Teacher Evidences on the Instruction of Learning Skills for Science as a Basis for Continuous Professional Development

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Abstract

One of the critiques of continuous professional development (CPD) programs is that they do not lead to educational change in teachers' practice. This dissertation presents an approach in which CPD programs can effect teacher change.

The context of the CPD was related to the 'Learning Skills for Science' (LSS) program, which advocates the incorporation of high-order learning skills and capabilities into science school curricula, in addition to content knowledge. The LSS comprises high-order scientific communication skills such as information retrieval, scientific reading, scientific writing, listening and observing, information representation, and knowledge presentation. In order for students to learn independently and develop scientific literacy, they have to be able to successfully implement these learning skills. The integration of learning skills with scientific contents instruction requires teachers to change their existing practice.

This approach studied in this dissertation is Evidence-based CPD which is designed to achieve this change and improve teachers' LSS practice. Teachers in this CPD program were required to prepare and to submit a portfolio that demonstrates their collection of evidence of LSS practice. By the term "evidence", we mean a collection of artifacts that show the teacher's work concerning their instruction and the students' learning, combined with written commentaries. The artifacts and commentaries are aimed at promoting the teachers' reflection on their practice and at presenting the teachers' practice for public discourse with colleagues, thus creating a community of practice.

 The goals of the study were as follows:

(1) Development of the Evidence-based CPD program and examination of its implementation in different in-service models (centralized and disseminated). The following questions were asked:

- What are the characteristics of Evidence-based CPD and how are these characteristics implemented in the centralized and disseminated models?
- Which kinds of difficulties occur during the CPD and how do teachers cope with them?

(2) Study of the influence of the Evidence-based CPD on teachers' performance of LSS practice. The following questions were asked:

- What are the characteristics of the evidence that presented in the teachers' portfolios?
- Which kinds of professional profiles of LSS instruction and evidence preparation, do the teachers display?
- Which changes occur during the CPD?

The Evidence-based CPD program was implemented in three consecutive cycles organized in two kinds of models: (1) Two centralized at the Weizmann Institute of Science and (2) one disseminated in three schools. In both models, teachers received personal or group support and scaffolding from tutors throughout the process.

In order to address the first goal, we compared CPD-implemented programs in both models. The results indicated that both models were similar in their main goals, the major content issues, the existence of collaborative learning, the support that teachers received, and in the CPD products. However, the models differed in their organization of the contents, the mode of implementing the major issues, the CPD providers, and the focus of the collaboration. The disseminated model also exhibited a better response to teachers' needs by adjusting the CPD program to their objectives.

The comparison indicated that an Evidence-based CPD progarm that includes support and scaffolding can be implemented either in a disseminated model or in a more adjusted way using a disseminated model. We also deduced that thorough preparation of CPD providers and tutors in preparing evidence and enhancment of their awareness of the Evidence-based approach are crucial to proper implementation.

To address the second goal, we analyzed 24 teachers' portfolios, containing evidence about LSS practice, from all three cycles of the CPD. We also examined teachers' interviews, transcripts that included presented intermediate evidence from CPD meetings, and other teachers' references regarding presented evidence and content issues. Three case studies are also reported describing the professional development of three teachers, using all the sources, designed at following changes in LSS pracice and evidence preparation.

Most teachers from both models succeeded to collect artifacts and to prepare evidence about LSS practice. We found a connection between teachers' former LSS practice, the extent of their presented LSS practice and the characteristics of the evidence they collected. Experienced teachers presented a wider range of LSS practice than beginners.

We also studied the dimensions and levels of teachers' practice, the profiles of teachers' accomplishment, their ability to present evidence about their practice, and the changes that they underwent. We analyzed teachers' portfolios (58 pieces of evidence) using a diagnostic tool that assessed the various dimensions of teachers' accomplishment in LSS practice: P- Perceptions of LSS instruction; M- Model of instruction; T- Using learning materials; A- Assessment; I- Influence in the school system; E- Evidence preparation. For each of these dimensions, we identified a hierarchy of levels on a scale of 1-5. The diagnostic tool revealed diverse LSS multidimensional professional profiles that demonstrated strong and weak aspects of teachers' performance. The strong aspects were all or mostly teachers that presented a high competency level (5) of their perceptions concerning LSS teaching and assessment (P), their declared instruction model (M), and the ability to use the learning materials. Most of them also work in departmental teams in the context of LSS.

We found a relationship among teachers' former LSS practice, the LSS-oriented culture of their school, and the teachers' competency levels of their implemented instruction model (M) and the flexibility of their use of LSS learning materials (T). Experienced LSS teachers or those that worked in skills-oriented schools exhibited higher levels of competence than beginners or those who worked alone in the context of LSS. Most teachers were able to perform criteria-based assessment of their students' LSS learning and were able to present either performance profiles or students' progression, but they found it too complex to apply both performance diagnosis and progression follow-up to all students. Teachers who had the opportunity to guide other teachers in LSS practice and evidence preparation expanded their influence beyond their schools (I). We found a relationship between the teachers' mean level of competence and the CPD cycle in which they had participated. Most teachers from the centralized model exhibited a better performance than those in the disseminated one.

Teachers mastered several stages of evidence preparation (E) such as formulating goals and collecting artifacts but displayed difficulties in analyzing artifacts, and in concluding and performimg rich reflection. The CPD cycle was related to the teachers' ability to analyze their artifacts. This was due to (1) improvement of the CPD providers' knowledge regarding evidence preparation that resulted in better guidance in this process, (2) better adjustment of the CPD program to teachers' specific evidence as was performed in the disseminated model of implementation. Diversity in artifact analysis and depth of reflection within cycles can be explained by a natural variability of teachers' thinking dispositions. Teachers' reflections were directed by practicality. They were interested in aspects that could enhance their actual practice and less in more theoretical ones.

We can conclude that the teachers' mean level of LSS competency is attributed to (1) teachers' former LSS teaching experience, (2) the experience gained by the Evidence-based CPD program, and (3) the quality of support and scafolding that teachers received.

The results suggest that Evidence-based portfolios about teachers' practice can serve as tools for assessment of teachers' accomplishment (e.g., for accreditation purposes) and as an authentic resource for customizing professional development programs to the needs of individual teachers.

Teachers' professional development was examined by following three teachers' LSS professional profiles throughout the Evidence-based CPD and by studying teachers' interviews and feedback.

In the case studies, the three teachers progressed in every possible LSS proficiency category. They improved in their instructional model (M), their flexibility in using LSS learning materials, in students' assessment, and in their ability to prepare evidence. Two of them made further progress while acting as tutors for other teachers, supporting them in their LSS practice and evidence preparation.

Teachers reported that the Evidence-based CPD had a positive effect on their professional development. They described changes that took place in their LSS knowledge, confidence, and practice as a result of evidence preparation and the CPD program. They emphasized changes in planning, implementing, and assessing LSS teaching and learning. They claimed that their reflecting thinking improved as well as their influence on the educational system.

We can definitely conclude that the Evidence-based approach to CPD proved to be a meaningful framework for teachers' LSS professional development and may even be used for other topics and disciplines.

Teachers also referred to challenges they encountered throughout the Evidence-based CPD and described how they solved their problems or what they needed to cope with the difficulties. Teachers described difficulties both in LSS practice and in evidence preparation but the proportion of the two types indicated that there were many more kinds of difficulties in evidence preparation (in reference to their number and frequency) than in LSS instruction. For example, teachers reported having problems teaching a learning skill that was new to them. Many of them described their frustration stemming from difficulties in understanding the concept of evidence and stressed that the process consumed much time and effort. Novice teachers had problems implementing two new strategies: LSS instruction and evidence preparation at the same time.

Future providers of an Evidence-based CPD should take into account these challenges and take appropriate measures. The following recommendations should improve the CPD:

- It is recommended to adjust the amount of requested evidence to the teachers' ability to cope with it throughout the regular science program.
- Teachers' support should be provided by qualified persons and should be tailored to the teachers' needs.
- CPD programs must include actions that clarify the process of evidence preparation and the this process should be divided into stages.
- Using participants' examples of evidence and artifacts as sources for learning about evidence preparation in the CPD program. This practice may enhance the relevance and motivation of the CPD to the teachers.
- CPD leaders should use special tools to provide frequent feedback for teachers' evidence.
- Generally, we suggest that the Evidence-based CPD should be advanced, based on former learning and experience with LSS instruction.

We suggest two models for further CPD programs using an Evidence-based approach. The first describes the essential components in such a CPD program and their relationship. The second deals with scaling-up of such a CPD program, referring to the extent of integrating evidence into the CPD process, to CPD providers and tutors' training, and the CPD program's dissemination in different areas.

The present study has several limitations that may direct further studies, some of which can be based on the present data, but others require additional study. The performance presented in teachers' portfolios may be analyzed by other categories besides those we used in our diagnostic tool or by further refining the diagnostic tool, as well as for other purposes. Our diagnostic tool may be adjusted for evaluating other domains, but then it should be applied and its effectiveness should be examined. The professional profiles and their changes were found in teachers' evidence and personal expressions, and they could be validated by comparison to data collected by classroom observations. Other disseminated models of Evidence-based CPD programs, besides school-based ones, should be examined.