

Implementing Reform: Teachers' Beliefs about Students and the Curriculum

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Abstract. This paper presents findings on how consistent teachers' perceptions of their students, their own role in the classroom, and the reformed curriculum are with the actual implementation of the reformed curriculum in the classroom. This study shows that the five participating teachers were consistent with their perceptions and their actual behavior in the classroom. The teachers who were engaged in designing the curriculum demonstrated consistent reformed teaching views and behaviors. The degree to which the teachers viewed the curriculum as useful to them and their students was an indicator of how reformed their teaching was as measured by the Reformed Teaching Observation Protocol (RTOP) [1][2]. Finally, it was determined that faithful implementation of a curriculum can mean faithfully implementing the theoretical foundation of the curriculum materials during instruction instead of implementing every component or lesson of the reformed curriculum. The work was supported by NSF DRL-0733140.

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INTRODUCTION

In the following manuscript, we investigate a small sample of teachers who implemented a new integrated math and physics curriculum, Physics Union Mathematics (PUM) in middle school and high school. This study is part of a larger investigation of the effectiveness of the curriculum. Five teachers volunteered to take part in the study; they have varying years of teaching experience, and varying levels of experience with the curriculum materials as well as different backgrounds in science and teacher preparation.

The authors used field notes and Reformed Teaching Observation Protocol (RTOP) [1][2] scores collected during observations of PUM lessons to create a narrative for each teacher describing how she/he used the materials in class. We then compared the narratives to what the teachers said in interviews conducted at the end of the implementation. This research focused on the following questions: (1) Are teachers' perceptions of the goals of instruction, their roles, and students' roles consistent with their behaviors? (2) Do these perceptions affect how they implement a reformed curriculum?

THEORETICAL FOUNDATION

The Physics Union Mathematics (PUM) curriculum is one of many curricular reforms designed to engage students as members of a learning community and to learn science through inquiry. The PUM curriculum uniquely integrates mathematics and physics across the middle school-high school grade band, with the *Investigative Science Learning Environment (ISLE)* [3] as its underlying framework. In *ISLE* classrooms, students are actively engaged in the processes of science to construct, evaluate, and finally apply physics knowledge. They also use multiple representations including motion diagrams, force diagrams, energy bar charts, and eventually mathematics to describe and explain new phenomena. The PUM curriculum contains these same components, but teachers have the ability to implement the entire curriculum or only certain activities keeping the *ISLE* framework in mind.

The teacher plays a critical role in the success of any curriculum reform [4]. Factors that are within the control of the teacher, such as classroom culture, classroom management, background content knowledge, and specific needs of the teacher or students make it possible for the teacher to adapt his/her teaching or the curriculum in order to fit his/her needs and successfully implement reform [5][6][7]. External and situational factors, such as the classroom set-up, the assigned curriculum, and student attitudes,

make it more challenging for teachers to be successful [8][9][10].

Teachers' beliefs have also been found to factor into curriculum reform efforts [5]. A few important examples are beliefs about how students learn [11], initial impressions about the curriculum [4][6], beliefs about a teacher's role in the classroom [11], beliefs regarding the ability levels of students [7][11], beliefs about relative importance of content topics [7][11], beliefs about the locus of control in regards to problems with curriculum implementation [7], and beliefs about the nature of science [7]. Research has shown that teachers are relatively resistant to changing their beliefs [11][12].

Change in beliefs and/or instructional practices have been shown to occur in elementary and high school teachers because of one of three things: the teachers expressed dissatisfaction with their current instruction and were actively seeking new techniques or materials, the goals of the reform program aligned with the teachers' beliefs, or the teachers were involved in designing the reformed curriculum [10][12][13]. Using this research as a starting point, we examine what teachers perceive and we investigate whether teachers' perceptions of the curriculum implementation match with their actual implementation.

DESCRIPTION OF THE STUDY

The participants in this study were five teachers who implemented the new PUM curriculum in their classrooms this school year. The participants teach at public high schools or public middle schools in the northeastern US. Their experience and background in teaching and with the PUM materials varies. See the table below for individual data.

Teachers were observed several times during the implementation of the curriculum materials. We recorded extensive field notes for each observation and met briefly with the teachers after each lesson. In addition, we determined RTOP scores for each lesson observed.

The authors read through all field notes and transcripts to determine patterns in each teacher's behavior, the classroom culture (i.e. role of teacher and students) and the goals of the lessons. After identifying these key behaviors, the authors created a narrative for each teacher. **Based on the discussions after each observation, we determined** teachers' understanding of the underlying philosophy of the materials and how faithfully they implemented each lesson or module and included this in the narratives.

TABLE 1. Teacher Experience and Background

Teacher	Teaching Experience	Grade Level and Subject	Teacher Training	Experience with Curriculum
KP	2.5 yrs	9 th grade physics	Certified through alternate route program. PhD in physics.	Did not participate in development of curriculum, no experience with <i>ISLE</i>
HD	4 yrs	9 th grade physics	Certified to teach physics through physics education program at large university. Strong physics background +methods courses	Did not participate in development of curriculum, grad classes with <i>ISLE</i>
AR	5 yrs	Middle school 8 th grade science class	Certified to teach MS science through K-8 education program at liberal arts college. Physics background through methods courses	Participated in development of curriculum, grad classes with <i>ISLE</i>
CK	3 yrs	High school conceptual physics	Certified to teach physics through physics education program at large university. Average physics background +methods courses	Participated in development of curriculum, grad classes with <i>ISLE</i>
DJ	6 yrs	High school college prep physics	Certified to teach physics through high school certification program at liberal arts college. Average physics background +methods courses	Participated in development of curriculum, grad classes with <i>ISLE</i>

When teachers finished using the materials in their classrooms, 30-60 min. interviews were conducted. Summaries of the interviews describing the teacher's and students' roles in the classroom, his/her goals for the materials, etc. were compiled.

We used the RTOP instrument [1][2] as well as the five components of constructivist teaching (personal relevance, uncertainty, critical voice, shared control, and student negotiation) identified by Taylor, Fraser, and Fisher [14] as a guide for identifying patterns in the narratives and interviews. The authors agreed upon

three main categories: classroom culture, lesson goals, and curriculum implementation. For each category, we then identified specific behaviors and observations from the narratives that described a continuum from traditional to reformed teaching. Each continuum was divided into five gradations. In order to place teachers along the continuums, both narratives and RTOPs were scanned for indications of how reformed the teacher was for that specific behavior. We then used the interviews to identify patterns and behaviors and create continuums for each of the main categories.

Interview summaries were used to place each teacher along the continuums.

FINDINGS

Table 2 summarizes collected RTOP data. The RTOP scores a lesson on 25 items, with total scores ranging from 0 to 100. A score of 50 indicates a partially reformed classroom that includes some group work [2]. As the table shows, three of the teachers run truly reformed classrooms. The other two teachers run partially reformed classrooms.

According to the narratives, all five teachers had students participate in classroom discussions, but AR, CK, and DJ let the students' ideas be a central part of the discussion and encouraged interactions between students. They also strongly emphasized group work and concept building. Both KP and HD heavily mediated classroom discussions and limited group work. They also emphasized facts, equations, and definitions.

TABLE 2. Summary of RTOP data

Teacher	KP	HD	AR	CK	DJ
# of Lessons Observed	4	2	12	5	4
Average RTOP Score	63	51.5	82.3	82.2	78
Standard Deviation	17.6	3.5	7.7	6.2	11.2

Tables 3-5 summarize our findings in regard to teacher position along the Reformed-Not-Reformed continuum. The scale used to place teachers along each continuum is similar to the ones used by other researchers [8][15].

The tables show that four of the five teachers are consistent in their beliefs and implementation. Both AR and CK were consistently placed on the reformed side. This matches their significantly higher average RTOP score. DJ leaned toward the reformed side of the tables but was not as consistent as AR and CK. This is also consistent with his somewhat lower average RTOP score and larger spread in his scores. All three implemented PUM faithfully. The interview and the narrative show HD to be consistently on the right-hand side of each continuum. The average RTOP score for HD also agrees with this placement, suggesting he is only partially reformed. His students did PUM activities but the philosophy of PUM was not visible.

KP was not very consistent in his placement along the continuums. His interview shows that he is more traditional in his goals and in his classroom culture but his placement in the center of the continuums for the narrative suggests he is in transition. His placement for beliefs about and actual implementation of the curriculum also show he is in transition to being a more reformed teacher.

TABLE 3. Lesson Goals (I = Interview, N = Narrative)

Reformed						Traditional
(I) Develop deep understanding of concepts and learn to apply them.	AR CK	DJ		KP	HD	(I) Move through each lesson and "cover" the content/material.
(N) Focus on deep concept understanding, relationship to evidence and process skills.	AR CK		DJ KP		HD	(N) Focus on facts, equations, definitions and "right answers" in class and homework.
(N) Let students be like scientists constructing and applying knowledge.	AR CK DJ		KP		HD	(N) The teacher expresses a need to cover each lesson or move through each activity.

TABLE 4. Classroom Culture

(I) Teacher's role is to support students' investigations in both small and large groups.	AR CK DJ			HD	KP	(I) Teacher's role is to lead students through lessons in mostly large group settings.
(I) Students are actively engaged in discussing their ideas and often work on their own.	AR CK	DJ		KP	HD	(I) Discussions are run by the teacher and the students depend on the teacher's help.
(I) Teacher is aware that students need space in order to struggle and learn on their own.	AR CK DJ				HD KP	(I) Teacher believes students need his guidance or does not think students need space to learn.
(N) The teacher supports and enhances student investigations, and student exploration precedes formal presentation.	AR CK	DJ		KP	HD	(N) The teacher leads students through investigations and formal presentation precedes student exploration.
(N) The teacher shares control of class with students; students have the freedom to interact with others; good behavior is expected.	AR CK	DJ		KP HD		(N) The teacher controls the class by deciding what students do, when and how they do it; teacher holds a tight reign on all interactions.
(N) Students are seen as "help" resources; and the teacher and peers value other students' thoughts and ideas.	AR CK	DJ KP			HD	(N) Only the teacher is seen as a "help" resource and teacher is viewed as the source of "correct" ideas.
(N) Students are respectful toward other students and the teacher.	AR CK DJ	KP			HD	(N) Students are disrespectful toward other students and/or the teacher.

TABLE 5. Curriculum Implementation and Beliefs

Reformed					Traditional
(I) The teacher mentions the strengths of the curriculum and how these help the students.	AR CK		DJ KP	HD	(I) The teacher describes flaws in the curriculum materials and does not mention any strengths.
(I) The teacher sees the theoretical framework as a way to teach non-PUM units.	AR CK DJ	KP		HD	(I) The teacher says the way they teach using PUM is different from how they normally teach.
(I) The teacher sees the curriculum materials as a way to challenge all learners. (DJ and CK – N/A)	AR		KP	HD	(I) The teacher feels the materials don't challenge the students or don't match all ability levels.
(N) Theoretical foundation is at the heart of each lesson.	AR CK	DJ	KP	HD	(N) A traditional teaching philosophy governs instruction.
(N) The curriculum materials are implemented completely.	CK	DJ		AR HD	KP (N) Only pieces of the curriculum are implemented at the teachers' discretion.

DISCUSSION

Based on our findings we can answer both research questions positively. Four of the five teachers in the study demonstrate consistency between their views and behaviors. The other teacher expresses more traditional views of lesson goals and classroom culture, but his behavior in these categories and his views of the curriculum show that he is in transition to becoming more reformed. This is evident in his placement in the continuum tables.

We found that teachers who had high RTOP scores tended to have higher opinions of the reformed curriculum than those with lower scores. The lowest scoring teachers mostly focused on the flaws and limitations of the curriculum. Additionally, those who participated in the design of the curriculum had more favorable opinions of it and implemented it more faithfully. They also received higher RTOP scores and shared the underlying philosophy. We cannot determine whether engagement in the design led to these shared beliefs or vice-versa.

Finally, it appears that the teachers with strong physics backgrounds did not implement the reform as faithfully as the teachers with minimal or average physics backgrounds. It is possible that the teachers with strong backgrounds felt comfortable enough with the content that they did not see the usefulness of the curriculum details for their students.

From our findings, we determined it is possible to redefine what is meant by “faithful” implementation of curricular materials. Although faithful implementation typically means implementing every component of the curriculum [15], we suggest that teachers can faithfully implement a reformed curriculum if they follow the theoretical foundation. In this way, teachers can remove or modify certain lessons or components while still enacting the major components of the reformed curriculum. Teachers like CK and DJ implemented most components of the modules as well as the theoretical foundation. However, AR implemented only some pieces of the curriculum. Most lessons he taught (including non-PUM lessons) followed the ISLE framework. Test results show AR's students performed significantly better than all other middle school and 9th grade students taught using PUM. Thus, in the case of the PUM curriculum, implementing the theoretical foundation can also be considered faithful implementation.

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