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**Learning a Part Together:**
**Ensemble Learning in a Competitive High School Marching Band**
Rogers Hall (Vanderbilt University)
Jasmine Y. Ma (New York University)

This article reports a descriptive analysis of ensemble learning in a high school marching band performance season. We follow how “The Show” was designed by instructors, translated into coordinate “dots” for band members, then learned and “cleaned” by the ensemble. We describe structural provisions for ensemble learning, compare these with similar cases in the literature, and ask how our findings might inform design when restoring or building new ensemble learning environments.

Keywords: Ensemble learning, musical performance, marching band, elective learning, mathematics of space and motion

[Post-Season Interview with Seniors]. *Watching a video recording of a complex (visual and musical) feature of “The Show” early in the previous season, a group of senior high school marching band members groaned and laughed. The accelerating music and rotating square of brass instruments on the field was a particularly dramatic moment in their performance, a “chunk” that was carefully designed for viewers and relentlessly practiced as the marching band season progressed.*

*What has gone wrong, we asked?*
Band members asked us to replay the video and began to unpack what they called a “tear” in the performance, a breakdown of coordination in which different sections of the band got ahead of or behind each other in the musical score. What was immediately painful for students to hear and see took us several replays, with their patient help, even to notice. After following these students and their “show band” over a five-month competitive season, we were still discovering what it meant to be a competent participant in this kind of ensemble performance.

So what can be done to repair a “tear,” we asked?

Students each gave a different answer, depending on their relation to the whole. Ultimately, they told us, you either get lucky or hope you start together on the next chunk. And if the ensemble was still tearing at competitions late in the season—long after football season, when half time shows were used to practice the performance—“then you shouldn’t be there.”

**Ensemble Learning in Activity**

This paper is about ensemble learning—learning things that you cannot do alone. In these settings individuals learn to play a part, but much of their learning and almost all of the desired performance happen together. Hence our title is learning a part together. The concept of ensemble learning in activity has several distinctive qualities. These in combination bound the phenomena we study. While many activities in everyday life are done with others (e.g., driving into the city), only some activities are understood by participants as things they are doing together (e.g., attending a basketball game). For a smaller collection of activities, the thing done requires multiple participants, who recognize their activity as a group achievement or performance (e.g., playing in a basketball pickup game). For a still smaller collection of activities, participants also must perform with other members of a group in order to learn to participate fully in that group (e.g., being a member of a basketball team). We propose the combination of
these three qualities—members understand the activity is done together, performance requires a group, and learning must happen in group performance—describes a family of situations in which people learn in ensemble activity.

We do not usually think of school learning in this way, though it is clear that people learn together in schools. Ensemble learning may be quite prevalent in school, but hidden by our received view of learning as the outcome of formal instruction, or of teaching as the delivery of an intended curriculum. Indeed, much of contemporary schooling is organized around systems of assessment that pull apart what people have actually learned together to focus on individual performance and the efficiency of instruction. We call the result modular learning, a residual category constructed by stripping away important processes of learning and capacities for distributed knowing and action (Bransford & Schwartz, 1999; Greeno & Gresalfi, 2008; Jordan & Putz, 2004). Our purpose in this paper is to analyze ensemble learning as an alternative to more familiar modular learning, based on close analysis of learning and artistic performance in a high school marching band. We provide a grounded, theoretical account of ensemble learning in this case to help think about restoring valued and powerful aspects of learning a part together in formal, schooled instruction.

Two related meanings of ensemble are useful for this project. The first comes from studies of development, where an ensemble has been understood as a unit of analysis—a heuristic device for researchers to identify and compare learning events at a particular temporal and social scale. Using an analogy to musical ensembles, (Granott, 1998:42) defined an ensemble as “the smallest group of individuals who directly interact with one another during developmental processes related to a specific activity context.” Building on this idea, (Stone & Gutierrez, 2007:45) saw these units as “micro-contexts of development that [were] embedded
within and in a bi-directional relationship with the larger cultural context […] Ensembles offer an ecological site to study the development of problem interpretations and how these interpretations mediate learning through particular assistance and assessment strategies.” We agree that ensemble learning involves emergent and negotiated understandings—interpretations assembled by participants concerning the meaning and future of their activity together. Ensemble learning is a member’s phenomenon (Stevens, 2010), something that is formulated by participants as learning and about something done together.

A related meaning of ensemble concerns which entities and relations are necessary for achieving a developmental outcome. In our view of ensemble learning, performance and learning both depend upon how people assemble entities and relations together. Replacing or removing entities, or reworking structural relations among them, might still lead to valued learning and performance, but of something else. This is one way to understand how systems of assessment operate (intentionally or not) to reorganize activity and result in quite different kinds of meaning, learning, and performance. From a historical perspective, this may also explain how varieties of what we call modular learning have come to dominate our received view of school learning, at the expense of meanings, processes, and structural provisions that may prove quite powerful if studied as ensemble learning in activity.

In the following sections, we describe our methods, findings from the study of a high school marching band, and how these compare with other studies of learning in settings where both performance and learning require participation in ensemble activity. But first, to help frame what follows, we give a brief overview of the kinds of meanings, processes, and structural provisions we have found are important for ensemble learning in activity. These include:
• The division of labor during ensemble performance strongly shapes opportunities for learning, including what new members can see or experience regarding what they will need to know in the future.

• Learning or knowing is experienced by ensemble members primarily as a form of doing with others, and less as a personal facility with representations of practice.

• Mediating devices (representations, tools) play a critical role in support of early learning, but these often fall away with time and increasing capacity for coordinated action among members of the ensemble.

• Members change their stance towards participation in activity over time, shifting from early concerns about personal adequacy towards a focus on coaching and supporting other, newer participants in activity.

• There are productive contradictions between values placed on individual accomplishment and being a reliable member of the ensemble.

• There are also contradictions between values placed on learning and high levels of performance, with consequences for access, for opportunities to develop an identity of belonging over time, and for the capacity of the ensemble to take up new activity.

Methods

We studied an extramural band program operating over 25 years in a suburban, middle to upper middle class high school in the mid-South region of the United States. We followed the Cedar¹ High School (CHS) Marching Band through one competition season from late July to mid-November, during which they intensively learned and practiced a performance that they called “The Show.” The band included 128 students, of whom 115 marched on the field, 2 served as drum majors (conductors), and others played in a stationary percussion “pit.” We
began with interviews of band alumni, then interviewed instructors in design sessions, where they wrote musical score and designed marching “drill” (formations) for competition. At a two-week summer band “camp,” we began observations of instrumental and marching practice sessions that continued weekly through the season. Once the school year started, we attended seven Friday night football games, and during two multi-day trips to regional marching competitions. After the end of the season, we conducted video-elicited interviews with instructors and a focus group of graduating seniors. Participating instructors included the Band Director (Mr. Cowen), an Associate Director (Mr. Edwards), a lead Drill Instructor (Ted), a lead color guard instructor (Eric), and two drill coaches.

The data we collected included video records of design sessions, over 10,000 digital photographs linked to audio recordings from different positions inside and outside the ensemble during practice sessions, video records of band performances provided by parents after football games or purchased from commercial vendors at competitions, and video records of interviews after the season. Recordings and photographs were indexed to field notes when captured, then logged and selectively transcribed as our analysis developed. We also gathered design and teaching representations used by instructors and students.

Field notes provided a start for grounded theoretical analysis (Strauss, 1987) of how The Show developed over the season, how new marchers struggled and were supported in learning to play and march in performance, and how more experienced marchers took on critical assessment and coaching responsibilities with their peers. As our understanding deepened, we gathered new field data strategically, pursuing deliberate comparisons to refine the scope and explanatory power of emerging analytic categories. Our work included detailed interaction analysis (Jordan & Henderson, 1995) with audio, photographic, and video records of ensemble practice sessions.
and performances. Two end of season interviews with instructors and focus group students used video episodes from performance to elicit responses. Also during final interviews, we asked instructors and students to solve a “math to marching” task, to elicit an explicit comparison of these activities from participants’ different points of view.

We studied a competitive marching band for several reasons. First, in a pilot study of pre-service mathematics teachers, alumni of high school marching bands thought about and constructed mathematical shapes at large scales very differently from their non-marching peers (e.g., drawing geometric shapes on a university campus). Second, Hall was the parent of a high school marching band member and believed that inter-generational relationships formed during elective participation could smooth the transition into high school and provide powerful heuristic resources for building an identity of belonging. Finally, we were interested in how the acting body supported mathematical understandings of space and motion (Hall & Nemirovsky, 2012), so decided to study how the design and teaching of marching band performances disciplined the body (Stevens & Hall, 1998) to create forms, with others, in ensemble activity.

We observed and helped in small ways with band practice sessions (e.g., helping carry things), but our participation with the band was initially minimal. Our persistence in showing up for practice and when the band traveled were eventually rewarded with personal greetings (from students and adults), and directors began looking out for us at competitive events (e.g., providing us with passes to follow the band onto the field in college and professional football stadiums).

[Field note from mid-season competition]. *It was Halloween, and after completing a morning rehearsal in their high school parking lot, the CHS Marching Band drove 60 miles to participate in a regional competition, which would last late into the evening. These kids were dressed in costume, but unlike many of their peers from school, they were not out to gather*
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candy and play tricks on friends. After an hour of stretching exercises, block marching drills, ritual dances within instrumental sections, a careful tuning by instructors for each instrument, and grooming of band uniforms, students in their black uniforms huddled around Ted. With arms locked and heads bowed, they formed a tight circle of bodies, listening.

Ted told them they owed their performance not to him, or to their parents, but to the generations of people who surrounded their circle, hundreds of marchers, going back in concentric circles around them to the first CHS band season in 1982. Their performance in a few moments, he told them, meant a lot to him as he thought about their still unrealized potential, both as artists and young people. He reminded them of the term, “hearts on fire,” saying this was what he hoped they would feel in a few moments during the performance. He could, Ted said, “see your hearts now.” And he knew they could give their hearts to the audience through The Show. “You can touch their hearts.”

**Ensemble Learning through Structured Participation in Activity**

Students and their families held a variety of reasons for participation. Some students joined the band because older siblings had been members. Several parents explained to us that the band drew the “best kids,” so provided a peer network that was comparatively safe and supportive for the development of young adults. Other students joined because friends were members, or because they were required to march as a condition of access to concert bands. Not all students stayed with the marching band through high school, but for those that did, the band and its competition schedule provided a core set of experiences and a durable school identity during high school. Alumni of the band regularly visited practices and football game half time shows, catching up with friends and telling instructors of their exploits. The CHS marching band was a multi-generational community, recruiting new members through a web of family and peer
friendship ties, providing a diverse set of heuristic resources for constructing an identity of belonging as a high school student, and even drawing some alumni back years after graduation.

There were structural aspects of the CHS marching band that contributed directly to processes of ensemble learning, and these tended to differ dramatically from instructional environments that ran parallel in students’ school experience. One was that the objective of learning was a multi-person performance, something done with the moving body that had a personal element of physicality (e.g., new marchers sometimes passed out from exertion on the practice field), while also demanding precise coordination with others. Forms of distributed, peer assessment were commonplace among marchers (e.g., spontaneous criticism and demonstrations of marching form during water breaks in rehearsals). Marchers also reported feeling the intensity of audience responses during football games, and especially during competitive performances. While learning and practicing The Show were supported by representational descriptions, performances were never defined or produced by them. As stated emphatically by one student, while manipulating equations or graphs was experienced as a defining aspect of college preparatory mathematics, marching performances were something done together, with audience response in real time. Students consistently told us this felt very different from “doing school.”

A second structural aspect of ensemble learning in this case was elective participation. While instructors sought to maintain almost military control over activities of marchers while on the road, each student participated voluntarily and engaged for purposes that were renegotiable in ways that compulsory schooling was not. Conflicts between instructors and students arose during the competition season, and these sometimes led students to resist directives or even to contemplate leaving the band. As the loss of marching personnel during the season could have dramatic consequences for The Show in competition, students’ voluntary engagement and
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instructors’ efforts to manage such a large group of teenagers produced recurring tensions.

A third structural aspect of ensemble learning in this case was diversity in the age of student participants and what they came to know, about The Show and about marching more generally. Unlike most classes they experienced in high school, student marchers had to work and learn together across age and grade levels. It was typical of stories told by students, parents, and band instructors that freshman marchers experienced a crisis in their first season, since they were often unable to play their instruments confidently, to memorize the musical score, or to find their moving positions on the marching field. It was partly the responsibility of older students, taking up leadership positions for particular instrumental groups (e.g., the trombone section), to teach younger students how music and marching could be coordinated. Local coordination for the individual marcher in relation to adjacent performers was absolutely necessary if The Show was to “read” for the audience and judges. Older students both elected and were asked to take on teaching roles for less experienced marchers. Thus differences in age and experience provided both a problem and a partial solution for ensemble learning as the season progressed.

Instructors were keenly aware of this web of connected teaching and learning among students, and they used it deliberately as a resource. For example, after a mid-season half-time performance before any major competitions, one of the instructors complained to us about a “run through” (a performance treated as practice). He shared that when individual students were asked to play their parts of the musical score during instrumental rehearsal, half of the brass section could not get through the score on their own. The instructor explained that they placed experienced marchers at strategic spatial/musical positions within The Show, in an effort to make stronger students’ performances (musical and marching) available as a model of what should be happening, during performance, to struggling peers. This distribution (along with other
strategies) built capacity for detecting and (harder still) being able to repair tears during performance. Positioning stronger instrumental players near less capable peers also tended to hide weaker playing from judges in competition. As the competition season progressed, instructors designed and cleaned The Show around these differences in capacity.

The Show as an Object of Design

The Show as a structure of coordinated action developed over approximately five months. Yet once completed and in performance, it lasted only nine minutes. The Show consisted of an “opener” that set the narrative frame of a young girl contemplating (pre-recorded narration) immigration to the United States from Europe, a “middle” in which the girl made a perilous crossing of the Atlantic Ocean, and a dramatic “closer” in which she and her shipmates were welcomed by the Statue of Liberty. By the final performance of The Show in early December at a national competition, students and band instructors had spent hundreds of hours designing, teaching, carefully dissecting run throughs, and cleaning this ensemble performance.

[Figure 1 here]

Figure 1 shows a performance chunk we followed closely as the season progressed. Designed to create a dramatic visual/aural “hit” during The Show’s opener, this was a rotating block of brass instruments, following a somber trumpet feature as the young girl contemplated leaving her home for the United States. The chunk consisted of a rotating, growing (in number of students), and dilating block, marched in double time as the music accelerated. We showed video of this chunk in our end of season interviews, and both instructors and seniors confirmed that this chunk was the most challenging feature of The Show in design, learning, and cycles of cleaning.

The left column of Figure 1 shows a sequence of screen images captured as the rotating block was designed by band instructors seated in a rehearsal room at the beginning of the season.
The band director used a software design tool, Pyware™ to arrange dots/marchers in visual forms, then to define marching pathways between forms as the musical score progressed. The rotating block initially expanded as it gathered marchers, then contracted while rotating and expanded again as the music quickened. Near the completion of this rotating block design, amid concerns about filling holes in the block with additional marchers/dots, the following conversation among designers/instructors took place.

**Transcript 1**

1. Cowen: Well, al- I'm not- I'm not concerned about that, it's just- that moment right there. As it fills in there? But it PRO[bably won't look-

2. Eric: [Yeah

3. Ted: But it's not gonna stop. [I mean-

4. Eric: [(inaudible)

5. Cowen: PRObably won't be a problem when we're-

6. Ted: When it's in context.

7. Cowen: And in perspective. *((switches to isometric judging view, animates block))*

8. Ted: See?


10. Cowen: That's a pretty tight mass of brass there=

11. Eric: =YEAH it is. I kinda like it=

12. Cowen: =I think we probably need to clean that up.

In the context of designing, cleaning referred to arranging dot/marcher configurations and moving pathways so the visual form, which Mr. Cowen and Eric jointly appreciated as a “tight mass of brass,” could be learned by a heterogeneously abled group of marching brass players.
Switching from plan (overhead) view to an isometric view (the viewing position of judges in the stands) allowed the instructors to anticipate evaluations of the chunk, later during competitions.

Designers balanced two distinct matters of recipient design in this activity. First they needed to be sure that marchers could actually move their bodies at the step sizes and pace used to build and transition between visual forms. Related to this, designers also carefully considered whether individual marchers would pass over yard markers in a sequence that would be learnable. In a second matter of recipient design, evident as Mr. Cowen switched perspectives (Turn 7), designers carefully considered how dynamic, flowing shapes would read for judges on the field and seated near the top of a typical performance stadium. Changing the viewing angle from plan to isometric positioned a viewer to read shapes differently (e.g., an equilateral triangle in plan view distorts into a different triangle in isometric view, a basic concept in projective geometry).

**The Show as a Learning Trajectory**

The middle column of Figure 1 shows a series of images for the rotating block, captured late during the pre-season band camp on the practice field, a CHS parking lot during the school day. The images were taken from atop a viewing tower where Mr. Cowen and Ted typically stood. Comparing the block as designed (left column), as initially performed (middle column), and as performed in the season’s final competition (right column, from the judges’ box) shows a trajectory for ensemble learning of The Show. What appeared to be a “tight mass of brass” in design was at first realized in a loosely coordinated jumble of marchers/dots, then after repeated practice and drill instruction, closely matched the intended visual design by the end of the season.

For students, The Show provided a learning trajectory that started with a musical score, which they were asked to memorize before band camp. Students were given individual “dot sheets” that listed positions they were to “hit” on the marching field while playing the music (left
in Figure 2). Reflecting a more global view of The Show, instructors and drum majors worked with “form sheets” showing the configuration of all marchers (dots, indexed by instrument type and number) in plan view for selected moments in the musical score (right in Figure 2).

[Figure 2 here]

In the pre-season band camp, marching drill and instrumental performance were initially separated. Students learned to read rows in the dot sheet as displacements on the field (e.g., the left of Figure 2 shows that at Set 8 in the opener, Euphonium #23 was to be 1.5 steps “inside,” or left, of the 40 yard line and 8.75 steps behind the front hash line). Early drill instruction also concerned how to place one’s feet, hold body posture, and step off in unison to form ensemble movements that would read as clean, moving shapes. The first time marchers found each dot on the practice field, they marked it with chalk for reference. As chunks of The Show were designed and given to students, drill and musical performance were progressively woven together. To learn each consecutive dot in a performance chunk, students marched the sequence forwards and in reverse, building toward longer sequences of dots. While rehearsing a chunk, after each repetition, students were asked to “stop” in formation, to “check” their position (look at marchers around them to see if they aligned in the right form), and then to “adjust” (look down at the field to see if they had hit their dot, and move to where they should be). This repeated process was called “cleaning” dots, and it continued well into the competitive performance season.

As the season progressed, students learned to pay less attention to their specific coordinates as dictated by dot sheets, and more to their locations in relation to the others around them (i.e., checking became more important than adjusting). In this sense, they first learned to march to dots, then to people and forms. The trajectory of attention and scale was reversed for instructors, who started the season designing whole forms and performance chunks, then shifted
into design refinements that focused on adjusting dots/individuals to fit the intended design to the developing capacities of the ensemble. For students as learners, the resulting tension between a discrete, dot-driven understanding of The Show and a more fluid, form-driven understanding was clear in a post-season interview with a group of graduating seniors.

**Transcript 2**

*{(After viewing video of a cleaning cycle; Nellie appears as Euphonium #23 in Figure 2)}*

1. Nellie: How you march with people depends on what you're doing. Like- how- When he's saying in here is like- you have to- we used- *(R hand held at face, rotates back and forth)* you switch where you look as the- [as the rotation-

2. Norbert: [Um hm

3. Nellie: Like especially with the rotations? So like if you're making- if you're- shifting to be a, uh straight line, *(hands form path pointed left, then rotate to center of body)* and then you're curving again to be a diagonal? Or like walking this way, to be a diagonal then you have to- He always talks about shifting. So you would- If you're marching when you're shif- *(hands form path forward from center)* You're look up the diag, and then suddenly you have to shift to look at the straight lines, *(held path rotates to point right)* and then you're looking up the diag again. So that's what he's talking about [in there.

4. Author2: [Ok.

5. Nellie: And that's like different ways of looking at the form. If you're-


7. Nellie: Oh [yeh *(laughing, inaudible)*] *(R arm forms path to right side of body)*

8. Kendra: [The diag is there *(R arm forms path to right side of body)*] and then-
at one point when they switch to the front, \((R \text{ hand swings to form path centered on body})\) [they have to switch their arms.

9 Mark: [They move their arm.]

10 Jenna: Well- which is supposed to simulate [where they're looking. \((L \text{ hand held at eye level, swings back and forth})\)

11 Norbert: [It's so the instructors can see where their vision is supposed to be going. \((R \text{ hand forms path centered on body})\) Cause you can't see where someone's eyes are facing? \((\text{two fingers point at eyes, then out from center of body})\) So if we use our arms, \((R \text{ arm extends out from center of body})\) it helps us to mentally- like think when we- So when we get to that dot, it's a visual thing to help us remember like what we're supposed to be doing. \((R \text{ arm extends out from center of body})\) So like I'm supposed to be looking here, versus I'm supposed to be looking over there.

12 Nellie: And that's completely different from marching a curve.

Students’ descriptions of learning to march rotations or curves (Nellie, Turns 3 and 12) illustrated clearly how instructors worked, from the tower and on the field, to shape and refine multi-person, whole body ensemble performances. Just as individual marchers learned where their dots should fall on the gridded surface of a performance field, they were expected to shift their attention towards how their moving bodies fit together with those around them in the ensemble to create visually coherent, moving shapes. During cleaning cycles, this shift was disciplined by explicit use of arms and pointing, both to remind students where their visual attention should be directed over time (e.g., looking at a “diag” then shifting to look at “straight lines,” Turn 3) and to provide instructors with information about what individual marchers
understood and were doing. The Show was progressively written into the bodies of members of the ensemble, as paper-based representations (dot sheets and musical score) fell away.

Students not only learned The Show as a particular arrangement of visual forms over the course of the marching season, but they also began to understand, model and teach marching in this way over the course of their marching careers. Beginning marchers tended to stick close to their dot sheets as spatial and musical coordinates, and this introduced new problems for more experienced marchers and instructors during cycles of cleaning the performance. The same seniors described the problem vividly in the post-season interview.

Transcript 3

1 Nellie: We should be able to march the dot and march the form (R hand taps two fingers of L hand), and that should be the same thing. (hands beat together on "same thing")

2 Mark: Yes.

3 Mary: (hands in vest pocket) Which causes a lot of problems because half the people march to their dots and get called, "DOT Nazi's".

4 Nellie: Yes.

5 Students: (laughter)

6 Mary: And the other half just try to follow the SHAPE. But since- people are doing two completely different things, [it causes a lot of (difficulties)- (there are) problems.

7 Nellie: [Well like in- in that situation- sorry, like if Mark was like, MARCHing to his dot (R hand cuts/beats on "dot"), TECHnically that should be where everyone else is going (R hand extends and traces path forward)). Even if they are marching to the form (R hand sweeps arc), they should still be
going to the dot ((R hand traces forward path)). So he should just be able to rely on his dot ((R index finger points at spot on table surface)) and be in the [form. ((L index holds spot, as R hand extends and traces path forward))

8 Willa: [Trust everyone else to=

9 Nellie: =But that doesn't usually happen.=

10 Betsy: =Yeh, I think there even becomes a negative connotation to like- going with the dot book. ((R hand cuts/beats on open L hand surface))

11 Norbert: YEH!

12 Betsy: Like then you're a ((gestured quotes)) DOT [Nazi.

13 Students: [Dot Nazi.

14 Norbert: Yeh, exactly.

15 Betsy: And like, not marching to PEOPLE, [and-

16 Norbert: [It was all-

17 Betsy: Just the words are very geared towards, ((hands together form a sphere)) like you SHOULD be marching with everyone else instead of like- ((R hand cuts/beats on open L hand surface)) (dot on) a piece of paper.

The shift in perspective—from marching to dots (a dominant relevancy for new members of the band) to marching to people or forms (something learned with time, and even taught to others)—was a major accomplishment of ensemble learning for students in The Show. While the term “dot Nazi” was grating for some students, it still circulated among students as a way to discipline newer members (often freshman) of the marching band. Marking this shift into a teaching role as an instrumental section leader, Kendra continued with an illustrative story.
Transcript 4

18 Kendra: Well- cause that's what happens. You end up like- I remember one time, this was like- not this year, but I was- there was a freshman. And we were supposed to be in a diag? ((L hand forms line/path)) And she:: marched her dots. ((R hand points/beats to the side of L hand)) Which (annoyed) me- one, because she's a freshman, she's like, “I'm right!” And she would- [LITERALLY the diag=

19 Betsy: [((laughing))

20 Norbert: Yeh, (follow through)

21 Kendra: =was like this way. ((R hand forms path)) She was here. ((L hand points to side of R hand)) She was like, way way out of the form. But she was like, “I'm in my dot. So it's ok.” But we're like- ((L hand traces path forward, repeatedly)) “NO:::!”

Learning an initial representation of The Show (dots through time) by less experienced, individual members of the ensemble could later impede the entire ensemble’s capacity to learn and clean more complex performance chunks. In this sense, trouble with learning trajectories of newcomers created conditions for the emergence of teaching among relative old timers. Instructors relied on more experienced members of the ensemble to repair problems of over-learning individual parts. In turn, relative old timers reported that figuring out how to teach new members was a significant learning accomplishment of their own.

Learning and Belonging in Ensemble Activity

The coordination of multiple, moving bodies, playing musical instruments was clearly an accomplishment grounded in the bodies of individuals. Students spoke of this progression—from dots to forms and from paper-based representations to doing—as building “muscle memory” for the relationship between their instrumental section’s playing of the score and their local
trajectory in a visual form. Once this coordination was established in cleaning cycles, as one student put it, “you wanna hit that relationship every time.” But not every student managed to embody this relationship during the season.

Early in the season, a struggling student was assigned to a role off the marching field altogether. This reassignment was resisted not only by the less capable player, but also by senior peers in the ensemble. When the reassigned player contemplated quitting the band, others considered doing so out of a sense of justice, arguing the reassignment gave a “negative outlook” on the band. From their perspective, the CHS band was organized to be “accepting” regardless of ability, so excluding students to enhance performance ran counter to their reasons for elective participation. This contradiction between production of a competitive performance, on the one hand, and providing an inclusive community, on the other, was deeply felt by students in our interviews. In the end, stronger players helped smooth over the conflict, the dissenting marchers stayed with the band, and with help from more experienced peers, the struggling student eventually became a capable member of the ensemble. While instructors maintained strict authority over design of The Show, its development as ensemble performance was constantly negotiated. Conflicts over competitive performance, membership, and opportunities to learn were not common, but they did arise and were addressed as part of the distributed network of assessment, teaching and learning that was central to practices of ensemble learning in this case.

**Interplay Between Marching and Mathematics**

One of our interests in studying The Show was to explore the family resemblance between marching drill and the mathematics of space and motion (e.g., transformation of geometric figures and movement through space in coordination with a musical score). Mr. Cowen told us CHS math teachers sometimes reported that marching band students had an
unusually strong grasp of coordinate positions on the plane. Perhaps related to this, students often asked Mr. Cowen for copies of form sheets to use as “real world” examples for assignments in their math classes. Also, instructors and band parents reported that students who elected to continue in the marching band had higher scores on college entrance exams.

We found no evidence during our study of The Show that school mathematics played an explicit role in design, learning or performance by the ensemble. Still we had reason to believe there were implicit forms of interplay between participants’ understanding of mathematics and the spatial and temporal organization of The Show. So while the purposes of our study were ethnographic and descriptive, we decided to include what we called a “Math to Marching” task in the post-season interviews with instructors and with a focus group of graduating seniors.

This part of the post-season interview, conducted with groups of students and their instructors/designers separately, was similar in spirit to experimental tasks used by Scribner (1986) in her studies of dairy loaders or by de la Rocha (1985) in her studies of calculation practices in the kitchens of dieters. By deliberately juxtaposing different cultural practices of competitive marching bands and high school geometry, we hoped to provide study participants with an opportunity to use familiar elements of both practices in dealing with a novel task. In this sense, the interview created an opportunity for instructors and students, positioned differently in the ensemble activity, to develop a hybrid practice (Ma, 2012) around space and motion within the confines of the interview. Our task for the instructors was as follows:

[Math to Marching Task]. Consider a triangle with sides of equal length. The triangle initially rests at the origin. Along a path with slope of 0.5 extending into the first quadrant, the triangle undergoes two transformations at the same time: (1) It is translated to a position that is 30 yards (positive direction) further along the x axis; (2) It is dilated by a factor of 3.
Can you design a chunk that achieves these transformations of the triangle?

Which dot (or dots) travels furthest? Which dot (or dots) travel fastest?

We simplified this task slightly for graduating seniors, using a slope of 1 (rather than 0.5) and dilating the equilateral triangle by a factor of 2 (rather than 3). Otherwise we read the task to each group and asked them to work on it in any way they liked. For readers not familiar with these types of geometry problems, a translation of a geometric figure moves all points contained in the figure to a new position on the plane, resulting in a congruent figure. A dilation of a geometric figure re-scales the figure around a point, called the center of dilation, using a scale factor. The result is a similar figure.

We expected both groups would find this task similar to the rotating block chunk of The Show, and both groups did remark on this similarity as they worked on the task. However, their solution approaches contrasted in interesting ways. Both groups groaned and laughed as we read the task to them, and several remembered their last mathematics class. Both instructors and students asked if they could work together on the task, and when we reminded them that they could do whatever they liked, each divided into two or more subgroups, working in parallel. In the end, students treated our task as a math problem and presented two solutions with different degrees of mathematical precision. In striking contrast, the instructors treated our task as an ill-conceived drill form, created a marching chunk that repaired the figure in our task, and then elaborated the chunk further into something they would find more interesting. Criteria for adequate performance adopted by students and instructors on this task were clearly different.

Students, who had experience learning and teaching marching forms from an intrinsic (within the form) perspective but had never designed a chunk, oriented to our task as a mathematics problem with a single correct answer. Their solutions varied primarily around
finding the distance each vertex of the equilateral triangle moved. One solution made drawings of the starting and ending figures on graph paper and measured distances with a ruler (Figure 3, top); another solution used coordinate pairs for vertices and distance formulas to calculate displacements. With both approaches, students stumbled over whether the triangle would expand from a vertex or the center of the figure, a dilemma that resolved quickly in favor of the center when one of us asked, “How would you do it if you were marching?” Viewing the triangle as a group of marchers, the students realized that dilation from a vertex of the starting triangle would create step sizes for some marchers that would be difficult to learn. Students were attuned to problems of finding and hitting “dots” they had encountered as members of the marching band.

[Figure 3 here]

Instructors approached the task differently. Mr. Edwards briefly sketched a geometric diagram at the whiteboard, but stalled on how to show the dilation. After others chided him for being “a nerd,” they quickly rejected our equilateral triangle as a form, arguing that it would never read in performance (i.e., from the viewing tower, sides lengths would not look equal). Worse, students would not be able to find their dots as the triangle moved across the field. Mr. Cowen launched Pyware™, and then he and the other instructors started a design session (see Figure 3, bottom). They made the triangle taller (an isosceles triangle), since this would read correctly as a form on the field from the isometric perspective of spectators and judges. They also put the taller triangle “on the grid” in a way that would give students “check points” (dots) to hit as the figure was translated and dilated. Setting the redesigned figure into an animation loop in the software, Mr. Cowen announced, “That’s the answer to your problem.” Eric then countered that “we would never have stopped it right there,” and the others agreed. They resumed design work, adding a rotation to the expanding triangle and then dispersing the
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marchers into a fan. The resulting chunk came to resemble the rotating block of The Show.

[Field note from regional championship]. We followed the CHS Marching Band to a regional competition at national scale, driving for over six hours to a neighboring state. After a hectic, pre-dawn start from the band’s hotel, we lost the CHS buses in traffic but found them just before they entered the contest venue—a massive NFL football stadium, home to a recent Super Bowl championship team. There were dozens of other bands in the parking lot, assembling next to their brightly painted buses. Using passes offered by Mr. Cowen, we followed as he led the band silently into the basement of the stadium, used as a warm up area. At his direction, there was no talking. After a nervous tuning and warm up routine, conducted with other bands in a cavernous room, we followed as Mr. Cowen and the CHS Marching Band took the field.

Walking out of the basement into the fully lit indoor stadium was disorienting. The space was vast, the artificial grass gleamed under foot, and stadium seating rose around us like a mountain range. As it was early in the morning, parents and family of bands on the early schedule filled only a fraction of the stadium. After a tense set up, in which the band’s sound system almost failed, the announcer introduced the band and delivered the field to the lead drum major. The Show was underway, and for the first time, we watched at field level, nodding along and listening for audience reaction to more dramatic elements of their performance. Applause after the closer was vigorous, despite a nearly empty stadium. As the band marched crisply off the field, we followed Mr. Cowen and other instructors, who seemed guardedly pleased with the performance. By definition at this point in the season, this was not a “run through.”

We met up again with the CHS Marching Band at an identified collection point late in the day. Students had been shopping in the stadium’s many concession stores, so arrived in groups carrying bags of loot related both to marching and to professional football. Instructors and band
parents, also bearing evidence of shopping, stood and talked. A sophomore from the brass section, who had become familiar with our study, approached us eating candy and with a huge grin on her face. She blurted out, “Epic FAIL!” and then, in response to our puzzled reaction, explained to us that the judges’ scores were not high enough for the band to advance beyond this day’s competition. We had watched the final performance of The Show from the field, earlier that morning. Leaving the stadium by twilight, we watched as performers strolled in small groups towards a nearby, downtown mall, looking for places to have dinner. We were stunned to lose our object of study, but they were at rest. The CHS Marching band season was over.

Discussion

Our study of the CHS Marching Band competition season provided an opportunity to examine ensemble learning in activity, at multiple scales and over a relatively long period of time. The Show as an ensemble performance was not a single story line that could be experienced and told from a unifying, external perspective. Performance sometimes got in the way of learning (e.g., students threatening to quit if a marginal marcher was excluded), but at other times, learning got in the way of performance (e.g., section leaders struggled to re-orient the perception of “dot Nazi’s” as the season progressed). As suggested by Granott (1998) and Stone & Gutierrez (2007), what served as an ensemble for learning shifted and emerged over different scales through time. Both from perspectives on design (by instructors) and performance (by marchers and instructors), units of ensemble activity that received the most attention were particularly complex moments of coordination in The Show, designed for judges and a viewing audience. The “tight mass of brass” appreciated by Mr. Cowen and Eric during design, for example, persisted as a chunk of coordinated action for marchers and for instructors throughout the season, in cycles of “cleaning” and half time “run-throughs” leading to the marching band’s
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final, competitive performance. Disciplining the bodies of marchers to reach high levels of precision in chunks of ensemble performance provided an artistic palette for this particular season, and over time, produced successive generations of marchers who were capable of incorporating more challenging (and higher scoring, if performed well) design elements for building shows.

These seasonal cycles of cleaning and competitive performance were not possible unless some of the same students whose bodies incorporated performance capacity also took up responsibility for assessing and teaching their more junior, student peers. Emerging units of ensemble activity also involved shifting goals and forms of engagement for students, who began to help others participate effectively in critical moments of ensemble performance. In this sense, learning in ensemble activity required that some students take on new relations to ongoing activity, which were sometimes marked by frustration, but at other times smoothed over conflict that threatened to pull the marching band apart. We came to think of their changing relations of participation as a kind of stewardship. Not only did more senior students provide a reliable palette of embodied skills for designing chunks that would be striking in competition, but some also created new identities of belonging in the marching band, mediating conflict in relations between students and adult designers and instructors. Mr. Cowen and the instructors expected this as part of building a competitive marching band, and they used student teaching as a resource when preparing for the competition season.

Our descriptive findings can be compared with other studies of what appear to be ensemble learning reported in the literature, to bring forward concepts concerning meanings, processes, and structural provisions for learning that might be quite general. One study was Hutchins’ (1995, 2010) analysis of learning to navigate on board a US Navy vessel, where new
participants learned along a “horizon of observation” that allowed them to observe more capable peers performing tasks the newcomers would eventually also need to learn. Operating devices within a stable division of labor, navigators had access to what they would need to learn for the future, and they were able to detect and correct errors produced by newer, less capable participants moving along a similar learning trajectory. Similar horizons of observation were present in our study, though bodies and mediating devices played very different roles in learning processes. Mediating devices in the environment for marching (e.g., chalk used to guide initial attempts to reach a location at a moment in the score) were deliberately removed as marchers approached full competence. In their place, we found intense efforts to discipline the perception (Stevens & Hall, 1998) and whole body actions of newcomers regarding how to move and play within the proximal environment of ensemble performance.

A second useful study concerns changing forms of engagement over time. Nasir (2002) found that as adolescents grew older, their reasons for engaging in peer-directed activities like playing dominoes or basketball changed, with consequences for emergent goals they structured and for subsequent learning. In our case, problems of learning and assessment in performances of over 100 moving musicians led marchers to take on increasing levels of responsibility for teaching and assessment as they grew more experienced. Shifts from learning to teaching for senior members of the ensemble activity were necessary within the marching season if the band was to become competitive in juried performances.

We are also interested in how adolescents get access to and creatively take up cultural resources that allow for identities of belonging as young adults (Boaler & Greeno, 2000; Holland, Lachicotte, Skinner & Caine, 1998; Kirschner, 2008). Nasir & Cooks (2009) reported that track athletes shaped new relations with peers, taking on relational identities of caring as well as
advancing in personal performance. At the same time, access to adult teaching and equipment were restricted for athletes whose performance did not show consistent improvement. In our case, joining the high school marching band offered students a broad palette of cultural resources for belonging in exchange for their intense engagement with the ensemble. These included opportunities to teach and mentor younger students. However, even in these new relationships between peers, there were contradictions between high level marching performance and support for inclusive participation, irrespective of personal skill or capacity. Over multiple marching seasons, high levels of competitive performance and peer-directed forms of support produced a marching band community that kept students going through high school and, for some, drew them back as young adults years after graduation.

A final comparison involves the value placed on individual accomplishment in relation to belonging to the ensemble. In Powell's (2005) ethnographic study of learning Taiko drumming, Apprentice drummers developed “muscle memory” for performance using multiple experiential modalities (drumming, movement within the group, and interactive chanting). Once players were able to make stable contributions to standard performance pieces, they were invited to take improvised solos, which became a defining feature of their identity within the ensemble. Like ensemble drumming, marching band performances wove together diverse cultural materials (e.g., martial drill, standard forms of parade music interleaved with highly memorable fragments of popular songs), and there were large stretches of time devoted to coordinating playing with drill/dance so that performance chunks could evoke an emotional response from the audience.

But there were also important differences. In the CHS marching band, only a few students played solo instrumental passages, and these were heavily rehearsed, sometimes even simplified to match the soloist’s instrumental fluency. When marchers took solos, the otherwise
dynamic sound and movement of the ensemble was deliberately quieted and brought almost to rest, opening an acoustic and visual space for the solo feature, usually performed by a motionless individual. Unlike Taiko drumming, where improvised solos defined individual membership and identity, full membership and belonging in the marching band required learners to submerge qualities of personal distinction in the service of creating a palette of coordinated forms for performance and design. For marchers, the scale of social participation both expanded and was considerably narrowed over time, bringing their emergent goals closer to the leading activity of the marching band as an ensemble—to deliver a performance (no longer a “run-through”) that was technically precise and dramatic, under the discerning eye of competition judges, parents, and past band members seated in the viewing stands. As Ted put it in a pre-competition huddle to the ensemble, “You can touch their hearts.”

Talk of touching hearts, participating in ensemble performance, and building an identity of belonging by teaching and looking out for others are not typical descriptions of college preparatory school work. Marching band students told us repeatedly that performing in The Show was primarily about doing, not about remembering or representing. That their experience of making The Show was remarkably (for them) different from formal schooling led us to probe possible relations between school mathematics and marching in our final interviews. While solving our “Math to Marching” task, both band instructors and students used their experiences related to marching band as a resource for problem solving. Instructors, from the stance of designers, rewrote the problem to read for judges and to be easier to perform and clean for the band. Using Pyware™ to animate the transformation allowed them to bypass mathematics their students pursued. But even in pursuing design goals, instructors engaged the task mathematically, implementing a complex stretching transformation that considered judges’ views from the stands.
above, as well as the ease of hitting “dots” when marching the transformation. In sharp contrast to instructors, students tackled our task without question as a classroom mathematics problem. When some got stuck deciding on a center of dilation for the transformation, our suggestion to consider how they would march the form re-contextualized (Jurow, Hall, & Ma, 2008) the task and helped students find resources in their experience of ensemble marching.

Whether structural provisions for ensemble learning in activity could support a more thorough re-construction of mathematical activity that would be recognizable, by high school marching band students, as doing mathematics together remains an open question. Our effort in this paper has been to develop a grounded theoretical account of how ensemble learning was organized in one case, comparing our findings with other studies that may form a family of instructive cases. Our continuing work explores these possibilities in experimental teaching, and we encourage readers to join us in this effort.

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1 Pseudonyms are used for places and people throughout.

2 Turns at talk are numbered for identified speakers. Continuous speech at turn boundaries is shown with =equal signs, while onset of [overlapping talk is shown with left brackets. EMPHATIC talk is shown in caps, and elongated enunciation is shown with repeated colons. ((Activity descriptions)) appear within double parens and in italics. (Uncertain transcription) appears in single parens.

3 Recipient design in conversation analysis (e.g., Schegloff, 1992) refers to how speakers shape an utterance to secure the attention and understanding of listeners. We extend this concept to the work of designing the sequential flow of multi-person, whole-body, coordinated actions in ways that anticipate the physical capacity of those acting as well as an aesthetic response from viewers.
References


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Figures

Figure 1. Image sequences for a visual/aural “chunk” (the rotating block) in the opener to The Show: (left column) instructors designed the chunk using Pyware™ software, (middle column) students practiced marching drill for the chunk on a parking lot painted as a marching field, (right column) students performed the chunk in their final competition.
Figure 2. Representational forms used with marchers (“dot sheet” at left) and with instructors and drum majors (“form sheet” at right). Each sheet shows locations at particular moments in the musical score.

Figure 3. Two solutions to the Math to Marching task offered by students (left) and instructors (right).