



# **PISA 2015**

## **Collaborative Problem Solving**

**Paul Borysewicz**  
**Eric Steinhauer**  
Educational Testing Service  
**November 3, 2014**



# PISA Collaborative Problem Solving

- Status
  - Collaborative Problem Solving measure is part of PISA 2015 assessment cycle alongside Reading, Mathematics, Science and Financial Literacy
  - In 2014 Field trial conducted in 54 countries in a total of 69 different language versions.

# PISA Collaborative Problem Solving

## Definition

PISA 2015 CPS is an assessment of *individuals* in a collaborative problem solving context.

Collaborative problem solving competency is the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution.

# PISA Collaborative Problem Solving

## Definition

Three competencies

|                                                       |                                                    |                                                    |
|-------------------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| (1) Establishing and maintaining shared understanding | (2) Taking appropriate action to solve the problem | (3) Establishing and maintaining team organisation |
|-------------------------------------------------------|----------------------------------------------------|----------------------------------------------------|

Four problem-solving processes

- |                                  |
|----------------------------------|
| (A) Exploring and Understanding  |
| (B) Representing and Formulating |
| (C) Planning and Executing       |
| (D) Monitoring and Reflecting    |

# Matrix of CPS Skills

|     | (1) Establishing and maintaining shared understanding                                            | (2) Taking appropriate action to solve the problem                                            | (3) Establishing and maintaining team organisation                                               |
|-----|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| (A) | (A1) Discovering perspectives and abilities of team members                                      | (A2) Discovering the type of collaborative interaction to solve the problem, along with goals | (A3) Understanding roles to solve problem                                                        |
| (B) | (B1) Building a shared representation and negotiating the meaning of the problem (common ground) | (B2) Identifying and describing tasks to be completed                                         | (B3) Describe roles and team organisation (communication protocol/rules of engagement)           |
| (C) | (C1) Communicating with team members about the actions to be/ being performed                    | (C2) Enacting plans                                                                           | (C3) Following rules of engagement, (e.g., prompting other team members to perform their tasks.) |
| (D) | (D1) Monitoring and repairing the shared understanding                                           | (D2) Monitoring results of actions and evaluating success in solving the problem              | (D3) Monitoring, providing feedback and adapting the team organisation and roles                 |

# Matrix of CPS Skills

|     | (1) Establishing and maintaining shared understanding                         | (2) Taking appropriate action to solve the problem                                            | (3) Establishing and maintaining team organisation                                               |
|-----|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| (A) | (A1) Discovering perspectives and abilities of team members                   | (A2) Discovering the type of collaborative interaction to solve the problem, along with goals | (A3) Understanding roles to solve problem                                                        |
| (B) | the meaning of the problem (common ground)                                    | (B2) Identifying and describing tasks to be completed                                         | (B3) Describe roles and team organisation (communication protocol/rules of engagement)           |
| (C) | (C1) Communicating with team members about the actions to be/ being performed | (C2) Enacting plans                                                                           | (C3) Following rules of engagement, (e.g., prompting other team members to perform their tasks.) |
| (D) | (D1) Monitoring and repairing the shared understanding                        | (D2) Monitoring results of actions and evaluating success in solving the problem              |                                                                                                  |

# Some design challenges and solutions

- To support assessment of individual skills, each student is teamed with computer agents

Student communicates with team members *via* a chat interface.

PISA 2015

**Making Medicine**

Introduction

Task: Produce two different varieties of the final medicine with different properties.

**Who's in the Chat**

■ You + Dr. Jones

■ You: Please send me a sample.

Dr. Jones has sent you a new sample.

■ You:

- What should I do now?
- Why haven't you sent a sample?
- I'm hungry. I think I'll just take a break.

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**Making Medicine**

**Ingredients**

Xelan 50 Rivon 50

**Intensity**

**Duration**

**Result**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 0                    | -      |
| <b>Side effects</b>  |        |
| 0                    | -      |
| <b>Costs</b>         |        |
| 0                    | -      |

Process

The problem to be solved is represented in a shared workspace.

# Some design challenges and solutions

- Assessment across languages
  - The student chooses chat responses from a set of options, rather than typing, since natural language processing for communication with computer agents could not be standardized.
  - Assessment of collaboration *via* communication cannot include selection of appropriate tone or register, aspects likely to vary with language and culture

Agent communication and agent actions are driven by scripts that branch at student choices of chat and problem-solving actions.

Items used in scoring are student choices of chat entries and student choices of actions, including composite items where the scorable options are identified optimal and non-optimal paths through the branching (and converging) logic of the CPS unit.

# Some design challenges and solutions

- Assessment across different cultures and educational systems
  - Teams were defined as teams of peers (fellow students) since differences in status among team members –e.g., when a student collaborates with a teacher—will have different effects on collaborative choices in different cultures.
  - Problems to be solved by teams are practical and non-academic. Problem scenarios were reviewed by participating countries for global applicability. Some scenarios were rejected: “students would not do that in our country.”

A problem scenario might involve a team of students planning an event, including making choices about activities and scheduling and roles.

# Some design challenges and solutions

- Effective assessment through extended problem-solving scenarios
  - Challenge: An initial misstep in collaboration or a mistaken problem-solving choice can compromise the informational value of the student's subsequent choices.
  - Solution: Building in resets and “rescues”:
    - Complex problems are broken down into parts.
    - Agents are scripted to “rescue” a student who makes an early non-optimal choice:

A “rescue”:

Agent A has information critical to solve the problem. The student is given reason and opportunity to ask for this information.

If the student asks [optimal]... Agent A will supply the information.

If the student fails to ask ... Agent A will volunteer the information

# Some design challenges and solutions

- Assessment across the CPS skills
  - Scripting and “CPS orientation” of the agents allow for the student to be provided with a variety of challenges calling for different CPS skills:
    - Sometimes an agent will neglect the goals or rules of the project
    - Sometimes an agent will forget the roles of the different members of the team
- Maintaining student engagement
  - Agent chat responses to the student supports engagement.
  - To maintain the sense of team, no agents appear to intentionally undermine the work (or lie). All display some competence.

Field Trial results show student engagement in terms of time-on-task.



## Making Medicine

### Introduction

*Read the introduction to the task. Then click on the NEXT arrow.*

In the following exercise you have to imagine you are a doctor working with a colleague to produce a new medicine for treating a rare disease. Your colleague works in another city and sends you a mix of medical ingredients that you process to produce the final medicine. The government agency paying for the development will tell you what exactly you have to produce. Note that your colleague does not have any of the information about the processing and the results you see on your screen.



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## Making Medicine

### Introduction

*Read the introduction to the task. Then click on the NEXT arrow.*

#### Task 1

You don't know what your colleague Dr. Jones can contribute to a solution, and Dr. Jones doesn't know anything about your processing and about the results you see on your screen. Your first tasks are:

- 1a. Find out what Dr. Jones can contribute towards producing a particular final medicine and inform her about what you can do.
- 1b. Produce two different varieties of the final medicine (with different properties) together with Dr. Jones.



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**Making medicine**

► Introduction

▼ Task

1a. Find out what Dr. Jones can contribute towards producing a particular final medicine and inform her about what you can do.

1b. Produce two different varieties of the final medicine (with different properties) together with Dr. Jones.

**Making Medicine**

**Ingredients**

Xelan 0 Rivon 0



**Intensity**

--- 0 ++

**Duration**

--- 0 ++

10 12 14 16 18



**Result**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 0                    | -      |
| <b>Side effects</b>  |        |
| 0                    | -      |
| <b>Costs</b>         |        |
| 0                    | -      |

Process

*Content is for illustration of format. Not PISA content.*



**Making Medicine**

▶ Introduction

▶ Task: Produce two different varieties of the final medicine with different properties.

**Who's in the Chat**

■ You   ♦ Dr. Jones

*Start the chat with Dr. Jones by clicking on a choice below. Then click on **Send**.*

■ **You:**

- Dr. Jones, what are you able to contribute to produce a medicine?
- Hi Dr. Jones. How are you?
- Dr. Jones, do you know what we are supposed to do?
- Unbelievable! How are we supposed to work without more instructions?
- What a silly task! I'm leaving!

*Content is for illustration of format. Not PISA content.*

Send

**Making Medicine**

**Ingredients**

Xelan  
0
Rivon  
0



**Intensity**

**Duration**



**Result**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 0                    | -      |
| <b>Side effects</b>  |        |
| 0                    | -      |
| <b>Costs</b>         |        |
| 0                    | -      |

Process



**Making Medicine**

▶ Introduction

▶ Task: Produce two different varieties of the final medicine with different properties.

**Who's in the Chat**

■ You   ♦ Dr. Jones

■ **You:** Please send me a sample.

*Dr. Jones has sent you a new sample.*

- **You:**
- What should I do now?
  - Why haven't you sent a sample?
  - I'm hungry. I think I'll just take a break.

*Content is for illustration of format. Not PISA content.*

Send

**Making Medicine**

**Ingredients**

Xelan  
50

Rivon  
50



**Intensity**

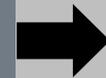
--- 0 ++

10 12 14 16 18

**Duration**

--- 0 ++

10 12 14 16 18



**Result**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 0                    | -      |
| <b>Side effects</b>  |        |
| 0                    | -      |
| <b>Costs</b>         |        |
| 0                    | -      |

Process



**Making Medicine**

▶ Introduction

▶ Task: Produce two different varieties of the final medicine with different properties.

**Who's in the Chat**

■ You   ♦ Dr. Jones

- **You:** What should I do now?
- ♦ **Dr. Jones:** I sent you a sample. Why don't you process the medicine?

*Dr. Jones has sent you a new sample.*

- **You:**
  - What should I do now?
  - Why haven't you sent a sample?
  - I'm hungry. I think I'll just take a break.

*Content is for illustration of format. Not PISA content.*

Send

**Making Medicine**

**Ingredients**

Xelan  
0
Rivon  
0



**Intensity**

**Duration**



**Result**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 10                   | -      |
| <b>Side effects</b>  |        |
| 20                   | -      |
| <b>Costs</b>         |        |
| 10                   | -      |

Process

**Making Medicine**

▶ Introduction

▶ Task: Produce two different varieties of the final medicine with different properties.

**Who's in the Chat**

■ You   ♦ Dr. Jones

■ **You:** Please send me another sample so that we try another variety of the final medicine.

*Dear participant, you achieved to produce two different varieties of the final medicine.*

*Please answer the following questions.*

1) What can Dr. Jones contribute towards producing the medicine?

■ **You:**

- She measures the properties of the final product.
- She can set the amount of Xelan and Rivon in the raw material.
- She knows what the correct settings for the treatment are.
- Nothing, the task can be solved without her involvement.
- She can set the amount of Blanium in the raw material.

*Content is for illustration of format. Not PISA content.*

Send

**Making Medicine**

**Ingredients**

Xelan  
0
Rivon  
0



**Intensity**

**Duration**



**Results**

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 30                   | -      |
| <b>Side effects</b>  |        |
| 40                   | -      |
| <b>Costs</b>         |        |
| 10                   | -      |

Process



## Making Medicine

### Introduction

*Read the introduction to the task. Then click on the NEXT arrow.*

### Task 2

The government agency paying for this research wants you and your colleague to produce a medicine with an effectiveness of 70 and keep the cost below 30. Side effects do not need to be considered at this point.



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**Making Medicine**

▶ Introduction

▶ Task: Produce a medicine with an effectiveness of 70 and keep the costs below 30. Side effects are not important.

**Who's in the Chat**

■ You   ♦ Dr. Jones

■ **You:** Please send another sample.

♦ **Dr. Jones:** OK.

*Content is for illustration of format. Not PISA content.*

Send

**Making Medicine**

**Ingredients**

Xelan  
80

Rivon  
20



**Intensity**



**Duration**



**Result**

| Value                | Value |
|----------------------|-------|
| <b>Effectiveness</b> |       |
| 0                    | 70    |
| <b>Side effects</b>  |       |
| 0                    | -     |
| <b>Costs</b>         |       |
| 0                    | < 30  |

Process

### Making Medicine

► Introduction

► Task: Produce a medicine with an effectiveness of 70 and keep the costs below 30. Side effects do not need to be considered at this point.

#### Who's in the Chat

■ You   ♦ Dr. Jones

■ **You:** You're sending samples with too much Xelan in it. I can't reach the goals.

♦ **Dr. Jones:** I sent 80% Xelan and 20% Rivon. Was that not correct?

■ **You:** No, sorry, the sample has the wrong properties.

♦ **Dr. Jones:** I thought we had to produce material with low side effects. Is that not correct?

■ **You:**

- That is not correct.
- No, we have been asked to focus on effectiveness and costs.
- Side effects don't seem important.
- Can you check that? I have a different instruction.

*Content is for illustration of format. Not PISA content.*

Send

## Making Medicine

### Ingredients

Xelan  
80

Rivon  
20



### Intensity



### Duration



### Result

| Value                | Target |
|----------------------|--------|
| <b>Effectiveness</b> |        |
| 10                   | 70     |
| <b>Side effects</b>  |        |
| 70                   | -      |
| <b>Costs</b>         |        |
| 70                   | < 30   |

Process

**Questions?**