

Assessing Reflection on Practice: A Problem Solving Perspective

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Reflection on practice (ROP) serves to support teachers that introduce innovative instruction into their classrooms. There is an inherent dilemma between competing goals in ROP workshops: developing teachers' skills as reflective practitioners (process), vs. developing specific favored practices (result). This dilemma affects the evaluation of such workshops, as evaluation methods should align with the goals. In this paper we will gain insight on how to resolve the dilemma from the perspective of teaching scientific problem solving, where a similar dilemma between process and result is sharply manifested and thoroughly explored. Assessment methods and tools derived from this perspective were applied in a formative evaluation of a workshop for high school physics teachers. We will show how these analysis tools enabled us to identify differences in outcomes between versions of yearlong workshops that used different approaches to guidance of ROP. Our research can contribute to the planning and evaluation of ROP workshops.

Introduction

Reflection on practice (ROP) is manifested in diverse professional development situations. Both in the context of daily teaching and in the context of action research [1], ROP is presented as an iterative process involving repeated rounds of focusing on a problem (analyzing learning goals vs. actual achievements), constructing solutions (instructional approaches) and deriving lessons from them. Thus, ROP can be seen as a problem solving process. In this paper we use a physics problem solving perspective to analyze ROP. What benefits does such a perspective provide? The cognitive research on teaching problem solving in physics [2] explored several notions that can be extended to clarify guidelines for establishing and sustaining effective pedagogical problem solving. These notions are:

1. There is a distinction between a problem and an exercise. A problem differs from an exercise in the requirement for a systematic iterative solution process. This process comprises of a description stage, a construction stage and a final evaluation stage.
2. A novice problem solver approaches problems differently than an expert. Novice problem solvers don't know how to approach problems in a systematic iterative manner.
3. Cognitive apprenticeship is an effective instructional approach that has been adapted for

teaching problem solving skills in Physics [3]. In this approach a) the students are required to solve context rich problems that usually do not serve as exercises even to advanced students; b) the implicit problem solving strategies of experts are externalized in a prescribed problem-solving framework through three stages: Modeling (the framework in the instructors' problem solutions), scaffolding (requiring the framework in students' solutions) and fading (reducing the requirements). Cooperative peer work is structured to provide students the opportunity to monitor the execution of the process.

How are these notions relevant for professional development of teachers, in particular in the context of introducing innovative instruction into the class? The teacher's struggle with daily pedagogical problems is not tolerant of failures; it demands immediate solutions. Introducing instructional strategies that differ significantly from traditional instruction requires teachers to go through a long iterative process of reexamining their concepts and habits. Such a challenge constitutes an extended pedagogical problem that requires a systematic iterative solution process, which is analogous to the context-rich problem discussed earlier. If we draw the analogy further, then we have to question whether teachers are novice or expert pedagogical problem solvers?

While most teachers are experts in solving daily problems, many are novices in approaching extended pedagogical problems in a systematic way. According to the cognitive apprenticeship approach, training the teacher to deal with such a problem calls for guidance to carry out explicitly the various stages of the process.

This approach served us in evaluating a workshop for physics teachers. The aim of the workshop was to assist teachers in introducing to their classes research based instructional innovations that promote self-monitoring in physics problem-solving. There are different models for using ROP in teacher education, and in annual workshops we tried different versions of cooperative ROP with the aim of raising the bar of attainable goals and suggesting a framework in which they can be achieved. We formulated the process of ROP operatively as measurable stages in the process of solving an extended pedagogical problem:

Problem analysis: Possible goals are discussed; the extent of attaining the goals in existing practice is examined and consequently goals are redefined.

Solution construction: a) Planning action: possible instructional strategies for achieving the focused goals are proposed and a course of action is chosen. b) Implementation: activities and materials are developed and carried out.

Solution evaluation: The extent of attaining the goals is examined, and a new solution cycle starts, in which the intervention is diagnosed and refined.

Tools for Measuring the Cooperative ROP

To evaluate teacher professional development through cooperative ROP one needs to answer:

- Which stages of the cooperative ROP were carried out? Did the process last?
- What was the division of roles between the leader of the cooperative ROP and the teachers? To what extent did the teachers initiate and take active part in the different stages?
- Was the reflection carried out on empirical information documented in the classroom, or brought up by teachers from their accumulated experience? Did information flow from the workshop to the classroom, and vice versa?

In order to answer these questions we defined two units of measurement to represent the workshop:

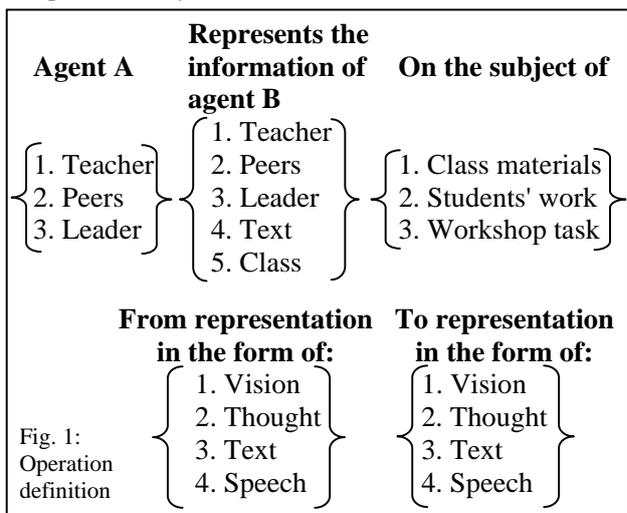
- A content-based unit termed "episode" to measure the execution of the cooperative ROP.
- A unit representing information transfer, termed "operation", to measure the division of roles.

Measurement unit "Episode": The workshop activities were designed to achieve several central goals. An activity associated with a given goal was sometimes carried out in nonadjacent meetings. In order to put together the components of such an activity we defined the "episode" unit. The workshop was represented as a series of episodes.

Measurement unit "Operation": The "episode" gives a picture of the goals the workshop deals with, but not the extent to which the teachers were active. Hence each episode is subdivided into "operation" steps that focus on the process of transmitting information between the teachers and the group. For example, consider the episode of "presentation of a class activity" by a teacher to his peers in the workshop. The operations in this episode are:

- Teacher's observation in class - the teacher represents the information from the class in his/her inner world.
- Account to peers - the teacher articulates his/her thoughts, while the peers translate the account into their understanding of it.
- Peer feedback - this operation resembles "account to peers", only the teacher and his peers exchange roles.

The next mapping sentence serves in defining an "operation" by means of its variable values:



Every stage in the episode that can be represented by a certain series of values was considered an "operation." For example, "observation in class" will be mapped in the following way: "The teacher represents information from class on the subject of students' work from representation in the form of vision and speech to representation in the form of thought" (see figure 1). The workshop was represented as a series of operations.

Tools for Analyzing the Cooperative ROP

The episodes were mapped to the stages of the solution process using the categories from table 1.

Stage in solution	Episodes applied in
Analysis	
Planning action	
Implementation	
Evaluation	

Table 1: Set of categories for mapping episodes

This mapping enables analyzing how many iterations took place in the process of context-rich pedagogic problem solving, which stages were executed and which were not.

The "operations" were sorted into the following categories:

Location: 1. Workshop; 2. Home; 3. Classroom

Source of information: 1. External (literature, leader); 2. Teachers' knowledge; 3. Internal – (earlier workshop product, class activity)

Who was active?: 1. Workshop leader; 2. Leader and teachers; 3. Teachers (derived from "agent A" variable attributed to the operation, see fig 1)

Who initiated?: 1. Workshop leader; 2. Leader and teachers; 3. Teachers

Approximate operation duration: 1. 5 minutes; 2. 20 minutes; 3. 2 hours

Representing the time distribution of the different categories enables answering questions such as: What was the division of work in the workshop? Did information indeed flow between the workshop and the class? Did the teachers make use of the earlier products that they developed?

Using the tools for evaluating the workshops

We held 3 versions of annual workshops for physics teachers that involved them in cooperative ROP. The tools of measurement described above served in formative and summative evaluation of the various workshop versions.

Example – Formative evaluation

In this workshop the leader presented several selected research based instructional strategies for discussion. The teachers were asked to develop together instructional activities suitable for the Israeli reality and to implement them in their classes. The teachers were asked to suggest how to evaluate their experience and to carry out this evaluation. Representing the workshop as episodes yielded a series of 21 episodes.

Mapping the episodes

Table 2 shows a mapping of this workshop's episodes to the stages of the solution process:

Stage in solution	Episodes (denoted by numbers) applied in each stage
Analysis	<u>1,2,3</u> clarifying learning goals; <u>4,5</u> examining existing instruction; <u>6,19,21</u> acquaintance with alternative instructional approaches
Planning action	<u>7,13,16</u> defining central goals for planning alternative instruction
Implement- ation	<u>8,9,10</u> developing 2 class activities <u>14,15</u> reporting implementation of the activities in the classroom by two teachers
Evaluation	<u>11,12</u> planning a limited action research project (not executed) <u>17,18</u> informal evaluation of the activities developed <u>20</u> open discussion on impressions from implementation

Table 2: Example of mapping episodes

Summary of results from the table: 1) Extensive analysis was carried out, and included clarification of the learning goals and examination of existing and alternative instructional approaches; 2) Considerable time was invested in the cooperative development of learning materials; 3) Implementation was limited; 4) No empirical evaluation or consequent improvement of the instructional activities were carried out.

Sorting the operations

Table 3 shows the time distribution (in minutes) and the number of operations (#) in the various categories of the entire workshop:

	Category	Min.	#
Location	Workshop	590	98
	Home	200	15
	Classroom	48	2
Source of information	External	185	43
	Teachers' knowledge	452	39
	Internal	201	33
Who was active?	Leader	256	44
	Leader and teachers	41	35
	Teachers	541	36
Who initiated?	Leader	562	90
	Leader and teachers	84	9
	Teachers	192	16
Total		838	115

Table 3: Sorting all workshop operations to categories

From Table 3 it can be seen that 1) very little of the workshop products were implemented in the classrooms. 2) Only 1/4 of the time in the workshop was based on its previous products. 3) The teachers were active 3/4 of the time, but the leader initiated the directions the cooperative ROP should continue in 3/4 of the time.

Table 4 shows a subdivision of the work at home (the bold entry **home** in the table above):

	Category	Min.	#
Source of information	External	96	4
	Teachers' knowledge	4	1
	Internal – workshop	100	10
Who was active?	Leader	52	12
	Leader and teachers		
	Teachers	28	2
Who initiated?	Leader	152	12
	Leader and teachers	48	2
	Teachers		
Total		200	15

Table 4: Sorting home operations to categories

It turns out that the leader is the one that did a lot of the work at home, summarizing former meetings and reviewing literature for discussion. This evaluation shows that the concept of teachers as developers and implementers who are involved in evaluation was not realized in the workshop.

Example – Summative evaluation

Following the formative evaluation of the workshop described above, a workshop was developed in which a meticulous framework was introduced for managing the cooperative ROP. Its

main function was to impose roles and a timetable. It involved rounds in which each of the teachers served in turn as "flagman", who is responsible for presenting in a computerized forum the "solution" he/she implemented. The peers were asked to give feedback in this forum. Next, a discussion was held to analyze the solution tried out and to suggest how to advance it. This was carried out repeatedly. Ten rounds were held in the workshop. The workshop episodes were mapped for stages of the solution process. The results of the mapping were that there was constant recurring execution of all the stages of extended pedagogical problem solving process. Analysis of the operations showed that most of the time the teachers were the initiators and the executors. As a result, the teachers developed, implemented and evaluated a variety of instructional strategies and materials. Their perception of what teaching problem solving means became sharper, their obligation became stronger and as a result a readiness was created to deviate significantly from the class routine in order to achieve new goals [4].

In summary, this study proposes ways to represent cooperative reflective processes that are helpful in planning and evaluating workshops that support extended pedagogical problem solving.

¹ McNiff, J., *Action research for professional development: Concise advice for new action researchers*. Mississauga, ON: The Ontario Public School Teachers' Federation, 1998.

² Maloney, D., Research on problem solving: Physics, in D. Gabel (ed.), *Handbook of Research on Science Teaching and Learning*, MacMillan, New York, 1994.

³ Heller, P., Keith, R., & Anderson, S., Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups, *American Journal of Physics*, vol. 60, pp. 627-636, 1992.

⁴ Yerushalmi, E., & Eylon, B., Teachers' approaches to promoting self-monitoring in physics problem solving by their students, *Proceedings of the GIREP meeting, Barcelona, Spain*, 2001.