players of those two companies are tested and those with faults are removed and sent for repair. The tables below compare the average number of players of each type that are made per day, and the average percentage of faulty players per day, for the two companies.

Company	Average number of video players made per day	Average percentage of faulty players per day
Electrix Company	5000	7%
Tronics Company	8000	5%

Company	Average number of audio players made per day	Average percentage of faulty players per day
Electrix Company	10,000	4%
Tronics Company	4000	3%

Which of the two companies, Electrix Company or Tronics Company, has the lower overall percentage of faulty players? Show your calculations using the data in the tables above

Results: Problem Reformulation

- Change the wanted (n=22 (10%))

The Electrix and Tronics Company make video and audio players. At the end of the daily production runs, the players of those two companies are tested and those with faults are removed and sent for repair. The tables below compare the average number of players of each type that are made per day, and the average percentage of faulty players per day, for the two companies.

Company	Average number of video players made per day	Average percentage of faulty players per day
Electrix Company	2000	5%
Tronics Company	7000	4%

Company	Average number of audio players made per day	Average percentage of faulty players per day
Electrix Company	6000	3%
Tronics Company	1000	2%

Find the difference between the number of faulty players (both video and audio) produced by Electrix and Tronics company.

Results: Problem Reformulation

- Change the given and the wanted ($n=32$ (15%))

Look at the following table

Company	Type of players	Number of production per day	Number of failure per day
Electrix company	Audio	21,000	1,000
Tronics company	Audio	20,000	800

Find the difference of percentage between the failure of audio player production of Electrix and Tronics company

Results: Problem Reformulation

- Change the context and change the wanted (52 (24%))

A coffee plantation located on the slopes of Mount Semeru planting Arabica and Trobos coffee. Consider the following table

	Number of plants	Percentage of dead plants
Arabica coffee	1500	12%
Kopi Trobos	1750	16%

Determine the proportion of the number of living plants and dead plants

Results: Problem Reformulation

- Change the context and the given (n=54 (25%))

Mrs. Ani and Mrs. Luki are brownies cake makers. The following table shows an average numbers of unsold brownies per week due to expiration.

Brownies maker	Type	Number of production per week	Percentage of unsold brownies	
Mrs. Ani	Chocolate brownies	70	4%	
	Cheese brownies	30	7%	
Mrs. Luki	Chocolate brownies	55	5%	
	Cheese brownies	35	3%	
	Corn brownies	30	4%	

Which of the two brownies makers, Mrs Ani or Mrs. Luki, has the lower overall percentage of unsold brownies? Show your calculations using the data in the tables above.

Results: Problem Reformulation

- Add information (n=30 (14%))

If the production costs of each motor unit are as follows

Company	Type	Price/unit
Troya	Troya 123	IDR 10,000,000
	Troya 300	IDR 7,000,000
Izuki	Grand	IDR 9,000,000
	Luxe	IDR 8,000,000
	Gio	IDR 7,000,000

Determine the amount of loss experienced due to failure of motor assembly in each company. Which of the two companies: Troya or Izuki who suffered greater losses due to assembly failure? give your reasons.



Results: Problem Reformulation

- Extension (n=11 (5%))

Given that the price of Troya is IDR 18,000,000 and the price of Izuki is IDR 15,500,000. A discount of 4% and a discount of 5% is respectively applied for Troya and Izuki. If five Troyas are sold and seven Izukis are sold everyday, determine the proportion of income between the companies of Troya and Izuki in two days.

Take Home Message

- The professional learning course offered in this model was developed around views of problem solving and problem posing activities.
- Most of the teachers design problem with single-step plausible problems with sufficient information and also use the techniques of problem reformulation varying from some single techniques to the combined techniques from those single techniques
- The implication of this study is to support teachers to design and use their own context-based mathematics task within their classroom teaching.