J. Korean Soc. Math. Educ., Ser. D, Res. Math. Educ. http://doi.org/10.7468/jksmed.2019.22.3.223
Vol. 22, No. 3, 223-243, September, 2019

The Voice of Mathematics Teacher Guides from Their Use of Pronouns, Modality, and Imperatives

Heejoo Suh (Visiting Professor)
Department of Mathematics Education, Sungkyunkwan University, suhhj@skku.edu

(Received August 29, 2019; Revised September 27, 2019; Accepted September 30, 2019)

Researchers have been attending to the potential of curriculum materials as resources for professional development. In order for a curriculum material to fulfil such purpose, curriculum authors should intentionally attend to educativeness of the material. A feature of educative material is that its voice speaks to teachers. In this study, I explore educativeness of Algebra teacher guides by attending to their voice. In particular, I focused on the use of pronouns, modality, and imperatives. Findings indicate that some teacher guides have more educative voice than the others and that the amount each guide talk to teachers were less than sufficient. Implications for future research and practice are discussed.

Keywords: educative curriculum material; teacher guides; discourse analysis; professional development
ZDM classification: U30
2000 Mathematics Subject Classification: 97U30

I. INTRODUCTION

Teachers' beliefs on their professional selves are known to influence how they teach (Zohar, Degani, & Vaaknin, 2001; Zohar & Dori, 2003). This implies that understanding what forms teachers' beliefs is central for designing productive teacher learning experiences. Self is a dynamic construct consisted with internal and external factors (Harré, 2012; Hermans, 2013). External factors are not to be neglected because people rely on "[their] personal background knowledge, and their attitudes toward each other, sociocultural assumptions concerning role and status relationships, as well as social values associated with various message components" (Gumperz, 1977, p. 191). What this is telling is that teachers' beliefs are less an individual phenomena, but more a reflection of the perspectives that are shared in a professional community (Parks, 2010; Parks & Wager, 2015; Taylor, 1996).

Researchers have been conceptualizing teacher professional self as a dymanic interaction between internal self-reflection and external world (Cooper & Olson, 1996; Hand & Gresalfi, 2015; Parks, 2010; Parks & Wager, 2015). Externally, expectations by the professional community, and images society broadly shares on teaching (Beijaard, Meijer, & Verloop, 2004; Reyes & Rios, 2003) may impact teachers' construction of professional self. An example to consider is when a teacher with innovative ideas confront pushbacks when her fellow teachers in general share perspectives that do not align with those innovative ideas. Another example is when the school system does not acknowledge how valuable those innovative ideas are, hence leave the teacher with no support (Davis, 2002; Deemer, 2004).

Teacher guides (hereafter, TGs) is an external factor that might impact teachers' development. Researchers found that the external factor close to teachers' daily teaching impact the development of their professional selves, regardless of the explicitness or implicitness of the messages (Cooper & Olson, 1996; Rennert-Ariev, 2008; Reynolds, 1996; Sugrue, 1997). More specifically, mathematics education research reports the on-reader impact of messages embedded in written texts (e.g., Dowling, 1996; Herbel-Eisenmann, 2007). Considering this line of research, curriculum materials have great potential to positively impact teachers' practice. Researchers suggest that an effective teacher development activity i) is connected to teachers' classroom practices, ii) goes through several iterations over time, iii) provides ongoing supports, and iv) allows teachers to do experiments and reflect on what they learned (Collopy, 2003; Remillard, 2000). Curriculum materials satisfy these conditions by being the kind of resource easily available for teachers and expected to be used through the whole semester. As such, I examined the potential of algebra teacher guides as a window for teacher professional development.

This study contributes to the discussion of identifying the degree of educativeness from already-developed curriculum materials. I paid particular attention to the educative potentiality that Algebra TGs have. These prior studies led me to consider three research questions as below:

RQ1: How Algebra TGs are using pronouns?

RQ2: How Algebra TGs are using modality?

RQ3: How Algebra TGs are using imperatives?

Although curriculum materials in fact use various means of communication in addition to linguistic features (e.g. Alshwalkh, 2016), such features are certainly one of the communication means. I focus on TG's use of language to examine a portion of the whole teacher-TG interaction, hoping that this investigation contributes to a deeper understanding of at least a slice of the whole picture.

II. LITERATURE REVIEW

1. TEACHERS GUIDE

Several researchers have given serious attention to maximizing the educative potential of curriculum materials as a resource for teacher development (Ahl, Koljonen, & Helenius, 2017; Beyer & Davis, 2009; McDuffie & Mather, 2006; Peercy, Martin-Beltrán, Silverman, & Daniel, 2015; Shkedi, 1998). Using the term *educative curriculum materials*, Davis and Krajcik (2005) suggested that well-designed curriculum materials can "help to increase teachers' knowledge in specific instances of instructional decision making" while helping them "develop more general knowledge that they can apply flexibly in new situations" (p. 3). Ball and Cohen (1996) also explored the potential of curriculum materials and how these materials can contribute more to teacher learning. More recently, Drake, Land, and Tyminski (2014) pointed out that "educative curriculum materials can and should be utilized in teacher preparation to support [prospective teachers] in developing not only knowledge and practices related to curriculum materials and their use, but also the broader knowledge bases needed for successful novice teaching" (p. 155). In other words, curriculum materials have potential to strongly impact teachers' development as professionals, partially depending on both what they convey (Koljonen, Ryve, & Hemmi, 2018) and how.

Research on educativeness suggested a list of design principles for curriculum material writers (Davis, Palincsar, Smith, Arias, & Kademian, 2017). Guidelines for identifying the degree of a curriculum material's educativeness, however, are not yet fully explored. Remillard's work shed light on this matter. According to Remillard (2000, 2005), educative materials *speak to* teachers, rather than *speak through*. Curriculum materials that speak through offer "steps to follow, problems to give actual questions to ask, and answers to expect" (Remillard, 2000, p. 347). Therefore, teachers are expected to mindlessly follow what is told by the guide. When a curriculum material speaks to teachers, it foregrounds "the rationales, assumptions, or agendas supporting them" (p. 347). This encourages teachers to engage with the guide's decisions, suggestions, and underlying ideas.

In order to understand whether a curriculum material is speaking to or speaking through teachers, examining its *voice* is helpful (Ahl, Koljonen, & Helenius, 2017; Herbel-Eisenmann, 2007; Remillard, 1999; Remillard, 2005). Voice, as suggested by Remillard (2005), is a term for the ways how curriculum materials communicate with teachers and/or students. Any text can have multiple voices that might even be contradictory (Herbel-Eisenmann, 2007). In her work on the voice of mathematics textbooks, Herbel-Eisenmann drew on Morgan's (1996) articulation of systemic

functional linguistics and attended to imperatives, personal pronouns, and modality to examine the interpersonal function of the books. According to Herbel-Eisenmann's use of Rotman (1988), imperatives can be either inclusive or exclusive. Inclusive imperatives, such as "consider" or "define," position readers as thinkers, whereas exclusive imperatives, such as "use" or "copy," position readers as those who perform actions. Pronouns are important because they portray the guides' (or guide-authors') personal involvement (Herbel-Eisenmann, 2007). Modality is another linguistic form that matters when examining voice of a text. Modality is to be found in the modal auxiliary verbs, adverbs, adjectives, and hedges (Herbel-Eisenmann, 2007). Modality reflects the degree of certainty of the voice. Drawing on this line of research, the current study attends to educative potential of TG, a curriculum material. In particular, the study focus on the voice, which could enhance a TG's potential as a space for teachers' learning and continuous professional development.

2. ALGEBRA

In this study, I narrowed my focus to TGs for middle-school algebra. I compared four teacher guides from different groups of authors. To control possible noise from mathematical content being different, I chose algebra as a subdomain. Algebra is known to have significant impacts on students' futures. Algebra has been conceptualized as a gateway to later academic achievement (Bush & Karp, 2013; Gamoran & Hannigan, 2000; Liang, Heckman, & Abedi, 2012; Smith, 1996; Stein, Kaufman, & Sherman, 2011; National Mathematics Advisory Panel, 2008). From both educators and policymakers' perspectives, algebra significantly impacts students' advancement in future mathematics and science courses and, in turn, influences their academic success (Liang et al., 2012). According to the Mathematics Advisory Panel (2008), algebra drew extra attention from those interested in educational policy because students' mathematics achievements drop drastically when they begin algebra coursework. The Panel further pointed out that "completion of Algebra II correlates significantly with success in college and earnings from employment" (p. xiii). The chance for college graduation was more than twice higher for students who took Algebra II than for those who took fewer mathematics courses. Access to algebra is better when it is given at earlier grades, because early access positively impacts students' high-school mathematics performance (Smith, 1996). Spielhagen (2006) mentioned that students who began algebra in Grade 8 enrolled in more high-school mathematics courses than did those who began it in Grade 9. Further, the author found that students who began algebra in Grade 8 were more capable of taking advanced courses in high school.

Despite such importance of algebra on students' future, I could find only a small number of research studies focused on teachers teaching algebra (Stein, Kaufman, & Sherman, 2011). Among the few, some researchers focused on developing frameworks and measures that could advance the field with understanding on the knowledge matters when teaching algebra (Buschang, Chung, Delacruz, & Baker, 2012; Izsák, Çağlayan, & Olive, 2009; McCrory, Floden, Ferrini-Mundy, Reckase, & Senk, 2012). Others attended to specific subdomains of algebra in relation to teaching (Even, 1993; Haimes, 1996; Nathan & Koedinger, 2000; Sánchez & Llinares, 2003; Stein & Baxter, 1990; Stump, 2001; M. R. Wilson, 1994). One observation from these efforts is that teachers' perception or knowledge of algebra and algebraic practice affect students' learning (Even, 1993; Nathan & Koedinger, 2000). With the potential of curriculum materials as a resource for teacher learning, the research so far reviewed suggests that teachers' sense of professional self, as represented in algebra TG, is a topic worthy of careful investigation. Echoing Doerr's (2004) point that "there is a significant shortage of research about how teachers learn to teach algebra, how they understand their own practice, and how they form and are formed by their own practice within their own specific cultural contexts" (p. 282), I paid specific attention to TGs as an external source of impact on teacher professionalism, rather than a container of a collection of algebraic contents with more impact on students than teachers (Geary, Boykin, Embretson et al., 2008). In so doing, I hope to suggest what authors can add or revise to better support algebra teaching by contributing to the understanding of teachers' sense of professional self.

III. RESEARCH METHODS

For the analysis of the voice, I chose a portion from each of the four U.S. algebra TGs: CMP (Lappen, Phillips, Fey, & Friel, 2014), Eureka (Great Minds, 2017), UCSMP (Brown et al., 2008), and Pearson (Charles et al., 2015). In choosing TGs, I not only considered market share but also included curriculum materials with a range of design principles and structures, while keeping the number of materials manageable. CMP and UCSMP are both research-based curriculum materials that are at least partially funded by NSF. Both curriculums are included to avoid a single case representing the whole research-based curriculums. Eureka and Pearson are the two curriculums with platforms that support wide dissemination. Pearson is one of the major textbook publishers in the US. The selected TG (Charles et al., 2015) promotes that it aligns with the Common Core State Standards, which could presumably contribute to the sales of the curriculum. Eureka is accessible via their website. On the website, Great Minds provide an editable version of their curriculum materials for no cost. Because of this, Eureka has a great potential to be

widely disseminated. To be clear, although I wanted to include a range of types of texts, I did not intend these four TGs to be a representative sample of any kind, but more of a purposeful sampling. This study's purpose is to explore what is being communicated to prospective and practicing mathematics teachers because those positionings may contribute to teachers' professional selves. By exploring this set of TGs, I hope to provide an in-depth description of a smaller part of the whole picture. All the TGs were the most recent version I was able to find when the study was conducted.

I analyzed texts from the first chapter of each TG. By exploring this set of TGs, I hope to provide an in-depth description of a smaller part of the whole picture. To digitalize the data, I scanned the selected portions of the TGs. Then, I copied each sentence and pasted into a cell from a spreadsheet. The table below shows the number of sentences and incidences identified from the TGs.

Table 1. Number of sentences and incidences identified from the TGs.

	UCSMP	Pearson	CMP	Eureka
Sentences with Pronoun	70(68)	17	45	13
Modality	68	17	45	13
Imperative Sentences	135	219	38	110
Imperative Incidences	137	223	38	114

Regarding the first research question, the pronoun, I recorded who the pronoun is referring to. All pronouns were referring to teachers, except for two from UCSMP that used *we* to refer to the authors.

When it comes to the second research question, modality, I analyzed the sentences with pronouns explicitly or implicitly referring to teachers. For each sentence, I marked the modal verbs. Then, I classified the verbs following Halliday and Matthiessen's (2004) suggestion (Table 2).

Table 2. Excerpts from Halliday and Matthiessen's (2014, p. 116) table for finite verbal operators.

	Low	Median	High
Positive	can, may, could, might, (dare)	will, would, should, is/was to	must, ought to, need, has/had to
Negative	needn't, doesn't/didn't + need to, have to	won't, wouldn't, shouldn't (isn't/wasn't to)	mustn't, oughtn't to, can't, couldn't, (mayn't, mightn't, hasn't/hadn't to)

In addition to modal verbs in Halliday and Matthiessen's work. I paid attention to bald assertions, i.e., sentences with no modality (Herbel-Eisenmann, Kristmanson, & Wagner, 2011), or *root modality* (Rowland, 2005). Having no modality, bald assertions give no room for negotiation but rather present a sentence as a fact that does not reflect the speaker's stance (Herbel-Eisenmann et al., 2011; Rowland, 2005).

For the third research question, the imperatives, I marked the verbs from each sentence. When a sentence had two or more imperatives, I noted all. I used the term Incidences to give proper number count for these situations. As such, a sentence with two imperatives are counted as two incidences. Then, I drew on Rotman's work (1988) to distinguish *exclusive* imperatives and *inclusive* imperatives. Exclusive imperatives strongly impose duties on the readers. Inclusive imperatives acknowledge the judgment the readers have. Therefore, understanding which types of imperatives are dominant in which TG is important.

In order to make possible cross TG comparison, I used the total number of incidences directed at teachers (IDT) and total pages (Table 3). By total incidences directed at teachers, I mean the sum of sentences with pronoun directed at teachers and imperative incidences.

Table 3. General information about the data.

	UCSMP	Pearson	CMP	Eureka
Total Sentences Directed at Teachers	203	236	83	123
Total Incidences Directed at Teachers (IDT)	205	240	83	127
Total Pages	49	82	20	48

IV. RESULTS AND DISCUSIONS

1. PRONOUN: GENERAL FINDINGS

In Table 4, I organized general findings regarding the use of the three pronouns.

Table 4. The use of pronouns.

	UCSMP	Pearson	CMP	Eureka
Total Referring to Teachers (Explicit)	26	15	28	3
Total Referring to Teachers (Explicit or Implied)	68	17	45	13
Total Sentences with a Pronoun	70	17	45	13
Pronouns referring to teachers per IDT	0.33	0.07	0.54	0.10
Pronouns referring to teachers per page	1.39	0.21	2.25	0.27

With the exception of two sentences from UCSMP, all sentences with a pronoun referred to teachers. Some sentences made explicit that the pronoun is directed at teachers. Two examples include "You might write or project the following so that students can answer these questions as they enter the classroom" (UCSMP) and "If you need to, show them or have a student demonstrate the answer to this question" (Eureka). Sentences Implied are those with pronouns open enough to refer to teachers and, at the same time, to

others (e.g. students, curriculum authors). This often happened when the TG described mathematical facts or processes. Consider the following example. "Point out that as you round off to more and more decimal places for your estimate, the estimate becomes more accurate." (Pearson). In this study, I counted this as a sentence with a pronoun implying teachers. The pronoun *you* in the previously example could include students – seeing the students as those who were rounding the numbers and teachers were expected to almost read to the students the sentence excluding "Point out that." Yet, there is a possibility to include teachers in the pronoun – imagine a teacher rounding off numbers showing students the estimate is becoming more accurate. Two sentences from UCSMP were using the pronoun *we* to refer exclusively to the authors. These are the two sentences: "In this book, we have chosen to think of terms as added" (UCSMP, p. 16) and "We have purposely separated them in Lessons 1-1 and 1-2 so that students will see the associative properties as switching order of operations, while the commutative properties involve switching the order of addends (in addition) or factors (in multiplication)" (UCSMP, p. 17). Here, the pronoun "we" refers to the authors, with a clear purpose of sharing their design principle with teacher readers. Therefore, these are the incidences where the TG is speaking to teachers.

In the rate of sentences with pronouns per total incidences directing at teachers, CMP was the highest, followed by UCSMP, Eureka, and Pearson. This order remained the same when the ratio was examined via pages examined. This might suggest that CMP is the curriculum speaking *to* teacher readers, while Pearson is speaking through them.

1) Pronoun You

Table 5 is a summary of my findings regarding the TGs use of the pronoun *you*.

Table 5. The use of the pronoun *you.*

		UCSMP	Pearson	CMP	Eureka
You	Teachers (Explicit)	26	15	19	3
	Teachers (Implied)	13	2	4	0
	Not Referring to Teachers	0	0	0	0
	Total Referring to Teachers	39	17	23	3
	Total Referring to Teachers per Total Sentences with a Pronoun	0.56	1.00	0.51	0.23

All sentences with the pronoun *you* were referring to teachers. With such direct addressivity, more sentences were explicit than implying, which means the pronoun was open enough to refer to others in addition to teachers. In UCSMP and CMP, slightly more than half the sentences with a pronoun used *you*. Pearson had no sentence with a pronoun other than *you*. About a fifth of Eureka sentences with a pronoun used *you*. The table immediately above indicates that, across the four TGs, the pronoun *you* was used to

communicate with teachers. This data indicates that all four TGs are acknowledging the teacher-reader presence, although with varied degree. The TGs more often explicitly referred to teachers. In addition, even when the sentences were not explicitly referring to teachers, they implied teacher presence. No use of the pronoun *you* excluded teacher presence. Drawing on my improvisation of speaking to versus speaking through (as explained in Chapter 3), this acknowledgment of teacher-reader presence indicated that the TGs are speaking to them. This result, however, does not guarantee that all TGs present teacher-reader with high visibility. Their use of other pronouns, modalities, and imperatives, which are discussed below, support this point. Considering that the TGs are written for teachers to read, all the sentences with the *you* pronoun referring to teachers is more of a natural phenomenon than anything else.

2) Pronoun We

The TG with the highest use of the pronoun *we* is UCSMP, albeit that Eureka has the highest percentage of *we* pronoun sentences (see Table 6). CMP used *we* in less than a fifth of its sentences with pronouns directed at teachers; no sentence using *we* is directed explicitly at teachers; instead, the pronoun is used in describing mathematical activity in the context the authors assume is to be shared among teachers, students, and the textbook. Another use of *we* is when describing general mathematical facts. The exception was UCSMP, which twice used *we* to make the authors visible (e.g. "We have purposely separated them in Lessons 1-1 and 1-2 so that students will see the associative properties as switching the order of operations" (UCSMP, p. 17).). Making authors visible is indeed a way to have the TG speak to teachers by acknowledging their presence. I observed such use of *we* from UCSMP only. Other TGs' use of *we* was to acknowledge the teacher-reader presence by referring to them.

Table 6. The use of the pronoun *We*.

		UCSMP	Pearson	CMP	Eureka
We	Teachers (Explicit)	0	0	0	0
	Teachers (Implied)	29	0	7	10
	Not Referring to Teachers	2	0	0	0
	Total Referring to Teachers	29	0	7	10
	Total Referring to Teachers per Total Sentences with a Pronoun	0.39	0.00	0.16	0.77

3) Pronoun I

In addition to the pronoun *we*, I also examined how TGs are using the pronoun *I*. Table 7 is a summary of my findings.

Table 7. The use of the pronoun *I*.

		UCSMP	Pearson	CMP	Eureka
I	Teachers (Explicit)	0	0	9	0
	Teachers (Implied)	0	0	6	0
	Not Referring to Teachers	0	0	0	0
	Total Referring to Teachers	0	0	15	0
	Total Referring to Teachers per Total Sentences with a Pronoun	0.00	0.00	0.33	0.00

Only in CMP is the *I* pronoun used. The explicit *I* pronoun is in questions on which teachers should or may reflect, such as "How will I use this to plan for tomorrow?" (CMP, p. 46). In terms of implied *I* pronoun sentences, CMP placed those sentences immediately after providing suggested questions to ask students. Typically in CMP, what comes after suggested questions are intended answers or pedagogical information for teachers. The intended answers are where CMP used *I*. For example, in the sentence "I could do more chores around the house to increase my allowance" (CMP, p. 42), the TG used the pronoun *I*, which seems to refer to students for the most part. In other lessons, the TG gave pedagogical information without using a pronoun. In the sentence "Students should notice that the rate of change for the quadratic function is different from that for linear or exponential," (CMP, p. 52) the TG is making clear that the sentence is more for teachers than students. This brings complexity. The TG placed at least two different types of sentences (i.e., intended answers and pedagogical information) at the same location (i.e. after the suggested questions) across different lessons. Taking this into consideration, I interpreted the *I* pronoun as open enough to imply teachers in addition to students.

With or without counting the implied cases, CMP is the only TG to place itself as the teacher-reader. This proactive level of communication appears in one TG, and a third of the total sentences with a pronoun. That is, the examination with *I* pronoun shows that CMP is most actively speaking to teachers while other TGs are not.

So far, I examined three pronouns in the TGs. From examining *you*, I found all four TGs were foregrounding teacher-reader presence with the pronoun. Regarding the pronoun *we*, Eureka used it most frequently to refer to teachers. Particularly interesting was UCSMP's use of the pronoun *we*. UCSMP is the only TG that used the pronoun to refer to themselves as authors to explicitly discuss their design principles**.** With the pronoun *I*, CMP is the only TG which used it. All in all, these findings suggest that each TG has its own way to highlight teacher-reader presence, hence speak to teachers in various ways. Because most of the sentences with pronouns were acknowledging teacher presence, what becomes salient is how often the TGs used these three pronouns. For example, Pearson used the pronoun *you* to refer always to teachers. Focusing on this particular finding, it suggests that the TG is speaking to teachers. What if, however, only

a few sentences in the TG had pronouns? Were this the case, it would be difficult to consider the TG as actually speaking to teachers. Therefore, the ratio of sentences with a pronoun to total sentences is worth examining. I presented results from such examination later in this study.

2. MODALITY

To understand the use of modality, I examined sentences with pronouns that are referring to teachers. In other words, among the total sentences examined in this study, I excluded the sentences without pronouns. Table 8 shows the number of sentences per each modality used in the sentences either explicitly or implicitly referring to teachers. [do] indicates sentences with no modality but a verb asking teachers to perform certain action. T indicates explicitly directed at teachers and (t) indicates implicitly directed at teachers. All modal verbs I found were positive, except for one case from Eureka that used *should not*. I count this as *should*, following Halliday and Matthiessen's (2004) classification (see Table 2 in the research methods section).

Table 8. Modality with explicit and implying combined.

	UCSMP	Pearson	CMP	Eureka
can	6	0	9	0
could	4	0	4	1
may	2	1	8	0
might	16	0	0	1
will	0	0	9	1
would	0	0	0	0
should	3	0	0	1
need	4	0	0	0
[do]	33	16	15	9
total	68	17	45	13

In my analysis, I combined the modality with low and median values as *suggestive* (can, could, may, might, will, would, should), and high value and bald assertions as *assertive* (need, [do]). By so doing, I sought to compare the degree of obligation TGs are imposing on teachers. Table 9 presents the number counts of the sentences with suggestive voice *versus* those with assertive voice. Some modalities from Halliday and Matthiessen's (2004) work are not assigned to either group because none of the four TGs used them. Some of the imperatives I had under *suggestive* may seem stronger than suggestive. My rationale for such grouping is that I wanted to be conservative with my coding in order to highlight when the TGs strongly impose duties on teachers. Table 9 shows that despite the decision to conservatively code the TGs, three of the four TGs

were using a more assertive voice than suggestive.

Table 9. Modality by suggestive and assertive.

	UCSMP	Pearson	CMP	Eureka
Suggestive (can, could, may, might, will, would, should)	31	1	30	4
Assertive (need, [do])	37	16	15	9
Suggestive per Total Modality Sentences	0.46	0.06	0.67	0.31
Assertive per Total Modality Sentences	0.54	0.94	0.33	0.69
Suggestive per IDT	0.15	0.00	0.36	0.03
Assertive per IDT	0.18	0.07	0.18	0.07
Suggestive per page	0.63	0.01	1.5	0.08
Assertive per page	0.76	0.20	0.75	0.19

In UCSMP, suggestive and assertive voices are used with similar frequency. Pearson and Eureka used assertive voice more often than suggestive voice. CMP is the only TG using voice more suggestive than assertive. Suggestive voice in CMP appears about twice as often as the assertive voice in it. This result suggests that CMP is the TG most highly appreciative of teachers' ability to make a professional judgment, followed by UCSMP, Eureka, and Pearson.

The ratio with IDT and page shows how frequently the two voices are used in the whole data set. In addition, the ratios make possible the comparison across TGs. Ratio per total incidences shows that overall modality is used rarely in Pearson and Eureka. Ratio per pages examined reinforces that CMP uses suggestive voice much more often than do other TGs, and that Pearson and Eureka rarely use modalities. That is, CMP is not only the TG that used more suggestive voice than assertive voice but also the TG that used suggestive voice with the highest ratio – 36% – among the four TGs. The limited use of modality, combined with more frequent use of assertive than of suggestive, indicates that such TG might be forcefully imposing teaching duties on teachers, rather than communicating with teachers. The duty seems highly obligatory in such TG.

3. IMPERATIVES

To find sentences with imperatives, I reviewed all sentences in the four TGs. In sum, I found in UCSMP 135, in Pearson 219, in CMP 38, and in Eureka 110. Some sentences had two or more imperatives, so my count is based on the imperatives used. For example, the sentence "Collect these papers, mix them up, and pass one out to each student" (Pearson, p. 28A), is counted as one imperative sentence and three imperative incidences. In Table 10, I organized the number counts and ratios of imperatives.

Table 10. Imperatives: General results.

	UCSMP	Pearson	CMP	Eureka
Total Sentences w/ Imperatives	135	219	38	110
Total Incidences w/ Imperatives	137	223	38	114
Incidences w/ Imperatives per IDT	0.67	0.93	0.46	0.88
Incidences w/ Imperatives per page	2.80	2.72	1.90	2.38

Table 10 shows that Pearson and Eureka are quite heavy with imperative sentences. Although the per-page ratio of incidences with imperatives is higher in UCSMP than in Pearson, imperative sentences in UCSMP are lower than those of Pearson and Eureka when compared to the total incidences directed at teachers. CMP's ratio is the lowest in both per incidences directed at teachers and per-page. With all imperatives directing teachers in what to do and do not acknowledge teachers' professional judgment (which I unpack in the latter part of this subsection) the high number count and the high ratio indicates a low degree of room for professional judgment. Pearson is the most obligatory among the four TGs, both in terms of its number counts and the ratio. The number count shows that UCSMP used more imperatives than Eureka. When the ratios are considered, Eureka is in fact using more imperatives than UCSMP. Slightly below half of all incidences in CMP were using imperatives. Therefore, if my assumption is reasonable – that all imperatives limit teachers' professional judgment – Table 10 suggests that CMP is the most speaking to TG and Pearson is the most speaking through one.

Table 10 by itself does not present enough information about the degree of teachers' professional judgment acknowledged by the TGs. This is so because the number counts or the ratio is not a direct reflection of the degree of an obligation imposed on teachers. To understand the type of imperatives each TG is using, I analyzed the kinds of imperatives. Ninety-seven imperative verbs appeared in at least one of the four TGs. UCSMP used 32 imperative verbs. Pearson used 45, CMP used 38, and Eureka used 48. Not all imperative verbs appeared with similar frequency. Table 11 presents the range, mean, median and mode of the imperatives.

Table 11. Range, mean, median, mode of the frequency of imperative incidences.

	UCSMP	Pearson	CMP	Eureka
Range	39	53	5	21
Mean	4.28	4.85	1.9	2.38
Median	2	1	1	1
Mode	1	1	1	1

As Table 11 above shows, the common feature across the four TGs is that they used most of the imperatives once or twice. In UCSMP, the two most-used imperatives were *have* (39 x) and *ask* (35 x). Excluding those two, the frequency range becomes 9, which indicates a relatively low frequency of the 37 imperatives. In Pearson, *use* (53 x) and

have (46 x) were the two most dominant imperatives; without those two, the frequency range becomes 19. Sentences in CMP used *ask* (5 x) and *tell* (5 x); again, not counting those two imperatives, the frequency range is 3. Eureka used *have* (21 x) and *ask* (17 x) the most; not counting those two, the frequency range is 5. Overall the four TGs, the three most-used imperatives are *have* (107 x), *ask* (67 x) and *use* (60 x); excluding those three, the range is 19. Imperatives such as *have*, *ask*, *use*, and *tell* all direct teachers to perform such action, hence exclusive. This result shows that all TGs used more exclusive imperatives than inclusive ones. Therefore, the numbers and ratios I present in Table 11 is a reflection of the degree of obligation each TG is imposing on teachers.

4. OVERARCHING FINDINGS FROM THE USES OF PRONOUN, MODALITY, AND IMPERATIVES

In the subsections on pronouns, I argued that all pronoun use can be interpreted as cases of speaking to, based on my improvisation of Remillard's (2000) original definition. I showed that the use of assertive modality and imperatives are the cases of speaking through. In Table 12, I presented results combining the findings from pronoun, modality, and imperative. Based on the combined results, I discussed the degree of an obligation imposed on teachers from each TG.

Table 12. Aggregated results.

		UCSMP	Pearson	CMP	Eureka
Total Sentences with a Pronoun Referring to Teachers		68	17	45	13
Modality	Suggestive	31	1	30	4
	Assertive	37	16	15	9
Imperatives		137	223	38	114
Pronouns Referring to Teachers per IDT		0.33	0.07	0.54	0.10
Suggestive per IDT		0.15	0.00	0.36	0.08
Assertive & Imperatives per IDT		0.85	1.00	0.64	0.97
Suggestive per page		0.63	0.01	1.5	0.08
Assertive & Imperatives per page		3.55	2.91	2.65	2.56
IDT per page		4.18	2.93	4.15	2.65

Considering the ratio of assertive voice and imperatives combined to the incidences directed at teachers shows that Pearson always uses language with high obligation of duties (1.00). Eureka is second-highest at 0.97. CMP is lowest at 0.64. That order matches the IDT ratio for pronoun use. Based on numbers in the table, UCSMP and CMP actively communicate with teachers (IDT per page), being more open than directive than the other two. Accordingly, the degree of obligation to follow the TGs suggestions is higher in Pearson and Eureka than in UCSMP and CMP. From this aggregated result, I suggest that

CMP and UCSMP are closer to the speaking to end of the spectrum while Pearson and Eureka are closer to the speaking through the end, due to the different level of teacher professional judgment each TG is allowing. Yet, the per-page ratios show that teachers are likely to read sentences limiting their use of professional judgment more often than the sentences acknowledging it.

V. CONCLUSIONS

Educativeness of curriculum materials is a topic worthy of significant attention because it supports teachers' continued professional development. Voice of a TG is one way to explore this topic. To examine the voices of the four selected Algebra TG, I examined their use of pronouns, modality, and imperatives in the sentences directed at teachers. When analyzing the sentences, I drew on the notion of speaking *to* and speaking *through* (2011). Curriculum materials speak through teachers when they guide teachers' actions, offer steps to follow, and give pre-designed questions to ask students. Materials speak to teachers when they give rationales, assumptions, or agendas supporting them. What I see to be central from this work is acknowledgement of teachers' professional judgment by making explicit the presence of teacher-readers. I attended to this particular aspect of speaking through *versus* speaking to dichotomy, instead of following the original analytical details as suggested by Remillard (1999; 2000; 2005). In doing so, I sought to understand the space available for teachers to enact their professional judgment.

Analysis suggests that, in general, the voices of UCSMP and CMP acknowledged teacher presence and their professional judgment more than did the voices of Pearson and Eureka. In other words, UCSMP and CMP spoke more *to* teachers than did Pearson and Eureka. In pronoun use, all but two were referring to teachers across the four TGs, either explicitly or implied. The two pronouns not referring to teachers were from UCSMP, referring to authors. Although these two incidences did not include teachers, by making explicit the UCSMP author's intentions, in fact, were speaking to teachers. For the purpose of cross-TG comparison, I calculated two ratios: i) pronouns referring to teachers divided by total incidences directed at teachers (IDT), and ii) by total pages. Both ratios showed the same result that CMP is the TG that most-proactively used pronouns (0.54 and 2.25, respectively), followed by UCSMP (0.33 and 1.39), Eureka (0.10 and 0.27), and Pearson (0.07 and 0.21), Eureka and Pearson being close to each other. Although Morgan (1998) argued that the use of first-person pronouns of *I* and *we* could broaden the distance between the authors and the readers, my analysis showed that the first-person pronouns contributed to the acknowledgement of teachers' professional judgment. In particular, the pronoun *we* in a mathematical textbook places the author as an authority of mathematics or assumes agreement from the readers (Herbel-Eisenmann, 2007; Rowland, 1999), but

this was not the case with the TGs.

To understand TGs' use of modality, I reexamined the sentences with pronouns. To understand the degree of obligation each TG was imposing on teachers, I classified the modalities and bald assertions as either suggestive or assertive. The result from the analysis supported that UCSMP and CMP spoke to teachers by using less assertive voice than that of the other two TGs. Regarding the ratio with IDT, CMP used twice-more suggestive modalities than assertive (0.36 and 0.18, respectively). UCSMP used more assertive voices than suggestive (0.18 and 0.15, respectively). The gap between suggestive modalities per IDT and assertive voice per IDT was smaller in Pearson (0.00 and 0.07, respectively) and Eureka (0.03 and 0.07, respectively) than in UCSMP and CMP, but this was because of the generally-low count in sentences with pronouns in Pearson and Eureka. CMP is the only TG with higher use of suggestive modalities than of assertive voice. Regarding ratio per page, CMP is still the only TG with higher use of suggestive modalities than assertive voice (1.5 and 0.75, respectively). In UCSMP more assertive voice was observed than suggestive modalities (0.76 and 0.63, respectively) and Eureka (0.19 and 0.08, respectively). Pearson's use of assertive voice is *twentyfold more* than suggestive modalities (0.20 and 0.01, respectively). The high frequency of assertive voice to suggestive modalities is not to be overlooked. This is so because I conservatively defined assertive voice by grouping median modalities together with low modalities (Halliday & Matthiessen, 2014). Despite the conservative grouping, the result shows that three of the four TGs used assertive voice more often than suggestive modalities. Assertive voice could potentially restrict teacher-readers' enacting their professional judgment by suggesting that the content of the TG was true and not up for negotiation (see Herbel-Eisenmann, Kristmanson, & Wagner, 2011).

For analysis of the use of imperatives, I focused on the sentences without pronouns. From the use of imperatives, I confirmed that CMP most proactively acknowledged teachers' professional judgment. Results for UCSMP, Pearson and Eureka, on the other hand, were mixed. Frequent use of imperatives itself might not be sufficiently-strong evidence to show whether the TG is speaking to or speaking through teachers. This was so because although those sentences did not use pronouns, some imperatives, such as *consider*, are inclusive. The pattern I observed in all four TGs, however, showed that exclusive imperatives such as *have*, *ask*, and *use* were more dominant than inclusive imperatives. Accordingly, more use of imperatives suggested a higher degree of speaking through teachers. Compared to IDT, CMP was the lowest in its use of imperatives (0.46), followed by UCSMP (0.67), Eureka (0.88), and Pearson (0.93). In its use per page, CMP was the lowest (1.90), then Eureka (2.38), Pearson (2.72), and UCSMP (2.80). If the use of exclusive imperatives places authority on the authors only (Martin & Rose, 2007; Rotman, 1988), this frequent use of imperatives in the TGs implied low authority placed

on the teacher-readers, hence limited opportunity for teachers to practice their professional judgment.

Comparing the use of suggestive modality *versus* the use of assertive voice and imperatives combined, CMP had the highest rate of incidences with suggestive voice (0.36 for suggestive and 0.64 for assertive or imperatives), followed by UCSMP (0.15 and 0.85, respectively), Eureka (0.03 and 0.97, respectively), and Pearson (0.00 and 1.00, respectively). This combined result with the other results discussed until now (i.e., examination of voice with TGs' use of pronoun, modality, and imperative) support that, in general, the voice of UCSMP and CMP were more open than the other TGs. In other words, these TGs acknowledge teacher professional judgment more pervasively than do the other two. Such use of language indicates that when compared to Pearson and Eureka, UCSMP and CMP were closer to the speaking to side of the spectrum than to the speaking through side. Attending to the high IDT per page ratio of CMP and UCSMP, an interesting topic for future study might be examining the relationship between talkativeness of a TG and the tendency of speaking to/through.

Results of this study align with the findings and discussions from Herbel-Eisenmann (2007) in that although the curriculum authors appreciate teachers' professional judgment, conveying such belief in the curriculum material is a different task that requires more than having strong beliefs. Therefore, education researchers should build on Davis and colleagues' work (2017) to suggest subject-matter specific guidelines for curriculum writers. In particular, linguistic and other features to utilize productive voice might be a place worth of examination. When developing curriculum materials, the writers can purposefully select pronoun, modality, and imperatives so that the voice of the material becomes inclusive to teacher readers.

REFERENCES

Ahl, L., Koljonen, T., & Helenius, O. (2017). The voice of curriculum developers in teacher guides. *For the Learning of Mathematics*, *37*(2), 35–39.

Alshwaikh, J. (2016). Investigating the geometry curriculum in Palestinian textbooks: towards multimodal analysis of Arabic mathematics discourse. *Research in Mathematics Education*, *18*(2), 165–181.

Ball, L., & Cohen, K. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, *25*(9), 6–14.

Beijaard, D., Meijer, P. C., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and Teacher Education*, *20*(2), 107–128.

Beyer, C. J., & Davis, E. A. (2009). Using educative curriculum materials to support preservice elementary teachers' curricular planning: A comparison between two different forms of support.

Curriculum Inquiry, *39*(5), 679–703.

Brown, S., Breunlin, R., Wiltjer, M., Degner, K., Eddins, S., Edwards, M., … Usiskin, Z. (2008). *The University of Chicago School Mathematics Project: Algebra. Teacher's Edition*. Chicago: McGraw-Hill.

Buschang, R. E., Chung, G. K. W. K., Delacruz, G. C., & Baker, E. L. (2012). Validating measures of algebra teacher subject matter knowledge and pedagogical content knowledge. *Educational Assessment*, *17*(1), 1–21.

Bush, S. B., & Karp, K. S. (2013). Prerequisite algebra skills and associated misconceptions of middle grade students: A review. *Journal of Mathematical Behavior*, *32*(3), 613–632.

Charles, R., Hall, B., Kennedy, D., Bellman, A., Bragg, S., Handlin, W., …Wiggins, G. (2015). *Algebra 1 Common Core. Teacher's Edition.* New Jersey: Pearson.

Collopy, R. (2003). Curriculum materials as a professional development tool: How a mathematics textbook affected two teachers' learning. *Elementary School Journal*, *103*(3), 287–311.

Cooper, K., & Olson, M. R. (1996). The multiple 'I's' of teacher identity. In M. Kompf, W. R. Bond, D. Dworet, & R. T. Boak (Eds.), *Changing research and practice: Teachers professionalism, identities and knowledge* (pp. 78–89). Washington, DC: Falmer Press.

Davis, K. S. (2002). "Change is hard": What science teachers are telling us about reform and teacher learning of innovative practices. *Science Education*, *87*(1), 3–30.

Davis, A., & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. *Educational Researcher*, *34*(3), 3–14.

Davis, E. A., Palincsar, A. S., Smith, P. S., Arias, A. M., & Kademian, S. M. (2017). Educative curriculum materials: Uptake, impact, and implications for research and design. *Educational Researcher*, *46*(6), 293–304.

Deemer, S. (2004). Classroom goal orientation in high school classrooms: Revealing links between teacher beliefs and classroom environments. *Educational Research*, *46*(1), 73–90.

Dowling, P. (1996). A sociological analysis of school mathematics texts. *Educational Studies in Mathematics*, *31*(4), 389–415.

Doerr, H. M. (2004). Teachers' knowledge and the teaching of algebra. In *The Future of the Teaching and Learning of Algebra The 12th ICMI Study* (pp. 265-290). Springer, Dordrecht.

Drake, C., Land, J., & Tyminski, M. (2014). Using educative curriculum materials to support the development of prospective teachers' knowledge. *Educational Researcher*, *43*(3), 154–162.

Even, R. (1993). Subject-matter knowledge and pedagogical content knowledge: Prospective secondary teachers and the function concept. *Journal for Research in Mathematics Education*, *24*(2), 94–116.

Gamoran, A., & Hannigan, E. C. (2000). Algebra for everyone? Benefits of college-preparatory mathematics for students with diverse abilities in early secondary school. *Educational Evaluation and Policy Analysis*, *22*(3), 241–254.

Geary, D. C., Boykin, A. W., Embretson, S., Reyna, V., Siegler, R., Berch, D. B., & Graban, J.

(2008). The Final Report of the National Mathematics Advisory Panel. *Washington, DC: US Department of Education.*

Great Minds (2017). *Eureka Math. Eureka Basic Curriculum Files. Algebra I*. Retrieved from https://greatminds.org/download_pages/eurekabasicfiles?opened_product_id=92

Gumperz, J. J. (1977). Sociocultural knowledge in conversational inference. In M. Saville-Troike (Ed.), *Linguistics and anthropology* (pp. 191–211). Washington DC: Georgetown University Press.

Haimes, D. H. (1996). The implementation of a "function" approach to introductory algebra: A case study of teacher cognitions, teacher actions, and the internded curriculum. *Journal for Research in Mathematics Education, 27*(5), 582–602.

Halliday, M., & Matthiessen, C. (2004). An introduction to functional grammar (3rd ed.). New York, NY: Hodder Arnold.

Hand, V., & Gresalfi, M. S. (2015). The joint accomplishment of identity. *Educational Psychologist*, *50*(3), 190–203.

Harré, R. (2012). Positioning theory: Moral dimensions of social-cultural psychology. In J. Valsiner (Ed.), *The Oxford handbook of culture and psychology* (pp. 191–206). NY: Oxford University Press.

Herbel-Eisenmann, A. (2007). From intended curriculum to written curriculum: Examining the "voice" of a mathematics textbook. *Journal for Research in Mathematics Education*, *38*(4), 344–369.

Herbel-Eisenmann, A., Kristmanson, P., & Wagner, D. (2011). Modality in French immersion mathematics. In M. Setati, T. Nkambule, & L. Goosen (Eds.), *Proceedings of the ICMI Study Mathematics and language diversity* (pp. 144–152). Sào Paulo, Brazil.

Hermans, H. J. M. (2013). The dialogical self in education: Introduction. *Journal of Constructivist Psychology*, *26*(2), 81–89.

Izsák, A., Çağlayan, G., & Olive, J. (2009). Meta-representation in an Algebra I classroom. *Journal of the Learning Sciences, 18*(4), 549–587.

Koljonen, T., Ryve, A., & Hemmi, K. (2018). Analysing the nature of potentially constructed mathematics classrooms in Finnish teacher guides – the case of Finland. *Research in Mathematics Education, 20*(3), 295–311.

Lappen, G., Phillips, E., Fey, J., & Friel, S. (2014). *Connected mathematics 3 teacher's guide*. Boston: Pearson Prentice Hall.

Liang, J. H., Heckman, P. E., & Abedi, J. (2012). What do the California standards test results reveal about the movement toward eighth-grade algebra for all? *Educational Evaluation and Policy Analysis*, *34*(3), 328–343.

McCrory, R., Floden, R., Ferrini-Mundy, J., Reckase, M., & Senk, S. (2012). Knowledge of algebra for teaching: A framework of knowledge and practices. *Journal for Research in Mathematics Education*, *43*(5), 584–615.

National Mathematics Advisory Panel (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education.

Nathan, M. J., & Koedinger, K. R. (2000). Teachers' and researchers' beliefs about the development of algebraic reasoning. *Journal for Research in Mathematics Education*, *31*(2), 168–190.

Parks, A. N. (2010). Metaphors of hierarchy in mathematics education discourse: The narrow path. *Journal of Curriculum Studies*, *42*(1), 79–97.

Parks, A. N., & Wager, A. (2015). What knowledge is shaping teacher preparation in early childhood mathematics? *Journal of Early Childhood Teacher Education*, *36*(2), 124–141.

Peercy, M. M., Martin-Beltran, M., Silverman, R. D., & Daniel, S. (2015). Curricular design and implementation as a site of teacher expertise and learning. *Teachers and Teaching*, *21*(7), 867–892.

Reyes, X. A., & Rios, D. I. (2003). Imaging teachers: In fact and in the mass media. *Journal of Latinos and Education*, *2*(1), 3–11.

Roth McDuffie, A. M., & Mather, M. (2006). Reification of instructional materials as part of the process of developing problem-based practices in mathematics education. *Teachers and Teaching*, *12*(4), 435–459.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry*, *29*(3), 315–342.

Remillard, T. (2000). Can curriculum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *Elementary School Journal*, *100*(4), 331–350.

Remillard, T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research*, *75*(2), 211–246.

Rennert-Ariev, P. (2008). The hidden curriculum of performance-based teacher education. *Teachers College Record*, *110*(1), 105–138.

Reyes, X. A., & Rios, D. I. (2003). Imaging teachers: In fact and in the mass media. *Journal of Latinos and Education*, *2*(1), 3–11.

Reynolds, C. (1996). Cultural scripts for teachers: Identities and their relation to workplace landscapes. In M. Kompf, W. R. Bond, D. Dworet, & R. T. Boak (Eds.), *Changing research and practice: Teachers professionalism, identities and knowledge* (pp. 69–77). Washington, DC: The Falmer Press.

Rotman, B. (1988). Towards a semiotics of mathematics. *Semiotica*, *72*(1/2), 1–35.

Rowland, T. (2005). The pragmatics of mathematics education. Taylor & Francies e-Library.

Sánchez, V., & Llinares, S. (2003). Four student teachers' pedagogical reasoning on functions. *Journal of Mathematics Teacher Education*, *6*(1), 5–25.

Shkedi, A. (1998). Can the curriculum guide both emancipate and educate teachers? *Curriculum Inquiry*, *28*(2), 209–229.

Smith, J. B. (1996). Does an extra year make any difference? The impact of early access to algebra

on long-term gains in mathematics attainment. *Educational Evaluation and Policy Analysis*, *18*(2), 141–153.

Spielhagen, F. R. (2006). Closing the achievement gap in math: The long-term effects of eighth-grade algebra. *Journal of Advanced Academics*, *18*(1), 34–59.

Stein, M. K., & Baxter, J. A. (1990). Subject-matter knowledge and elementary instruction: A case from functions and graphing. *American Educational Research Journal*, *27*(4), 639–663.

Stein, M. K., Kaufman, J. H., & Sherman, M. (2011). Algebra a challenge at the crossroads of policy and practice. *Review of Educational Research*, *81*(4), 453–492.

Stump, S. L. (2001). Developing preservice teachers' pedagogical content knowledge of slope. *Journal of Mathematical Behavior*, *20*(2), 207–227.

Sugrue, C. (1997). Student teachers' lay theories and teaching identities: Their implications for professional development. *European Journal of Teacher Education*, *20*(3), 213–225.

Taylor, P. C. (1996). Mythmaking and mythbreaking in the mathematics classroom. *Educational Studies in Mathematics*, *31*(1-2), 151–173.

Wilson, M. R. (1994). One preservice secondary teacher's understanding of function: The impact of a course integrating mathematical content and pedagogy. *Journal for Research in Mathematics Education*, *25*(4), 346–370.

Zohar, A., & Dori, Y. J. (2003). Higher order thinking skills and low-achieving students: Are they mutually exclusive? *Journal of the Learning Sciences*, *12*(2), 145–181.

Zohar, A., Degani, A., & Vaaknin, E. (2001). Teachers' beliefs about low-achieving students and higher order thinking. *Teaching and Teacher Education*, *17*(4), 469–485.