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# UNDERSTANDING THE TRANSITION TO KNOWLEDGE GENERATION ENVIRONMENTS: EXAMINING THE ROLE OF EPISTEMIC ORIENTATION AND TOOL USE

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## Abstract

Current reforms in education have emphasized shifting learning environments from a traditional replicative framework to be much more aligned to knowledge generation environments. These environments are focused on promoting student engagement with the epistemic practices of the discipline, which are the argumentative practices used to generate disciplinary knowledge. Helping teachers to shift from their more traditional pedagogical approaches requires professional development programs that enable them to not only experience learning within a generative environment but to also engage with the theoretical underpinning of such environments. To better understand the complexity involved in helping promote teacher change, the researchers implemented a professional development program that focused on asking teachers to examine their orientation to learning and how this influenced their pedagogical approaches. The knowledge generation approach, Science Writing Heuristic (SWH) approach, was the focus of the professional development as the work was centered on improving science teaching and learning.

The professional development program focused on examining cognitive learning theory, the use of epistemic tools of argument, language and dialogue, the development of pedagogical approaches and development of teaching units that aligned with school curricula. The K-5 teachers were drawn from two states and were involved in 10 days of professional development – 6 during the summer and 4 during the academic year. To study teacher transition to these environments the researchers developed three new survey instruments focus on epistemic tools that are utilized in these environments: argument, dialogue and language. The teachers also completed an epistemic orientation for generative environments survey. Teachers completed these survey instruments every six months across the three years of the project.

This presentation focuses on the first year of participation in the project as this represents the critical transition time for teachers in moving to implement the SWH approach within their classrooms. Using Latent Transition Analysis the 95 participating teachers were classified into three initial profiles. During the first six months there were transitions from both low to medium, and medium to high implementation. However, the reasons for the transitions were different. Low to medium transition was around improvements in orientation and dialogue, while for medium to high the transition was around understanding argument. The transitions during the second six months shifted to be centered much more on orientation, than epistemic tools. Once teachers transition to a new profile, they remain at that level or potentially move to the highest profile.

***Keywords:*** *Epistemic orientation, epistemic tools, transitions.*

## 1. Introduction

Current reforms in education have emphasized shifting learning environments from a traditional replicative framework to be much more aligned to knowledge generation environments. These environments are focused on promoting student engagement with the epistemic practices of the discipline, which are the argumentative practices used to generate disciplinary knowledge. These environments reflect the current emphasis place on promoting epistemic practices that underpin much of the new curricula being implemented in the western world. Particular emphasis is being placed on ensure that students can experience the epistemic practices of the discipline as they generate conceptual understandings of the topics being studied. This shift to focus more on the engagement of epistemic practices, is not about replication of practices.

Epistemic practices by their nature are how a discipline advances the field of study. These are not procedures that need to be replicated by students. Simply getting students to follow the step-by-step application of the epistemic practices is not how arguments are built. Epistemic practices are practices which focus on the processes by which knowledge is generated – it is how we come to know new knowledge, how we embed knowledge into our conceptual understandings. That is, how we generate new understandings.

A critical question that arises from such a position is what are the essential tools that will help students generate rich understandings We argue that there are three critical areas that important for learning: Argument, Language and Dialogue

Argument from a disciplinary perspective is how a discipline moves forward. In science education the concept of argument has emerged as an emphasis area since the late 1990s. The emphasis has been centered on replication of the particular practices related to argument – these are represented in the Next Generation Science Standards in the US as eight practices (Cavagnetto, 2010). From posing questions, gathering data, generating claims and communicating to audiences. The major approach to utilizing these practices has centered on the replication of these – students are generally provided questions to explore, and are expected to complete procedures that will enable them to arrive at the scientific outcome. The approach to argument that is much more focused on immersing students in science argument is the Science Writing Heuristic (SWH) approach – this approach places importance on students posing questions, participating in generating designs, and gathering data from which they can use reasoning to generate evidence for a claim. Such an approach places much more emphasis on students generating understanding through utilizing argument as an epistemic tool.

Language is critically important because as Norris and Phillips (2003) have emphasized, there is no science without language. Science cannot happen without knowledge - this is language in all its forms of text, graphs, equations (chemical and mathematical), diagrams etc. To be able to both understand and to communicate science ideas students have to engage with the appropriate language that will best represent the idea. Importantly, students need to be able to move between these modal forms, be able to link these modal forms, and to ensure the resultant output is able to fully represent the idea being explored. Understanding that being able to connecting between modal forms is a critical element of building understanding. This shifts the emphasis from using language as a means to complete the work, language becomes an epistemic tool (Prain & Hand, 2016).

Dialogue is critical in implementing environments where students have to socially interact as an element of learning. Recent research into dialogical education has begun to highlight the benefits of engaging students in opportunities to dialogue with each. These opportunities are for both small group and whole class forms of negotiation. Importantly these dialogical opportunities are seen as forms of negotiations – they are not monological exchanges where speakers talk past each other. Dialogues are generative, they build as participants exchange ideas with each other. It is an epistemic tool - through these social interactions, students negotiate and generative new understanding.

What becomes important is how teachers approach the use of these tools. The orientation that they have to learning will dictate how effective these tools will be. We believe students utilize these tools as they need to in every situation. However, the question that is important is how to maximize the use of these tools? We believe that the orientation to learning is critical for maximizing the opportunities for students to use these tools. The difference between the derived and fundamental sense of literacy is the shift away from viewing learning environments as being about completing a product (replication) to focusing much more on the processing (generation) of knowledge. This is critical for how a teacher sets up his/her classroom environment. As highlight in the study by Cikmaz et all (2020), the students' utilization of their epistemic tools of argument, language and reasoning was impacted by the learning environment. In the chemistry lab classroom, which was framed on the SWH approach, students developed and utilized these tools as elements of the classroom engagement. When the same students went to the physics lab class, the focus was much heavily focused on completion of traditional formats with a limited amount of interactive classroom dialogue. As a result, student utilization of their epistemic tools was greatly reduced.

Encouraging students to engage in understanding the processes of knowledge generation is critical in helping them develop and utilize the epistemic tools that underpin a discipline. Understanding how we can help teachers move to adopt these types of approaches is critical in helping students learn science better. This study was focused on examining how teachers' shift in their understanding as they move towards becoming more generative in their teaching. Helping teachers to shift from their more traditional pedagogical approaches requires professional development programs that enable them to not only experience learning within a generative environment but to also engage with the theoretical underpinning of such environments. To better understand the complexity involved in helping promote teacher change, the researchers implemented a professional development program that focused on asking

teachers to examine their orientation to learning and how this influenced their pedagogical approaches. The knowledge generation approach, Science Writing Heuristic (SWH) approach, was the focus of the professional development as the work was centered on improving science teaching and learning.

## 2. Method

The research reported here is based on a 3-year National Science Foundation grant focused on grade K-5 teachers in two states within the US. The grant was focused on a professional development program that was focused on examining cognitive learning theory, the use of epistemic tools of argument, language and dialogue, the development of pedagogical approaches and development of teaching units that aligned with school curricula. Teachers were asked to shift their science teaching to adopting the SWH approach. This approach has been shown to improve science knowledge, critical thinking skills and help reduce the disadvantage gap for IEP and low SES students (Hand, Chin & Suh, 2021). The K-5 teachers were drawn from two states and were involved in 10 days of professional development – 6 during the summer and 4 during the academic year. The teachers shifted each teaching unit in science to the based on the SWH approach.

Data Collection: To track the shift in teachers shift to generative learning environments and their abilities to develop adaptive expertise, the researcher developed three instruments related to the three epistemic tools that underpin science learning: Argument, Language and Dialogue. The teachers also completed an epistemic orientation for generative environments survey. The intent of these surveys was to provide information related to teachers' perceptions on these particular critical elements of any learning environment. Teachers completed these survey instruments every six months across the three years of the project. Information related to teacher implementation of the approach was also collected.

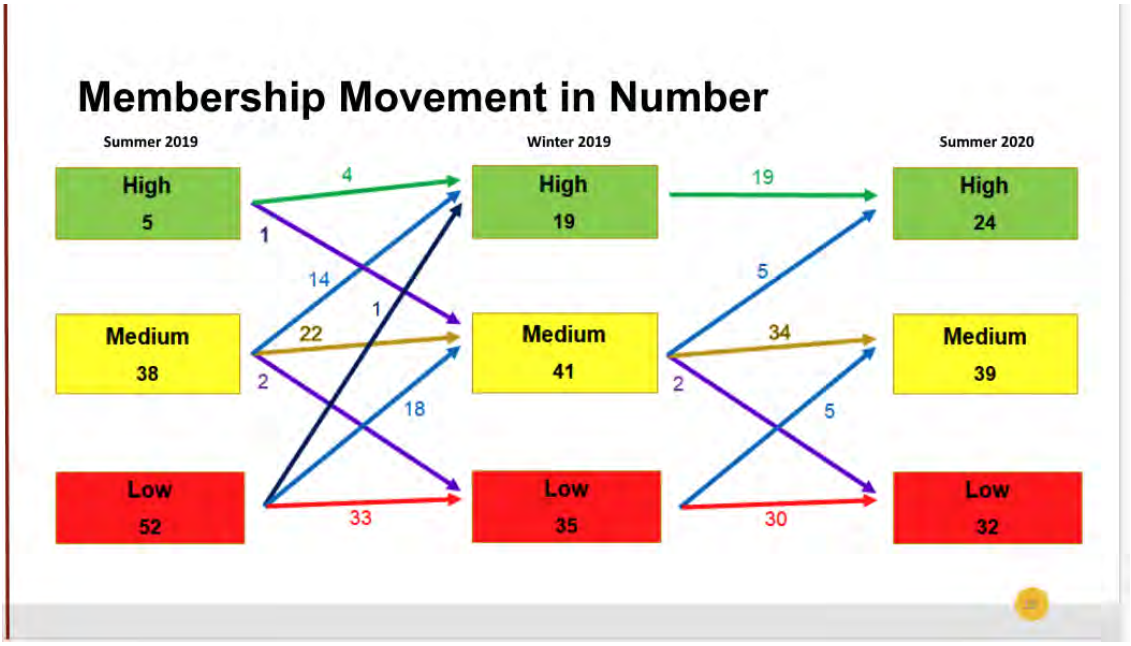
Data Analysis: Latent Transition Analysis (LTA) was used to examine the degree to which the 95 participating teachers shifted in terms of their shifting perceptions related to epistemic orientation, language, argument and dialogue. The LTA generates profiles of teachers at each time point – in this presentation these time points represent at the start of the professional development, six months later, and just prior to the second summer professional development workshop (12 months after the first).

## 3. Results

The teachers were classified into three initial profiles. The profiles were generated based on the interplay between orientation, argument, dialogue and language. As can be seen from the figure below, at time point one the majority of the teachers were in profile 1 – classified as the lowest profile. The teachers generally had the lowest scores for EOS and tended to be centered around a more replicative perspective, that is, these teachers appeared to be focused on ensuring students received the correct science information. The distribution of teachers in the other two profiles was lower, with only 3 teachers being in the highest profile – that is, the profile representing the highest scores in all four survey instruments. During the first six months there were transitions from both low to medium, and medium to high implementation. However, the reasons for the transitions were different. Low to medium transition was around improvements in orientation and dialogue, while for medium to high the transition was around understanding argument. Interestingly, there was one person who transitioned from profile one to profile three. Importantly for the researchers there were only 3 researchers who move down from their previous profiles – one from profile 3 to 2, and 2 from profile 2 to 1.

There was a second round of transitions during the next six-month period. However, the emphasis on what promoted the teacher shift was based on appeared to be centered much more on orientation, rather than epistemic tools. Again, there were only two teachers who moved down from their previous profiles - in this case from profile 2 to profile 1. An interesting outcome was that once teachers transitioned to a new profile, they appeared to remain at that level or potentially move to the highest profile. This is important because it would appear that the professional development program is successful in helping teachers develop and maintain an orientation towards adaptiveness.

*Figure 1.*




## 4. Discussion

The success of implementation of new curricula is dependent upon the ability of teachers to develop an adaptive expertise that will promote generative learning environments. Such environments enable students to be active participants in their own learning as they generate understanding of the science concepts being studied. Such environments require the utilization of epistemic tools that underpin learning – argument, dialogue and language. Through a professional development program based on modeling these generative environments, the researchers interested in building understanding of the transition teachers make in developing an epistemic orientation centered on generative learning.

There are a number of interesting outcomes arising from this study. The first is that teacher learning is not a linear process – it is complex and should be treated as a complex. Rather than treating each of the particular elements in a decontextualized manner, the researchers were interested in treating the four elements of orientation, language, argument and dialogue as intersecting with each other. That is, the researchers believe that there is a complex interaction between these elements and that the nature of the different types of interaction promote different transitions.

Second, the transitions between levels or profiles were different – different in terms of combination of elements and different in terms of timing. During the first six months the transitions were around orientation and dialogue (profile 1-2) and orientation and argument (profile 2-3). During the second period the transitions were more centered on orientation. These differences highlight the concept of complexity – there are different pathways for teachers to become adaptive.

Third, a critical question which has not been addressed in the literature is what percentage of teachers will make the transitions when involved in professional development. Promoting a generative professional development model and encouraging teachers to generate their own understandings of generative learning environments and the pedagogy required, requires paradigm shifts in teacher understanding. In looking at the number of people who shifted profiles, nearly 50% of the teachers shifted. We believe that this is significant but underexplored.

Fourth, an important outcome for the researchers was that there was very little transition occurring from profile 3 to 2, or 2 to 1. That is, once teachers make the transition they remain in the higher profile. Teachers can continue to move to a higher profile or they remain within the profile. We believe this is important and needs further exploration – the stability of profiles.

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