

CREATING PROFESSIONAL DEVELOPMENT SERIES FOR OPERATIONAL FORECASTING

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Joseph P. Lamos* and Elizabeth Page
UCAR/COMET
Boulder, Colorado

1. INTRODUCTION

A challenge for weather services is maintaining the currency of operational forecasters' skills and knowledge. As new science, technology and processes develop and need to be integrated into operations, a baseline of functional competencies and their corresponding skills and knowledge needs to be readily available to serve as a reference for modifying or enhancing existing training. In addition, there is a need for an effective way to represent the overall performance expectations for the operational forecasters in specific areas of job responsibility. This representation of competencies and performance expectations would serve as a means for forecasters to effectively and efficiently access training resources. Based on a white paper, *Operational Forecasters' Professional Development Series Training Program* (Lamos, 1997), and with the assistance of the COMET Program, NOAA's National Weather Service has been exploring the development of professional development series (PDS) in the areas of fire weather forecasting, aviation forecasting, and marine forecasting. Two early PDS specifications for climate services and severe convection forecasting and warnings have been accomplished.

2. BACKGROUND

At the start of the COMET Program in 1990, the goal of the COMET distance learning activity was to provide training resources that could support the on-station training programs guided and implemented by the newly established position of the Science Operations Officer (SOO) in the National Weather Forecast Offices (WFO).

A major COMET endeavor was to provide stand-alone, computer-based learning (CBL) materials that could be taken in the forecast offices. Technology of the day was a driver, and the available technology in the early '90s that would allow a rich mediated learning experience was video-disc based. Because of the production expense, this technology was maximized, with a "module" being several hours in length and dealing with broad areas such as forecasting extratropical cyclones.

Based on both feedback from the field and the availability of CD-ROM technology to distribute CBL, COMET modules became more focused on specific areas such as *Forecasting Aviation Icing: Icing Type and Severity*. In the early days of the COMET distance learning (DL) activity, a distance learning planning committee met once or twice a year to negotiate a list of priority areas to focus DL development on. Beginning in the late 1990's DL modules began to become Web-based, which they are entirely now. Currently, the COMET MetEd Website has over 600 hours of online learning.

As the COMET Program progressed through its second decade of providing educational resources for the operational meteorology community, two types of feedback from the field kept prevailing: 1) a desire to be able to access content based on specific operational performance needs and 2) the ability to do so in a targeted manner. Correspondingly, COMET's primary sponsor, the National Weather Service (NWS), had established its National Strategic Training and Education Plan (NSTEP) process. This process requires on a yearly basis, field and program area representatives to submit requirements in the form of "Performance Need Statements" (PNS). The focus of the NSTEP process and the submission of PNSs is to focus and ensure that training resources are properly targeting mission critical areas and are properly

*Corresponding author address: Joseph P. Lamos, UCAR/COMET (Deputy Director, retired), Boulder, CO 80307; email lamos@comet.ucar.edu or jplden@gmail.com

focused on performance gaps that require skill and knowledge development.

2.1 Performance Improvement Movement

Ever since the publication of Thomas F. Gilbert’s (1996) seminal work *Human Competence: Engineering Worthy Performance* in 1978, there has been an increasing awareness in business and industry that training is part of, but neither the whole nor even necessarily the proper response to, increasing performance in the workplace. Gilbert spoke of achieving “worthy” performance (W) which he described as the ratio of valuable accomplishments (A) to costly behavior (B) or

$$W = A/B$$

Basically if the cost of the behavior (because of wasted time, inefficient actions, missed opportunities, poor decisions) exceeds the benefits of what is finally accomplished, then the performance is not worthy. This brings focus on those elements that inhibit competent performance in the workplace. Gilbert identified a six celled matrix as follows:

	Information	Instrumen- tation	Motivation
Environment	Data	Instruments	Incentives
Person	Knowledge/ Skill	Capacity	Motives

It was, and still is, often the case that training requirements are based on addressing the one cell in Gilbert’s matrix - knowledge and skill development. However in the absence of a focus on achieving performance improvement, training results can be less than is desired. A “performance gap” may be due to a lack of knowledge and skill, but not necessarily. The relationship of each of the six cells can be discussed extensively but for the purposes of this paper, the focus is on ensuring that a cost-effective approach can be taken to accomplish identifying skills and knowledge and corresponding training resources that are linked to desired job outcomes while considering other sources that could be the cause of performance gaps.

2.2 Adult Learning

Obviously operational forecasters are functioning as ‘adult learners’ when they engage in their own professional development. Also, as more learning opportunities have become available via online capabilities, operational forecasters also have more opportunity to select the learning resources they need and when they should be engaged. These choices would ideally be guided by a “professional development roadmap.”

Malcolm S. Knowles (1977) in his book *The Modern Practice of Adult Education* contrasted pedagogy, the transmission of cultural knowledge in structured environments primarily geared toward children, with “andragogy.” Andragogy is a term that Knowles coined to represent adult learning and its processes. For Knowles, adult learning is characterized by the ability of adults to build on experience, their desire to be involved in planning their own learning, and a capability for self-evaluation. Knowles pointed out that for planning and self-diagnosis the following three things need to be present:

1. A model of the competencies required to achieve a desired model of performance.
2. Provision of diagnostic experiences or capabilities to allow a person to assess their level of competence versus the model.
3. The ability to identify the gaps between a person’s current capabilities and those required by the model.

Another important characteristic of pedagogy versus andragogy is that the former is subject-focused while the latter is problem-focused (Knowles, 1970). Adults in non-school situations approach learning based on their life experience and as a solution to problems or situations they are facing either in their private or work lives. In a period of over two decades there has developed a body of work based on principles of “situated cognition” and “situated learning.” Learning occurs as result of authentic activities common to a particular community of practice and that learning is not just an accumulation of knowledge through direct instruction, but also results from the participation in the activities and processes of a community of practice (Orey and Nelson, 1997).

How does one identify the need for performance-based training that recognizes the reality of situated cognition and learning? There needs to be a representation of what it means to be competent that is derived from an active community of practice.

2.3 Competency

The notion of measuring competency is attributed to David C, McClelland (1973) in an article in the *American Psychologist* titled “Testing for competence rather than for “Intelligence.” In this paper McClelland was taking a position against classic “intelligence” testing as representative of a person’s capabilities. Instead he was suggesting that testing be focused on measuring competencies involved in clusters of life outcomes. The problem was that though McClelland linked competencies to skills, he never operationally defined what a competency was (Evangelista, 2008). McClelland did caution that though testing should be based on criteria (what people can do) based on job analysis, the resulting tests could become extremely specific and thus not represent competency. Competency is a collective attribute of skills and knowledge applied in context.

Over time this idea of competency has become defined as, “...the capability of applying or using knowledge, skills, abilities, behaviors, and personal characteristics to successfully perform critical work tasks, specific functions, or operate in a given role or position” (Ennis, 2008). Competencies are now seen as the basis by which organizations outside of postsecondary education can provide performance-based learning opportunities (Jones, Voorhees, & Paulson, 2002).

2.4 Performance-Based Training

To develop a performance-based training program, competencies and their related clusters of abilities, skills and knowledge need to become the focus of the training and not topics. Knowles (1970) cautioned that one of the difficulties in addressing adult learning is that the influence of pedagogy is so strong that adult learners will tend toward directed learning rather than self-directed learning. We would add that also when working professionals are asked to define training requirements, they have a tendency to do so in

terms of topics rather than performance outcomes. For operational meteorologists this will be in the form of the disciplinary structure that guided their postsecondary education or the technical attributes of the tools (hardware and software) that they use in their profession. To counter this a road-map for professional development for operational meteorologists needs to be clearly anchored in job responsibilities and the competencies related to job duties and functions.

Additionally, any system to define such a professional development roadmap has to be anchored in the community of practice — practicing forecasters with field experience. As part of the community of professionals defining a professional roadmap, people in the field should take ownership of an area of competency or job performance. Performance-based requirements are the responsibility of the practitioners, not the training organization. The training organization should be a facilitator and an “implementor” not a definer.

3.0 PROFESSIONAL DEVELOPMENT SERIES (PDS) MODEL

The Professional Development Series (PDS) model has two major components to it. The first is the structuring component for defining a professional development ‘roadmap.’ The second component is a set of roles for creating a PDS community of ‘responsibility.’ Working with teams in the National Weather Service, for the following areas of focus these PDSs have been defined or are in the process of being defined

1. Severe convection forecasting
2. Climate Services
3. Fire weather forecasting
4. Marine weather forecasting
5. Aviation weather forecasting

3.1 PDS Structure

A PDS is meant to focus on a specific area of responsibility. Responsibilities are associated with organizational goals and outcomes. When defining a PDS structure, it is important to focus on an area of responsibility that has performance results. The challenge in doing this is to focus on the proper breadth of description. Since a PDS will serve as a roadmap for guiding professional

development, it should be specific to what would be recognizable professional outcomes in the organization. For example, basing a PDS on a position such as “Lead Forecaster” would be too broad. Instead a PDS should be based on a more specific responsibility such as “Issue the marine forecast.”

Guidance for setting the span of a responsibility comes from two sources in psychology. The first is that people handle information loads by organizing content into meaningful chunks. Remembering and learning is aided by organizing information into five to nine groupings or ‘chunks’ (Miller, 1956). Studies of experts such as chess masters show that they, compared to more inexperienced players, do not treat a chessboard at any moment in the game as a set of individual pieces but instead as a more manageable set of five to six familiar configurations of moves. (Simon, 1998). A manageable area of responsibility for a PDS is one that ideally would not encompass more than five to seven distinct areas of competency.

The defined area of responsibility for a PDS is structured into Professional Competency Units (PCUs). For each PCU the following are specified:

- Description of Job Competency to be Achieved
- Description of Need
- Performance Elements (abilities, skills and knowledge)

Let’s look at structure of the fire weather PDS currently under development:

Responsibility: Issue fire weather forecasts and provide fire weather services.

Professional Competency Units:

1. Develop and maintain customer awareness and partnerships
2. Assess the fire environment
3. Make the warning decision
4. Provide fire weather products and services

Each of the PCUs is stated with an ‘actionable’ verb. The focus is on performance and what people who have competency should be

able to do. To further connect PCUs with an organization’s goals and outcomes each PCU should have a written description of the competency desired and the need for that competency. For example, taking the PCU “Assess the fire environment,” the following descriptions apply:

- *Description of Job Competency to be Achieved:* Monitor and analyze the fire environment to anticipate and identify critical fire weather patterns, fuels and topography.
- *Description of Need:* Identifying important features in the fire environment enables the forecaster to focus on specific threat areas within the CWA. Moreover, assessing the spatial and temporal evolution of the fire environment can improve decision-making skills by allowing the forecaster to better judge the potential severity of anticipated fire weather.

Sample performance elements from this particular PCU are:

- Identify and assess critical fire weather patterns, conditions and climatology
- Identify and assess varying weather regimes in complex terrain, and diurnal and local effects
- Analyze and Integrate data from remote sensing tools.

With respect to the last performance element above, it is important to note that quite often in establishing requirements for training, commonly used tools that cut across various areas of performance are pulled out of context and taught separately. The research done on situated cognition tells us instead, that context is very important for learning and mastery. Professional tools are subsumed under and placed in the context of performance outcomes associated with responsibilities and functional areas of competency.

As the performance elements of a PCU are further specified, they become the basis for identifying available instructional components that a person can access to acquire or maintain the stated competency. Again the PDS is a roadmap

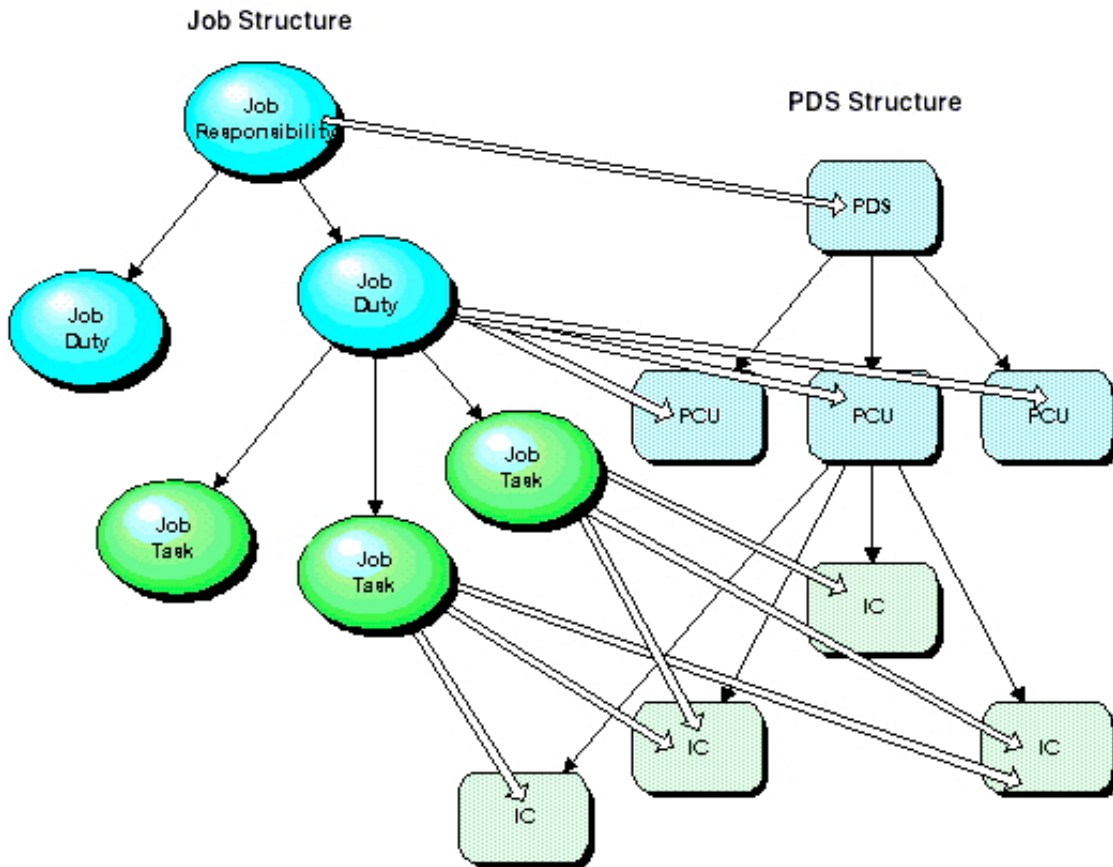


Figure 1: Relationship of Job Structure to PDS Structure

for professional development. As will be explained, the PDS is also a baseline for helping determine potential performance gaps and possible, but not necessarily, training solutions to meet those performance gaps. Figure 1 represents the relationship between job functions and PDS structural elements.

3.2 PDS Roles

The PDS concept involves establishing a team of practitioners from the 'community of practice' that will ensure that the responsibilities and areas of competency being defined are appropriate to the performance outcomes desired. This team is not meant to be a one-time gathering

of individuals but needs to be an on-going activity. The fundamental concept is to establish a strong partnership between the field and the training organization on an on-going basis. Once established the PDS becomes a baseline for discussions and planning for performance improvement efforts whether resulting in new training endeavors or not.

The PDS definition team becomes what may be called a "community of responsibility" such that they monitor performance needs and the adequacy of professional development resources associated with the defined PCUs.

There are three key roles that are played in relationship to establishing and maintaining a PDS. Because the activities associated with a PDS are project-oriented and fluid (development needs are not necessarily continuous but intermittent) the labels for these roles are borrowed from the content production industries such as film and music where development work is also project-based and fluid. These roles are executive producer, producer, and solution director.

Executive Producer: The executive producer is the person responsible for the overall integrity of the PDS. This role is focused on identifying requirements and securing resources and serves a strategic function for performance improvement. This person should come from the specific professional community or organizational function that the PDS responsibility serves. In the case of operational forecasting, the executive producer for aviation weather should be someone from that community that has significant management level experience and can operate at a regional or national level in the organization. The executive producer focuses on resources, both budgetary and personnel, to ensure development of the PDS and, then subsequently, on-going maintenance of the PDS. If the executive producer doesn't have direct control of these resources, he or she will have the ability to make strong recommendations to secure those resources.

Producer: The producer is responsible for a competency area. This is a tactical function. They control a PCU, initially helping define it and then monitoring and assessing how changes deriving from technology advancements, new operational procedures, or organizational initiatives could impact the abilities, skills and knowledge required for their area of competency. The producer looks for potential performance gaps based on those changes and initiates new training requirements. Producers will come from regional and line offices in the organization.

Solution Director: This individual directs the development of performance solutions to meet identified performance requirements. The solutions can be new training initiatives but they can also be other forms of performance intervention such as the revision of work procedures. The solution director assesses the identified performance/training requirement and

proposes an appropriate solution to the PDS producer and executive producer for approval and support. Solution directors will be in the training or operational support functions of the organization.

Recalling that the scope of a PDS should encompass around 5-9 competency areas at most, the practical PDS team will number 6-10 individuals at most. Research on effective teams indicates that the ideal team size appears to be from 5-9 individuals (Knowledge@Warton, 2006), which happens to be same range as the number of competencies areas that should be defined.

The purpose for establishing a PDS is to ensure that professional development and performance improvement are the focus of both the operational and the training sides of the organization. A PDS that is well defined can then become a roadmap for people to see what the performance that is expected of them as well as a roadmap for accessing professional development resources to acquire or maintain the skills and knowledge necessary to perform effectively in their roles.

4.0 IMPLEMENTING A PDS

Assembling the PDS team is challenging, but important, in setting the project up for success. Successful teams have included representatives of training agencies, experienced people accomplishing the job for which the PDS is being developed, and program managers at regional and national levels. Most of these people will work on the PDS in addition to their regular jobs responsibilities, so it's important to agree on mutual expectations when beginning a PDS project.

When it has been decided to establish a PDS, an initial "kickoff" meeting is held. Attendees at this meeting should be selected on the basis of their potential service in the roles of executive producer and producers. This initial meeting should be facilitated by someone familiar with the PDS concept and who has a performance focused view of training and its function in an overall performance improvement activity within an organization. There are processes for going from a performance analysis to a training needs analysis (Rossett, 1999; Burner, 2010), but these processes benefit from having a foundational

representation of the performance that is expected. The team for establishing a PDS should have the experience and capability to represent the competencies to be defined.

As already indicated, the greatest challenge by far in this process is changing the mindset of professional meteorologists to think more in terms of performance rather than simply in background knowledge organized around topics, those topics usually derived from their prior academic experience. Once this approach has been accepted within the team, the process can move more quickly. It is important to constantly review the analysis to ensure it addresses what people providing these products and services are actually doing as part of their job.

After the initial kickoff meeting, generally work on the PDS will need to be accomplished at a distance for budgetary reasons. To help facilitate these activities, utilizing conferencing software, wikis, and mind mapping tools has proven to be helpful. We have successfully used wikis to help house our working documents and provide a

structure for the PDS roadmap. A powerful aspect of collaboration software is the ability for several people to work on the same files or website simultaneously. We have used various wiki sites to provide access to PDS work to all of the team members. This is very helpful in organizing the files and support resources needed in creating the PDS. However, we have run into reluctance of team members to change or "write over" their colleagues' work. In these cases, the Producer of that PCU has coordinated changes from other team members.

Mind mapping software has proven very helpful in supporting brainstorming efforts in analyzing specific job tasks and the supporting skills and knowledge needed to perform them. These visual depictions of the relationships help to organize the PCU components and to then identify training that already exists to support the required skills and knowledge as well as to determine where training gaps exist. We have run into some resistance from team members to learn yet a different type of software package. We've

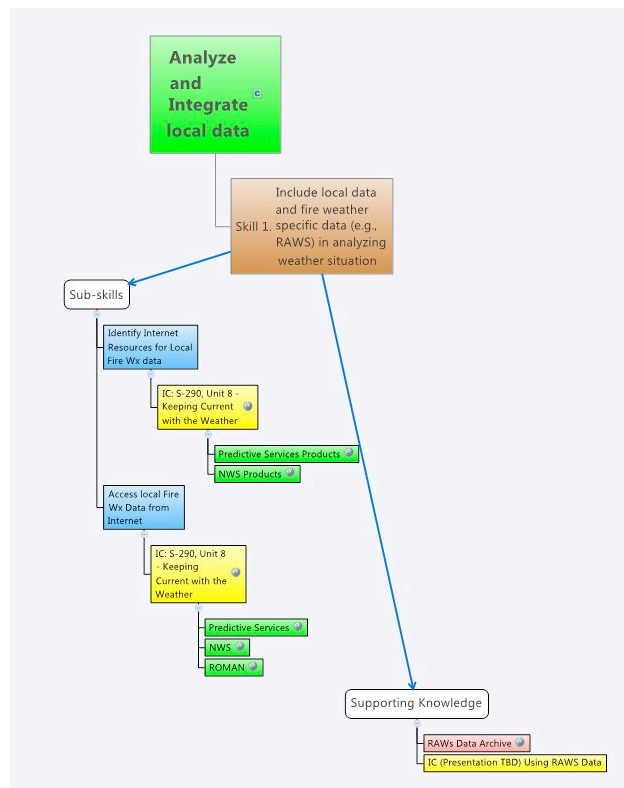


Figure 2: Mind map of an ability within a competency area

found that providing some basic recorded tutorials and templates give team members enough training and support to mitigate this resistance. Identifying a focus person on the team to help others work directly with the tools keeps the development of the PCU moving forward.

Figure 2 shows an example of the representation of skills and knowledge for an ability required for the fire weather competency area “Assess the fire environment.”

By far the approach that has been most successful with the PDS teams with whom we’ve worked has been to hold regularly scheduled

conference calls using virtual meeting software. Bi-weekly calls can help with continuity of thinking as well as keeping team members on task.

Eventually, the developed PDS should be made accessible via a Web-based site. The PDS can serve to create “learning paths” within an LMS or it can serve as a direct access to professional development resources. Figure 3 shows an example of an early form of PDS website that is available from the NWS’ Training Portal site (<http://www.nws.noaa.gov/training/pds.php>)

Warning Decision Training Branch Professional Development Series

Severe Convection Forecasting and Warnings

PCU 1: Optimizing Office Strategies for Convective
Operations

Producer: Steven Martinaitis, WDTB



[Click here first for an Introduction](#)

[Click here for a Needs Assessment](#)



Specific Job Task Skills and Knowledge:

Task 1.1: Review and update your office’s Station Duty Manual and/or Severe Weather Operations Plan (SWOP).

Instructional Components:

IC 1.1: The sections below provide a brief description of the different aspects of severe weather operations in a Weather Forecast Office (WFO). Each aspect listed below contain link(s) to pages and presentations related to the material.

Staffing Strategies
Communications
Office Setups
Office Strategies

Figure 3: An example website page from a developed PDS

5.0 CONCLUSION

Time for training and the resources to develop training are becoming more limited in many weather services as a result of increasing job demands and reduced budgets. However, with the growth of e-Learning more online resources both in the form of structured course materials, informational presentations and video, and reference materials are available and easily accessible. Being able to have a PDS road-map of expected job competencies, their related abilities, skills and knowledge specified and linked to professional development resources will serve two purposes. First, they will provide operational forecasters with a means to attain or ensure the maintenance of their own job capabilities or to see how they can gain new capabilities to allow them to take on new job responsibilities. Second, it will be a baseline by which the weather service organization can assess where performance gaps are likely to develop as a result in changes in technology, processes and procedures or new science. The team aspect of the PDS creates an active partnership with the operational elements of the weather service and the training development elements of the weather service.

When the PDS concept was first introduced, the difficulty of convening the people needed to staff a PDS initiative and maintain on-going contact between the PDS team members were roadblocks to the concept moving forward. Today with the virtual collaboration tools and the means for online working at a distance, PDS development is far more doable. Also, the increasing availability of online professional development resources makes having a PDS roadmap more necessary to point people to those resources and to see how those resources can be integrated into a professional development program that is focused on achieving and maintaining job performance.

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