

## **Exploring Interactions Between Internal and External Factors that Shape Middle School Science Teachers Curriculum Enactments Presentation at ASTE 2023**

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### **Issue/Challenge**

Remillard (2005) defines curriculum materials as “the resources and guides used by teachers” (p. 213). Curriculum materials serve as a cornerstone of teaching; teachers use them daily for making decisions about what content to teach and how to teach it (Ball & Cohen, 1996). Original conceptions of teacher curriculum use focused on the level of fidelity of implementation - implementing curriculum materials without change, deviation, or adaptation – for teacher adherence (O’Donnell, 2008). But fidelity to curriculum materials is not a beneficial measure as curriculum materials are mediators for teacher activity. Teachers actively use their materials within a “continuous process of transformation and creativity” (Wertsch & Ruppert, 1993, p. 230). They bring to life the ideas, as they interpret them, within curriculum materials (Brown, 2009). Yet *how* a teacher interprets the curriculum materials are subject to internal factors, such as their ideas about how students learn, and external factors, such as established cultural norms and routines within their educational settings (Troyer, 2019). The mechanisms that underlie the use of curriculum materials as mediators within science education is “limited” (Davis et al., 2016, p. 146), particularly in how internal and external factors interact to shape an individual teachers’ curriculum use and enactment (Coburn, 2004; Troyer, 2019). This is important to understand as exploring these interactions gives insight to curriculum developers and professional developers in what kinds of internal and external factors teachers navigate in curriculum implementation. This is where this study is situated. Here, we explore how internal and external factors interacted and affected five middle school (MS) science teachers use and enactment of a new place-based energy literacy unit called Energy and Your Environment (EYE). Our questions: (1) *What internal factors impacted implementation of EYE?* (2) *What external factors impacted implementation of EYE?* (3) *How did these factors interact to shape EYE implementation?*

### **Theoretical Framework**

We take a sociocultural approach to studying the teacher-curriculum relationship (Wertsch, 1998). A teacher’s work with curriculum materials is through mediated action in which their curriculum materials serve as mediators that support, as well as constrain, their teaching actions (Wertsch & Ruppert, 1993). Identifying the role of curriculum materials as affordances and/or constraints occurs as a result of both internal and external factors. Internal factors include a teachers’ personal orientation towards the materials: their “perspectives and dispositions about...teaching, learning, and curriculum that together influence how a teacher engages and interacts with a particular set of curriculum materials” (Remillard & Bryans, 2004, p. 364). For example, a teacher who holds a positive stance towards the role of curriculum materials in their teaching may choose to implement the materials. However, a teacher that views curriculum materials as constraining may choose to draw on the materials intermittently or not to implement.

External factors that impact curriculum implementation include district/state assessments, the school setting, available resources, and/or district policies (Burkhauser & Lesaux, 2015). Even if a teacher’s internal factors are in alignment with the materials, external factors can significantly

constrain curriculum implementation and vice versa. Therefore, different teachers implementing the same curriculum materials will produce a wide range of enactments and student learning outcomes across classrooms (Debarger et al., 2017). Coburn (2004) suggests five ways that internal and external factors interact to form curriculum implementation. They are rejection (materials not enacted), symbolic (materials enacted superficially), parallel structures (materials are enacted in parallel with existing practices), assimilation (adopts the materials but transforms materials to fit internal and external factors), and accommodation (adopts the materials with minor changes).

### **Our Current Work**

This exploratory qualitative study took place in a single school district in small midwestern city (pop. ~122,000) with 5 experienced science teachers from four of the six middle schools in the district. The teachers participated in a study to develop and implement a 6-unit place-based energy literacy unit. The unit centered energy transfer and transformation through the school building, such as observing and measuring light through windows and modeling the transfer and transformation of energy from the sun through the window into the classroom. The lesson sequence is: (1) *What is Energy?* (2) *How do Humans Harness Energy?* (3) *What are Energy Harnessing Impacts on Earth Systems?* (4) *Light Energy* (5) *Thermal Energy* (6) *Designing and Building an Energy Efficient Building*.

**Data Collection:** The teachers volunteered for the project through an announcement during a school district teacher work day. Teacher and school demographics are presented in Table 1. Baseline data collection began during the COVID-19 pandemic where each teacher taught their district designed business-as-usual unit virtually (2020 – 2021). Next, teachers and researchers met for a 5-day summer workshop to co-design the place-based nature of EYE. All five teachers agreed to implement the unit in school year 2021-2022, which was in person. EYE was the first unit implemented for the school year. Within the district, two to three science teachers are assigned at each grade level and are considered teaching teams with regular co-planning time. Opportunities to teach EYE were provided to all partner teachers. A data collection summary is presented in Table 2 Data includes teacher interviews, observations, artifacts and student data. Teacher focus groups, individual interviews, and teacher weekly surveys and enactment notes about unit implementation were primary data sources. Secondary data sources were student artifacts and classroom observations. In addition, at the start of the 2021-2022 school year, the new superintendent implemented electronic assessments written by each district curriculum coordinator (science, math, etc.) to be given every 6 weeks. The teachers were not provided access to the assessments prior to their implementation. The first science assessment was given six weeks into the 2021-2022 school year and focused on potential and kinetic energy.

**Data Analysis:** This was a single case study analysis of the school district (Yin, 2009) with each teacher presenting as an embedded case. Two teachers, Melissa and Hannah, who were teaching partners at the same school and co-planned, were so closely aligned that we treated them as a single case. The remaining teachers were individual cases. Analysis occurred in Excel using classical content analysis (Patton, 2002) for pattern matching (Yin, 2009). First, we read through all data for each teacher in chronological order to look for internal factors (perceptions, perspectives, and disposition for and about curriculum materials) and external forces (standard alignment, district/state assessments, school setting, administrative and/or teaching team support). Once we established patterns for each teacher, we examined the teachers comparatively and explored how patterns for implementation matched Coburn's (2003) five types of curriculum implementation (rejection, symbolic, parallel structures, assimilation, and accommodation).

## Findings

Across the five teachers we saw a wide range of curriculum implementation. We briefly discuss the cases below, but go into greater depth in our presentation and final paper. Table 3 is a summary of dominant internal factors and external factors and type of implementation.

**Melissa & Hannah.** *Dominant Internal Factors: Importance of Making Place-Based Connections.* Melissa and Hannah had worked as teaching partners for several years. Both teachers articulated that they prioritized opportunities to make place-based connections within their science teaching. The place-based nature of the EYE unit was an important factor in their choice to participate in the project. They both discussed that a place-based unit, in which students could clearly see the connections between the science content and their everyday lives, was the dominant factor why they chose to implement the EYE unit. They also stated that teaching energy using their school building provided them an opportunity to think about energy in a different way than they had previously. As Hannah stated “A lot of our students would not think about these things [energy flow in the building]. It [the unit] has definitely prompted a lot of discussion about our building.” (Hannah, Fall21). In addition, they discussed how EYE was an opportunity to learn more about science content within architecture, which they had also not considered.

*Dominant External Factors: Support within their School.* Melissa and Hannah both discussed the support from each other, their school, and the district administration. As Melissa stated: “We always are supported. I feel like that's never an issue. My teaching partner [Hannah] did this project also. So that helped that we both were doing it, we plan it together and decide, okay, what are we going to talk about the next day? And then our principal has gotten nothing but support for us in doing this. So, I mean, he followed up with me today asking how it went... And then our science coordinator is the one who presented us with this opportunity...” (Melissa, Fall21). Overall, both teachers felt supported in implementing a new science unit and teaching the unit in its entirety even though the unit went longer than the district scope and sequence. They were supposed to switch to force and motion at the six-week mark, but both commented that they were still teaching EYE because the ideas within the unit were important.

*Internal and External Factors Interaction to Shape Curriculum Implementation.* Melissa and Hannah implemented all six EYE lessons. We found that their implementation followed: accommodation for lesson 1, assimilation for lesson 2 – 3, and accommodation for lessons 4 – 6. They each shifted to assimilation for lessons 2 – 3 to add additional materials to teach potential and kinetic energy to meet the requirements of the new district assessment. However, after lesson 2 – 3, they made few modifications to the lessons.

**Donna.** *Dominant Internal factors: Presenting content as practical knowledge.* Donna discussed that content taught as practical knowledge where the useability of the ideas was immediately evident to her students was crucial. This was an important factor to her about the EYE unit. As she stated: “...with this energy thing, this could be conversations families can have. And they can identify with it [mimicked a parent’s voice] “Oh! It's about time these schools are teaching kids something they need to know!” I mean that's the conversation I can hear!” (Donna, Fall21). She articulated that EYE had a clear practicality with immediate relevance to her students and families: “They [parents] understand you gotta keep our heat up at 85 degrees in the winter, or...if we can find where we're losing the heat or whatever, and if we can block that off and that could keep our house warmer...I just feel like any it doesn't matter where you are on the income level that's going to hit home” (Donna, Fall21). Throughout Donna’s data, her emphasis on the relevance and practicality was a significant aspect to her in choosing to implement EYE.

*Dominant External Factors: School Support for Unit & District Implemented Assessment*

Two external factors were dominant for Donna. First, Donna's teaching partner did not implement EYE. Donna identified this as challenging: "I thought it would be more of the partnership...and it's not been" (Donna, Fall21). She expected that working with a partner teacher would support creativity and planning, yet she did not find this relationship with her current teaching partner. Second, the district implemented standardized science assessments were a concern to Donna. She felt that insufficient information was provided about the assessments and she did not know how the assessment data would be used. Even though all of our teachers were in the same district, Donna was the only teacher that contacted us about the assessment and discussed her concerns about the assessment and how the data would be used. She decided to only focus on potential and kinetic energy for six weeks so her students would be prepared for the first assessment.

*Internal and External Factors Interaction to Shape Curriculum Implementation.* Donna only implemented the unit for approximately two weeks in which she taught Lesson 1 - 2 as those lessons included potential and kinetic energy. For those lessons, her enactment was *accommodation* with few curriculum modifications. However, after the first two weeks, Donna switched to *rejection* and did not teach the remainder of the unit. While the unit matched her internal factors, the external factors of her lack of teaching partner support and implementation of district assessments created too much tension for her to negotiate, which resulted in unit rejection.

**Rachel.** *Dominant Internal factors: Importance of Storyline.* Rachel articulated that it was important to her that her science scope and sequence create a coherent storyline across the school year. Her teaching goal was to create connections across all of her content to create a coherent storyline. She was frustrated at the lack of a consistent storyline within the MS grades. During the 2021-2022 school year, Rachel moved from 6<sup>th</sup> to 7<sup>th</sup>-grade and commented: "As a first-year teacher in 7th grade it was really challenging! When I'm teaching something new, I need to see what has been done, what would a road map looks like so I can design my own path..." (Rachel, Summer22). Her frustration with trying to build a coherent storyline was a strong theme across her data. She articulated that this was her reason to participate and implement EYE as she was searching for a clear path of connections across her units. She identified that this clear storyline was critical to her students learning and she viewed EYE as providing this storyline.

*External factors: Teaching EYE in an RTI section.* Since the EYE unit did not fit with the 7<sup>th</sup>-grade scope and sequence, Rachel's principal suggested she implement EYE in her Response to Intervention (RTI) period. Rachel's teaching partner did the same so they co-planned throughout this study. RTI periods are approximately 30-minutes of class time with several district-level requirements (reading intervention, required outdoor days). This left approximately two RTI days a week for EYE (~60 minutes per week). Also, RTI cohorts switch teachers every eight weeks, so Rachel and her teaching partner wanted a clear ending within eight weeks. These external factors contributed significantly to Rachel's implementation. She combined lessons 1 – 3, taught one idea from lesson 4 and one idea from lesson 5, and spent three class periods on lesson 6. RTI is not graded so she added competitive games to EYE to support student motivation.

*Internal and External Factors Interaction to Shape Curriculum Implementation.* Rachel was able to negotiate between her internal and external factors by shifting continuously between accommodation and assimilation. Due to the nature of RTI, she transformed her materials to meet the external factors of RTI through modifying and reducing most of each lesson and adding in games. However, the portions of the unit she enacted aligned with her internal factors as she identified that she still maintained the coherent storyline, even with her the modifications.

**Sharon.** *Dominant Internal factors: Familiar content and activities.* Sharon's internal factors were her ideas for how to teach energy. Where Sharon identified areas of the unit that did not align with her internal factors for teaching energy, she removed those pieces and replaced them with her usual activities. For example, during the potential and kinetic energy portion in lesson 1 and 2, Sharon articulated that her students were not connecting to these ideas using their school building. She said she told her students "Let's start with something that you probably can connect to" (Sharon, Fall21). These connections were made, for her, through the incorporation of toys. She identified herself as a "huge toy person" (Sharon, Fall21) and discussed how it was important to her that she have her students play with toys to understand potential and kinetic energy because those were familiar items: "[My] classroom has the most toys, I swear. And so, we got Hot Wheels. Almost every kid in my class knows what a Hot Wheels is. They really can connect with that...and then they could kind of take it back and they...finally started putting the two connections together." (Sharon, Fall21). As shown within this quote, Sharon depended on her usual strategies and routines to teach energy and only minimally implemented EYE.

Within the unit, where the content and activities aligned with her internal factors for teaching energy, then she implemented those facets of EYE. For example, there is an initial activity in lesson 5 where students are introduced to thermal energy ideas through solar ovens. Sharon previously implemented a solar oven activity as a capstone project for her energy unit. For EYE, she implemented the solar oven activity, but used it as a large competitive activity to see whose solar oven could cook food. She concluded the unit with this activity.

*External factors: Students quarantined at home due to the COVID-19 pandemic.* During the 2021 – 2022 school year, the district policy for students that tested COVID positive were quarantined for 10 school days. In addition, teachers were no longer allowed to use Zoom for quarantined students. Sharon was the only teacher that discussed her frustration with the COVID-19 epidemic and district policies. The external factors of not being able to Zoom her students during class time so that students missed 10 consecutive class days constrained all aspects of her teaching. She spent time video-recording her lectures to the school platform (e.g., Schoology) and answering student questions through email. Particularly, she was concerned about students missing discussions that occurred in class, so she worked to provide those discussion opportunities in one-on-one conversations with her students either through email or phone calls.

*Internal and External Factors Interaction to Shape Curriculum Implementation.* Sharon's internal factors and external factors shaped her EYE implementation as *symbolic* that shifted to *rejection*. She removed connections to the school building within the unit and taught energy using activities and methods that were familiar to her. She shifted to *rejection* in lesson 5.

### **Presentation, Contribution, and Interest to Membership**

Each teacher has an individualized relationship with curriculum materials defined by their internal factors which is their orientation towards the materials (Remillard & Bryans, 2004). In addition, teachers must respond to pressures from within their districts, buildings, and classrooms, which also influences their relationship with their curriculum materials (Coburn, 2003). It is where internal and external factors interact that ultimately determines if and how an individual teacher will implement the materials. Within the work here, we found that when internal and external factors are congruent, such as for Melissa, Hannah, and Rachel, then the materials are implemented within the affordances and constraints of their classrooms. However, when internal and external factors are incongruent with each other, such as Donna, or the teachers' internal factors are incongruent with the materials, and external factors create additional challenges, such as

Sharon, the materials are ultimately rejected. In this session, we will share the range of internal and external factors that created differences in curriculum material implementation. We will propose implications for educational researchers, curriculum developers, and professional developers to highlight further research and needed supports for teacher internal and external factors, such as the criticality of creating and sustaining teacher teams to support curriculum implementation. Our study will be of interest to those studying the teacher-curriculum relationship within teacher professional development, and those working on curriculum design and implementation.

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**Table 1.**  
*Teacher and School Demographics*

<b>Teacher</b>	<b>School</b>	<b>Years Exp</b>	<b>Free/Reduced Lunch</b>	<b>School Demographics</b>	
Melissa	South MS	29	29%	9% Asian	9% multi-racial
Hannah	South MS	9		10% Black	66% White
				6% Hispanic	
Donna	North MS	15	59%	3% Asian	10% multi-racial
				33% Black	38% White
				16% Hispanic	
Rachel	Southwest MS	10	19%	9% Asian	8% multi-racial
				10% Black	68% White
				4% Hispanic	
Sharon	Central MS	18	34.7%	4% Asian	10% multi-racial
				21% Black	61% White
				4% Hispanic	

**Table 2.**  
*Data Collection Timeline and Focus*

<b>Timeline</b>	<b>Type of Data Collected for Teachers</b>	<b>Data Collection Focus</b>
Spring 2020	Semi-structured interviews	Internal and external factors about curriculum materials overall
Fall 2020	Semi-structured interviews Student pre/post-baseline energy knowledge	Internal and external factors with business-as-usual curriculum
Summer 2021	Semi-structured interviews	Goals for new energy curriculum
Fall 2021	Semi-structured interviews Observations of curriculum enactment Teacher weekly surveys about enactments	Internal and external factors with place-based energy literacy curriculum

	Teacher enactment notes	
	Student pre/post energy knowledge	
Summer 2022	Semi-structured interviews	Internal and external factors for implementing EYE

**Table 3.**  
*Teacher Factor Summary*

Teacher	School	Internal Factors	External Factors	Curriculum Implementation
Melissa	South MS	Teaching energy in a novel way	Class Length	Assimilation → Accommodation
Hannah	South MS	Teaching energy in a novel way	Building Support	Assimilation → Accommodation
Donna	North MS	Content presented as practical knowledge	No Building/District Support	Assimilation → Rejection
Rachel	Southwest MS	Meaningful connections within and across scope and sequence	Teaching in an RTI Section	Assimilation ↔ Accommodation
Sharon	Central MS	Familiar content and activities	District COVID Policies	Symbolic → Rejection

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