Representing a Problem Space: Towards a Deeper Understanding of the Practice of Instructional Leadership

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Abstract: Understanding how principals solve the problems they encounter in practice is a critical step in improving instructional leadership in schools. Traditional approaches to extracting expertise in principals are sufficient to capture some differences in behavior and may hint at cognitive differences, but we argue that they do not tackle differences in the architecture of the problem space that principals construct when they are working on instructional problems. Drawing on a subset of data from a larger study of 40 principals, we present our visual approach to understanding how principals reason through problems. We conclude the paper with a discussion of how our approach could be used to better understand the practice of instructional leadership.

Introduction

It is clear that effective leadership is a critical factor in the academic success of schools. Several studies have shown that principal leadership is important for promoting the school conditions that lead to improved instructional practice and student achievement (Hallinger & Heck, 1996; Liberman, Falk, & Alexander, 1994; Rosenholtz, 1989; Seashore-Louis & Kruse, 1995). This is despite the fact that very little is known about the way that principals think and solve problems; cognitive research on leadership has traditionally limited itself to studying how a leader's decision making influences their actions and behavior (Green & Mitchell, 1979; Newmann & Wehlage, 1995; Pfeffer, 1977; Simon, 1976; Weick, 1979). Leithwood & Stager (1989) point out that this focus on decision-making can only reveal simple cognitive structures of the 'black box' that is the principals' mind, leaving a detailed understanding of the process of how principals reason through problems undiscovered. Leithwood & Stager tackle this problem through the use of unstructured administrative scenarios, which were given to principals of varying expertise. They were able to draw parallels between the expert strategies of principals working on scenarios and individuals in other domains that the problem solving literature has studied. Leithwood and Stager found that the best scenarios for differentiating between experts and typical principals were those that were the most unstructured or 'ill-structured'. These problems are so termed because they force one to structure the problem, as well as come up with a solution. In fact, as Simon (1973) points out, structuring an ill-structured problem is often harder than finding the solution.

Although Leithwood and Stager's work demonstrated that problem-solving strategies were the same across domains and could be used to differentiate between experts and typical principals, they left room to further unpack the 'black box that is the principal's mind' (Leithwood & Stager, 1989). Their approach made extensive use of what they called the 'grounded components' of the problem, but they did not address the way that those individual components interacted, or how they structured and populated the problem space. We may know that principals exhibit expert problem solving skills, but we still don't know how those qualities interact to form a problem space that the principal can use to solve problems in practice. One of the ways that we understand this construction of a problem space is as the building, by principals, of a mental model of the world in which they act.

Willett Kempton's (1986) work on folk theories for heat control serve as an example to illustrate the benefits of such an approach. Kempton analyzed the folk models that individual's use for operating their thermostat, revealing that what appeared to be small differences in the usage of thermostats was actually caused by wildly differing mental models on how thermostats worked. For example, one participant believed that by turning the heat all the way up, the thermostat would trigger the heater to a powerful level, slowing down as the room temperature approached the set thermostat level. Kempton found that by asking more questions and comparing the thermostat to the oven temperature, the participants would question their own model and ultimately change it. This reveals that the participants were using a rough heuristic that governed how the thermostat worked. Upon investigation, the participants eventually realized that the heuristic didn't match other models that they held. Kempton's work is interesting in its own right as well as for its grounded approach to understanding how individuals perceived the problem space of using a thermostat.

Davis & Davis (2003) recently argued that principals rely on heuristics for the better portion of their problem solving strategies. When Kempton interviewed individuals about their actions with the thermostat, it was evident that many of them used heuristics to get the desired temperature rather than a clear understanding of the thermostat's functionality. We concluded that using a methodology that would reveal some of the mechanics of those heuristics would be a great platform from which to both compare expert and typical principals as well as to discover the content of principals' models of particular elements of instructional practice. This differentiated our work from what had previously been done in the literature because although the literature could provide a good understanding of the more general components of principal problem solving, it did not provide any insight into how principals modeled the world that they operated in.

This paper presents an approach that exposes the problem spaces that principals generate when presented with instructional scenarios. It is important to note that we deviated from Kempton's approach, as we were not interested in discoursing with the principals about their heuristics, but rather just capturing their way of working on the scenario. We ground our approach in the data gathered from a larger study, thus immediately testing it with relevant data. Our use of data in this paper is intended only to be illustrative of our approach. We will not present an analysis that is refined enough to draw any general conclusions about, for example, how typical and expert principals differ. Our conclusions focus solely on the merit of our methodology as a means of understanding the way people reason through problems. Overall, our goal is to begin to show that our approach to understanding principals thinking reveals much more about their practice than other approaches have previously managed. Moreover, we believe that in the future this approach could be implemented in the larger study to rate comparisons of salient relations in the problem space.

Research Design

The data that we analyzed for the purpose of this paper was taken from an ongoing study of 40 active principals and 20 novice principals participating in a training program. The active principals were selected on the basis of several leadership and organizational measures from a public-use dataset of teacher surveys. Informed by the aforementioned literature that highlights the qualities of effective school leaders, we drew on measures of instructional leadership and teacher-principal trust to assess leadership skill. Then, to verify that the principal was having an effect on the organization, the organizational measures of collegiality, peer collaboration, innovation, focus on student learning, reflective dialogue, and school commitment were also assessed. Principals who exhibited an increase in their leadership and organizational measures over several years were classified as experts. Principals whose leadership and organizational variables were comparatively low and stayed low over the length of their tenure were classified as 'typical' principals. This dataset was then cross-referenced with socio-economic data to match the two group's ethnic makeup and poverty rates (as measured by free and reduced lunches).

Interviews were conducted at the school, usually in the principals' office. To accurately capture the way that principals structured the scenarios that they were given, the principal's response was not interrupted or 'led on' with additional questions that might artificially cause the principal to think about new elements in the problem space. The principals were encouraged to think about the problem and respond as they saw fit. The scenario segment of the interviews took about 20 minutes. The scenarios were preceded by questions about the participant's background and responsibilities as principal of the school to ease the principal into the format of the interview. After the scenarios, the principals were given a series of leadership and organizational questions.

Since the goal of this paper is to illustrate our approach, we draw only on the data from two participants (one expert & one typical) of this larger participant pool, as well as just the scenario segments of the interview. The scenario that we will be analyzing in this sub-study is as follows:

> After your first day as principal of your school, you realize how poorly the previous school improvement plan was done. Apparently, the previous principal used last year's plan and changed a few paragraphs. As the new instructional leader of this building, how do you approach this situation?

All names referenced in this paper are pseudonyms to protect the research participants.

Approach

The new approach presented here was developed, in part, due to specific limitations in other approaches, developed by earlier researchers, that we attempted to apply. Crudely speaking, these earlier approaches work by assigning codes that are part of a category scheme to portions of a transcript. These earlier approaches tend, for example, to attribute broad characterizations to principals. For example, they might code portions of a particular problem-solving attempt as indicating that a principal is "focused on student learning". However, this sort of approach failed to capture some of the most salient features of our data. Namely, we noted that the same specific elements repeatedly showed up in principal's problems solving attempts.

Thus, we set out to develop an approach specifically directed at capturing the problem spaces that principals construct. As a first step in our approach, we attempted to extend the categorical coding approach in a relatively straightforward way. We read through the data and sought to identify grounded objects in the problem space that we saw. Objects that the principals populated their problem space with were noted as interesting fixtures, representing some sort of function to the principals. We tried not to prematurely look for differences but rather just to get a feel for an accurate representation of the way that everything interacted. Soon we had a rich ecology composed of feelers, causes, actions, and links that each served some purpose for the principal in the solving of their scenario. For example, the following excerpt from the transcript highlights this process. A {*x*} denotes the beginning of the element, and the {/*x*} denotes the end. We adopted this convention from TAMS, an open source text analysis markup language (Weinstein, 2003)

> "Well if the {object}previous principal{/object}, as you indicated, {link}was making {/link} little changes in what they were doing on a year to year basis certainly {cause}you need to do{/cause} your own {object}needs assessment{/object} to {feeler}find out{/feeler} where your {object}building {/object} is at the time that you arrive."

This first step of our approach gave us what we were looking for in terms of an understanding of the ontology of the problem space. However, we still felt that this approach, where we attempted to directly "see" elements of the problem space in the transcript, still missed much that was important. Namely, what we were looking for, we realized, were the 'levers', that the principals mentioned in their response. The 'levers' are elements of the problem space that give the principal some traction in solving the problem. For example, in the excerpt above, the principal is explaining how he would begin addressing the scenario with a needs assessment. However, our analysis does not capture the fact that the principal wants the needs assessment to be done on the building so that he can find out "where it is". We capture an object (a static item), a feeler (a data gathering action), and another object, but there is no specific point in the text that reveals the connection between the three items (the lever), and so all we can say is that there is a feeler and two objects. The relation between them that reveals how the needs assessment is used by the principal to learn about the building is lost and is not readily recoverable with such a coding scheme. We know the needs assessment is a lever because it is a type of tool that the principal will use for leveraging a solution. We needed a different coding scheme that could capture the true nature of levers in the problem space. Furthermore, while brainstorming about the nature of these levers, we realized that some of our elements should not really exist on their own and were necessarily compound. For example, we came to understand feelers as specific types of levers that must necessarily have an output or datum (in this case an understanding of the building), and ideally at least one action based on that output. By being able to build a rule that a feeler lever must have a connected object, one or more actions, and a datum, we would be better equipped to tease out differences in the ways that expert or typical principals constructed their problem spaces. We did the same thing for actions, because we realized every action necessarily needed some impetus, the action, and a target. An action lever had to have an initiator object, an action, and a target object. Feeler levers differed from action levers in that feeler levers were focused on gathering data and action levers were ways that the principal could effect change in the organization. An added benefit that these action and feeler levers brought was the inclusion of empty objects into the problem space. Instead of just being able to say what a principal populated the problem space with, we could now also say what they didn't populate it with.

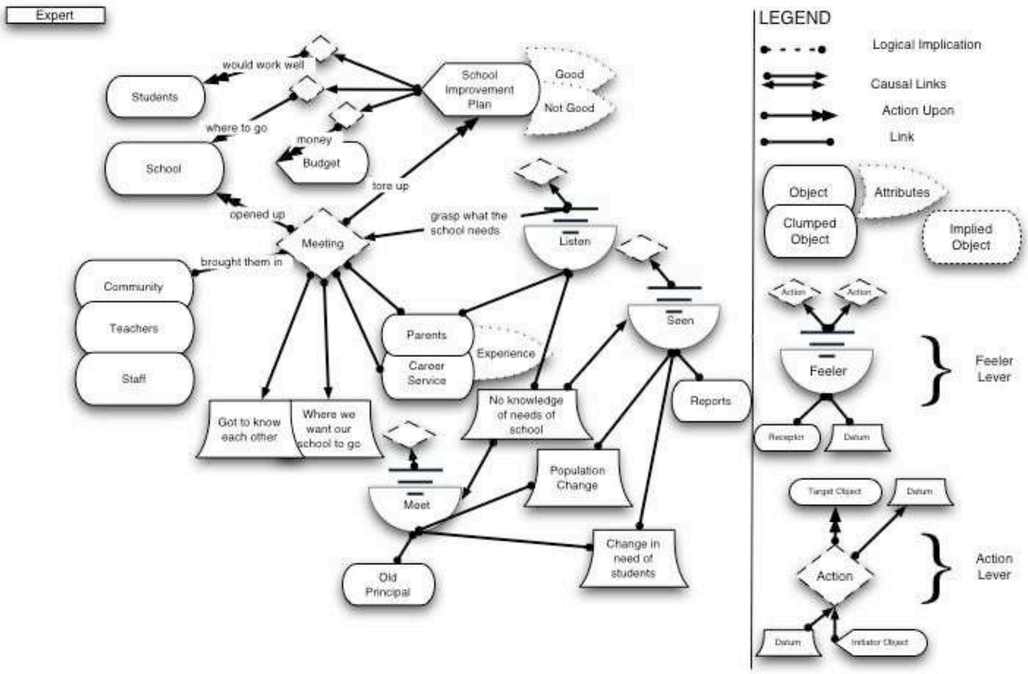

Figure 1. An expert response.

At the same time as discussing rules that governed what levers looked like, we were working on a meaningful way of representing both the individual as well as the levers in the problem space, and well as the relations between them. We wanted an approach that allowed us more latitude in making inferences, and that allowed us to capture more of the structure of principals' mental models than a simple categorical coding. We thus set out to represent connections graphically, thus telling a graphic story for each principals and each scenario. However, being a graphic representation, we immediately recognized the need to subject the representation to a certain number of rules that structure the look of the diagrams. Our worry was that by an arbitrary placement of objects, things would look different but would not really be any different at the conceptual level. We also had to make sure that the representation was useful for something other than its own sake, i.e. it had to reveal new things that could also be compared across individuals, perhaps even individual scenarios. To do this we had to be careful not to connect things that we felt should be connected but were not explicitly connected in the data or subject to our set of rules. These worries were all realized in the initial drafts, so with each revision we added rules to standardize the output as well as to reveal in more detail, which principals were not doing what their counterparts had. After several revisions and the adoption of a standard set of objects that the problem space was filled with we arrived at what seemed to be a working formula, which we are still improving upon as we work through scenarios. Figures 1 and 2 reproduce an expert and typical principal working the scenario mentioned earlier. The full transcripts that yielded these models are included at the end of this paper.

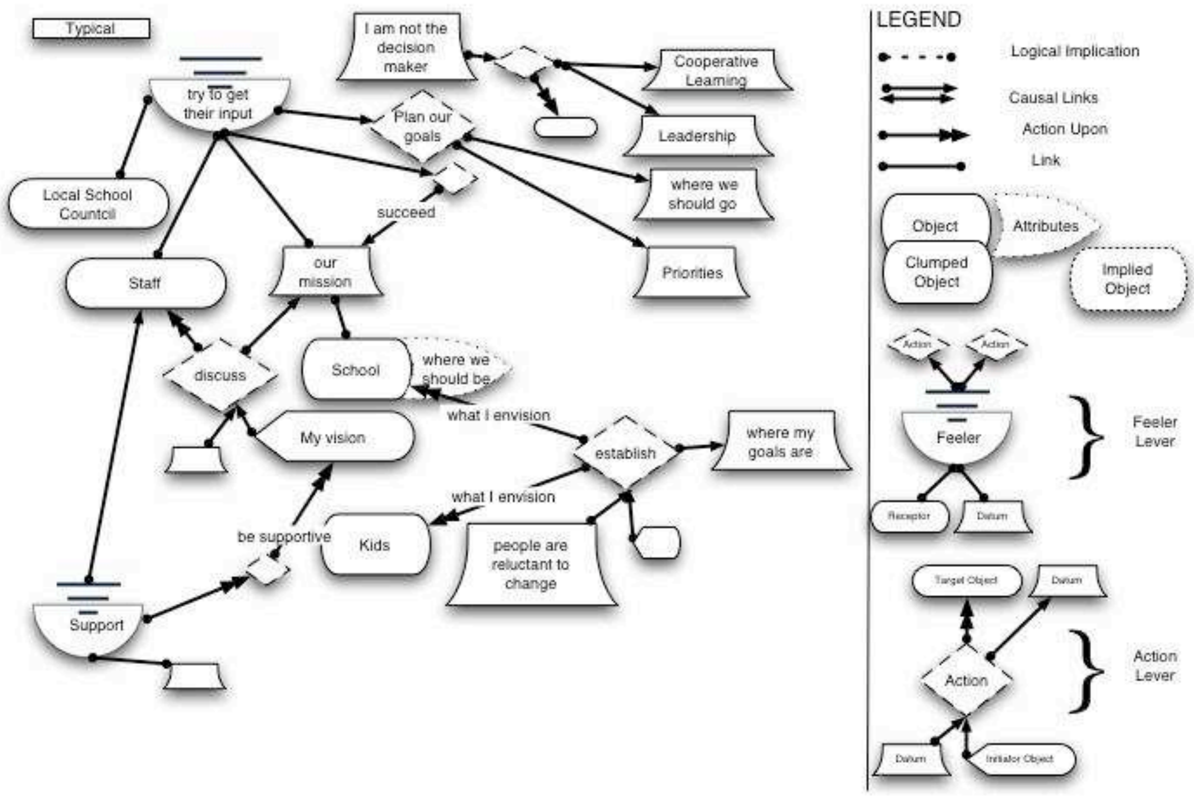

Figure 2. A typical response.

We will now discuss three viable methods for analyzing the above models. The first most obvious method is just to look at the two models as a whole and see whether they look different. Though being quick, this method is hampered by our decision to not systematize the location of objects (e.g. in columns) resulting in models that may have objects placed differently but actually be the same thing. This was done intentionally so that the lines in the model would remain uncrossed. With this caution in mind we can still use this method to see that the 'meeting' action in the expert response (Figure 1) takes a much more prominent role than the 'discuss' action in the typical response (Figure 2). In addition, we also see from this method that the expert model seems more interconnected than the typical model, which has several weakly connected datum in the upper right. This brings us to a second method of assessing differences between models, doing a thorough inventory of the individual items in the model and then comparing the counts of the two models. At first sight, this method is very similar to the textual coding example outlined earlier in this paper because all we are doing is counting individual elements in the model. However, the graphical representation gives us the benefit of being able to also count connections between objects. This is problematic in the textual example as the connected objects might be at opposite ends of the textual response and therefore hard to code as connected items. In the graphical representation, they are very clearly linked together, thus counting as a connection wherever they may be in the text. An example of this is in the expert response where the principal initially refers to the School Improvement Plan in the context of the budget, but then later again in the context of the meeting. This is something that would be very hard to capture using a traditional coding method.

The true strength of this graphical representation is revealed with an analysis focused on the combinations of individual elements and levers. Capturing this level of detail is practically impossible at the lower textual level because we are incorporating both connections between elements that may be scattered all over the response of the principal, as well as the unpopulated items that exist as part of the action and feeler levers. So, looking at the expert response, we see that in the top section the meeting is part of a lever to change the school improvement plan, which via some undefined actions changes the school, the students and the budget. Looking at the lower right hand corner, we see several feeler levers, meeting with the old principal, listening, and viewing reports. Taken together, these two clumps show highly complex associations, centered on action in the problem space of the expert. In contrast, the typical principal's feelers have connections that are, for lack of a better description, much weaker in substance. The typical principal does make attempts to gather input and support like the expert principal, but the feelers link to planning goals and being supportive of the principals own vision, rather than specific objects such as the budget, the school improvement plan, reports, etc. This is reminiscent of what was noticed using the previous methodology where we highlighted how the datum in the typical model were not as integrated into the model as with the typical principal. More insight can be had of the expert model by looking the way that the parents are more central to the model by virtue of their attribute of experience, their connection to the feeler lever "listen", and their connection to the meeting. This gives us a unique insight into how the principal perceives the different interests at the meeting.

There may be several more ways to analyze these graphical representations, for example by looking at the number of hops there are between students and action units, but we are not trying to exhaustively capture each possible way slicing the model but rather the three principal methods for doing so that is useful for understanding the problem space. Nor are we claiming that the differences we have shown offer any generalizable information about how expert or typical principals construct their problem spaces. We offered the three methods to satisfy the requirements that we set out for ourselves, namely that the new coding scheme be something that could be used as a tool to extract quantifiable differences in the way that the principals constructed their problem spaces to solve scenarios. To recap, the first method of coding using the graphical representation is to just look and see if the models are different, the second is to count the objects or connections, and the third is to look at the levers and the integration of those levers into the larger model. It is the third method that we feel best captures the nuances of the data and would be best for discriminating between expert and typical principals on a larger scale.

Discussion

We have argued that although other coding approaches can extract data from textual passages, they do not preserve the subtlety of the interactions of different elements in the problem space. Nor do they account for interactions amongst more compound elements, such as levers, with the other elements. Given this limitation, we have detailed our approach for gaining a deeper understanding of the way that principals think through the use of a graphic representation of the problem space. This approach, as well as the rules and methods to extract data are still in a refinement phase. We cannot stress enough that the strength of our approach lies not in the specific terminology or levers within the problem space. The strength of the approach comes from its power to elucidate the interactions between elements in the problem space. In another domain we could well imagine different levers, different elements. However, in this domain there is a confluence of elements that allows us to orient ourselves around particular levers (action and feeler) and other objects, so we may compare across principals with different experience levels and still manage to extract meaningful results.

What constitutes 'meaningful results' is what we perceive to be the central critique of our approach. Throughout the development of the graphical representation we struggled with developing a set of rules for how to convert text into a graphic representations. For example, one struggle focused on whether to sacrifice simplicity for logical consistency. For example, when a typical principal talked about "People" and then "Staff" followed by 'the Bandwagon' are the three objects to be left as separate, or should they be combined under the general rule that "Staff" is a sub unit of "People" and therefore should be within it? By combining them the model is simplified, but at the same time there are some subtleties that are being lost. We did not successfully arrive at a rule to govern this, so some of the models have more than one of the same units for example, "my vision" and "my goals" in the typical example. Things must be handled on a case-by-case basis and are another reason that the first and second methods for analyzing the data (counts) might be corrupted by a decision to combine, or not to combine, elements. Throughout the coding of our graphic representations, one of the things that we struggled with was overcoming the natural tendency to simplify what was being said. It was only through successive readings of the data and corrections of the representation that one was satisfied with the way that the text was represented. This naturally has implications for how quickly these models can be generated in comparison to coding text. Ultimately, the use of such a graphic representation is a tradeoff. The approach we have presented here allows one to capture subtleties in the connections between elements that the textual coding scheme cannot do because the units cannot be decomposed and rearranged to form a problem space. Textual coding essentially forces a gloss that brushes over the data and prevents us from accurately understanding the problem space. Moreover, the cognitive act of building the graphic representation through successive iterations allows one to interact much more closely with the text giving a real understanding of what was and was not said, and so our actual understanding of the problem space was deepened just by going through the motions of creating the graphical representation. For different theoretical models and research, it is quite conceivable that the problem space may be irrelevant and so a textual coding will suffice. However, we argue that in order to fully understand the practice of instructional leadership, it is necessary to be able to unpack the cognitive elements that form a principals' problem space.

Our approach to graphically representing reasoning would benefit greatly from more research investigating its application to different problem settings. We believe that as more research is conducted into how individuals solve problems, the need for a coding system that captures the way that people think through the problem space will only grow correspondingly. However, we know nothing of how robust such graphical representations are across domains. Can the same representations be created for the way that individuals solve physics or economics problems? How do those graphical representations differ from the ones that we have created in this paper? Are the differences more superficial in nature, or is for example the very concept and structure of 'feelers' that we have developed here not applicable in different settings? The best way forward is for more research of this type to be conducted so that our combined efforts can help us proceed towards a formalization of the way such graphical representations of thought are created.

Transcripts

Expert Response: Ok. Well how we did it here as far as how do we work with our school improvement plan; in order to give us money in the budget so that I can in-service the, well not in-service but bring in a group of parents, teachers, staff, community members on a Saturday. And what we did is we opened up the school. And at that time we tore up the SIP. And we looked at all the, I had a lot of ___ in there also by the way. But what we did is we looked at it and we looked at well, this is good, this is not good, this is where we want our school to go, this would work well with our students. And it was at that time I wasn't that knowledgeable about the needs of the school. I had seen the reports on the school prior to coming to the school and I knew where they were at, I knew where they were at according to the city and the state. But the programs they were involved in the school I wasn't, you know that much into because the principal did meet with me and we knew what was going on. But at the same time there was a change in population. There was a change in needs for the students. So the best way, at that time, to be able to grasp as to what the school needs was to listen to the people that had experience with the school; the parents and the career service (?). So that's what I did and I brought 'em in. it was a whole day. We had food sent in. we had coffee in the morning. We met as a group, we got to know each other. And with that we broke it apart and we looked at you know, this is working well, this is how much money we're gonna put here, we're gonna put there and so forth. And that's how it was done the very first year when I was here.

Typical Response: Um, well I believe I would get the staff together and discuss what my vision is, what our mission for the school should be and our mission of where we should be. And um, try to get their input. I believe in having the staff give me input; I'm not the decision maker, we do cooperative learning, leadership. And plan our goals, figure out what our priorities are and where we should go from there with their input. And also have some input from the local school council; bring them in. and sometimes people are reluctant for change and you know I think I have to establish where my goals are and what I envision for our school and our kids. And I have to see how many of those people on my staff are gonna jump on the bandwagon and be supportive of it. But I want them to have the input otherwise we probably wouldn't succeed in our vision.

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