The PS-I Pedagogy in a Level 5 Undergraduate Microeconomics Course

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Introduction

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- Arguments in favour of I-PS: (a) reduced possibility of students making errors and floundering, (b) increased attention to critical and relevant aspects of the domain material (Kirschner et al., 2006).
- Arguments in favour of PS-I approach: student preparation for future learning (Schwartz & Martin, 2004) by giving them opportunities to notice and encode critical domain features on their own (Loibl et al., 2017).

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- The literature has mainly focussed on the efficacy of PS-I on STEM students and their learning.
- Recent literature has challenged the traditional view that Direct Instruction followed by Problem-Solving is preferable when introducing a new mathematical concept (see, i.e., Kapur 2008, 2012, 2014; Loibl and Rummel, 2014).
- Learning is facilitated with PS-I via the following mechanisms: prior knowledge activation, awareness of knowledge gaps, and recognition of deep features (Loibl et al, 2017).

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- Sinha and Kapur (2019) review doubled the surveyed article base compared to Loibl et al. (2017) and shifted the focus from why PS-I works to when and why it does not work:
- Lack of (a) follow-up instruction built on suboptimal learner-generated solutions, or inclusion of group work as the participation structure (b) explicit feedback regarding what problem-solving actions need rethinking.

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- The experiment ran in the 2022-2023 academic year.

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- Students did (on average) better both in the end of class quizzes/tests and in the final module assessments later in the block, which is a good indication of (a) activation of knowledge gained and (b) deep learning.

Method and Results

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- PS-I classroom: The students were asked to work in groups and think about a problem related to the new concept.
- All students obtained the necessary toolkit to work on the problems (e.g., knowledge of how to calculate expected payoffs and visualise such payoffs graphically).

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- During the Instruction phase, I synthesised student responses to model the canonical solution.
- Students had the chance to reflect on "where things went wrong" and practice further.

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- End-of-term assessments in the form of an in-class exam and an individual report tested all targets set above, whilst the second assessment also tested student ability to apply the knowledge created in real-life scenarios.

Example of a Quiz Question

	Left	Right
Left	4,-4	9,-9
Middle	6,-6	6,-6
Right	9,-9	4,-4

Figure: Think about an attacker (row player) and a goalkeeper (column player) in a penalty kick game!

Example of a Quiz Question

- 1. In the Penalty kick game, there is a dominant strategy for the row player.
  True False (25 POINTS)
- 2. Suppose you are the penalty taker, and you know the goalie will dive to the right. Then, it is in your best interests to shoot to the left.
  True False (25 POINTS)
- 3. Suppose you are the penalty taker in the penalty kick game. Explain whether you would choose to shoot to the middle. (50 POINTS)

Example of a Quiz Question

	Party	TV Show
Party	2,-2	-2,2
TV Show	-2,2	2,-2

Figure: Think about the two-player strategic game with the payoff matrix as above:

Example of a Quiz Question

- 1. Look at the payoff matrix of the game. The row player has a dominant strategy.
  True False (10 POINTS)
- 2. Look at the payoff matrix of the game. The column player has a dominant strategy.
  True False (10 POINTS)
- 3. Look at the payoff matrix of the game. There is a Nash equilibrium in pure strategies.
  True False (30 POINTS)
- 4. Find the Nash equilibrium in mixed strategies. Explain. (50 POINTS)

Results

- Students in the PS-I classroom produced multiple Representations and Solutions Methods, and whilst their views on the new concepts were not correct in a strict sense, they provided an excellent basis for discussion as regards the concept at hand in the Instruction phase.

Results in the After Class Quiz

	Mean	Standard Deviation
Intervention 1	58	8.7
Intervention 2	53	7

Mean and standard deviation in a traditional classroom.

	Mean	Standard Deviation
Intervention 1	63	6.59
Intervention 2	67	7.35

Mean and standard deviation in a PS-I classroom.

- Students in the PS-I classroom did considerably better in questions testing their procedural fluency and conceptual understanding.
- The students in the PS-I classroom in the second intervention did increasingly better, especially in questions related to the activation of knowledge gained in the first intervention.

Results

- Implications for deep learning:
- End of block assessments: students from the PS-I classroom again did on average a better job.

	Mean	Standard Deviation
In-class exam	55	12.5

Mean and standard deviation in a traditional classroom.

	Mean	Standard Deviation
In-class exam	62	11.3

Mean and standard deviation in a Productive Failure classroom.

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- We find a positive effect of PS-I on student learning.
- Future steps:
- Pre-sessions test related to the new concepts instead of relying on past grades.
- Further use of the PS-I pedagogy in Microeconomics and other T&L environments related to Economics.