PERFORMANCE-BASED CLUSTER GROUPING
IN NINTH GRADE HONORS PHYSICS

by

Jessica L. Christman

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ABSTRACT

Gifted students at Twin Valley High School often report that they are not academically challenged during their freshman year. A lack of rigor may promote poor work habits, study skills, and attitudes among the brightest students.

This action research study compared two concurrent sections of ninth grade Honors Physics. Both sections were taught by the same teacher; however, only one section received the intervention of performance-based cluster grouping with targeted instructional strategies. The four-week intervention included homogeneous grouping by table, along with opportunities to demonstrate mastery of certain skills with fewer repetitions by completing the most difficult practice problems first. A variety of data collection measures were utilized, including student surveys, the Force Concept Inventory, summative assessments, and semi-structured interviews.

The results of this action research project highlighted the importance of incorporating purposeful homogeneous grouping into the regular classroom setting. The majority of students reported that they learn best when working with peers of a similar ability level. Additionally, within the homogeneous groups, the cluster teacher observed a more even distribution of the workload and more in-depth conversations among the students.

The majority of students attempted to complete the most difficult problems first at least once and indicated a positive or neutral attitude towards the instructional strategy. Interestingly, students who always attempted the most difficult problems first performed better on summative assessments than those who did not attempt the most difficult problems first. Although this difference was not quite statistically significant, a strong positive correlation was observed between how often students opted to try the most difficult problems first and how well they performed on their summative assessments. This finding suggests that the students exercised good judgement when choosing whether or not to attempt the most difficult problems first.

The results of this action research project suggest that the Most Difficult First strategy positively affected student confidence in their math ability. However, there was no apparent effect on student’s conceptual understanding, as measured by the average normalized gain on the Force Concept Inventory.
INTRODUCTION AND BACKGROUND

Problem Statement

Gifted students at Twin Valley High School (TVHS) often report that they are not academically challenged during their freshman year. Students expect a higher degree of difficulty when they transition from middle school to high school; however, high-achieving gifted freshmen typically state that they have little homework and rarely study for their Honors courses. Fiedler et al (2002) cautions that “without regular encounters with challenging material, gifted students fail to learn how to learn and have problems developing the study skills they need for future academic pursuits” (p. 92). Furthermore, it is more likely that they will develop an elitist attitude (Fiedler et al, 2002). Consequently, there is concern that a lack of rigor may promote poor work habits, study skills, and attitudes among the brightest students.

The National Education Association defines tracking as “a school's practice of separating students into different classes, courses, or course sequences (curricular tracks) based on their academic achievement”. For the past 15 years, Twin Valley has prided itself on not tracking students. The district’s student services webpage states, “The Twin Valley School District has a longstanding commitment to the inclusion of students requiring specially-designed instruction within the general education environment to the extent appropriate for the individual child.” At the high school level, this district philosophy results in students’ ability to choose the level of their core courses, starting in ninth grade.
Twin Valley High School’s 2016-2017 Program of Studies differentiates between honors and academic level courses:

Honors level courses will cover more material in greater depth, and demand more work than academic level courses. Students must be committed to fulfilling all course requirements. Students choosing honors level courses should have a strong academic record and a desire to attend a competitive four-year college. Students receive weighted credit for honors level courses. With the implementation of the Pennsylvania Core Standards, rigor is demanded at all levels – including academic. Courses at this level will provide a strong academic background in order to prepare students for college and career readiness (p. 5).

Giving students the option to select Academic or Honors Physics during their freshman year has likely resulted in more incoming freshmen electing to take the higher level. In the past five years, nearly 40% of freshmen have registered for Honors Physics. As a result, teachers commonly express frustration with students who have chosen to take Honors but struggle with the conceptual depth, mathematical calculations, and/or faster pace of the course. Over time it is possible that freshman Honors classes have become less challenging as teachers “teach to the middle”, contributing to the gifted student perception of freshman Honors courses as easy.

At the population level, intellectually gifted individuals signify one extreme, while intellectually disabled individuals represent the opposite extreme. The distribution of the Intelligence Quotient (IQ) in the population follows a bell curve with an average score of 100 and a standard deviation of 15. Notably, only 5% of individuals score more than two standard deviations away from average (with an IQ score ≤70 or ≥130).

Feldhusen and Moon (1992) advocate for both intellectually gifted and intellectually disabled students: “Special grouping in a regular classroom and beyond becomes increasingly necessary for students whose achievement levels, aptitudes, learning styles,
and motivations are at extremes and whose needs are not met by the regular classroom” (p.64). Moreover, they claim, “The needs [for special grouping] increase as students move to higher grade levels and to conceptually more complex and abstract curricula and become more diverse in their achievements” (Feldhusen & Moon, 1992, p. 64).

In practice learning support students with the most significant needs are carefully placed into co-taught classrooms, while gifted freshmen are randomly assigned to course sections. At present the only intervention that the gifted population receives during the critical transition from middle school to high school is extra counseling during course selection. As the gifted support teacher at TVHS, I discuss subject acceleration, colloquially referred to as “doubling up,” with the gifted eighth graders. This strategy allows motivated students to access classes at a higher grade level in their area(s) of strength, while the rest of the student’s courses are with age peers. By doubling up in math and/or science freshman year, students can increase the overall rigor of their course load, which may promote positive work habits and study skills.

School Demographics

Twin Valley High School (TVHS) is a public school in rural southeastern Pennsylvania that serves approximately 1,100 students in 9th through 12th grades (PA School Performance). The faculty and students at TVHS are predominately Caucasian, with only 7.9% of students identifying as a racial minority (PA School Performance). Although relatively homogeneous in terms of ethnicity, the student population varies considerably in socioeconomic status. As of October 2016, approximately 28% of the student population was considered economically disadvantaged, qualifying for free or
reduced lunch (PA School Performance). Table 1 compares Twin Valley to neighboring school districts in Berks and Chester counties.

Table 1
Comparative Demographics of Twin Valley High School

<table>
<thead>
<tr>
<th>Public High School</th>
<th>County</th>
<th>Student Enrollment</th>
<th>% Caucasian</th>
<th>% Economically Disadvantaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Valley</td>
<td>Berks &amp; Chester</td>
<td>1069</td>
<td>92.1</td>
<td>28.2</td>
</tr>
<tr>
<td>Daniel Boone Area</td>
<td>Berks</td>
<td>1154</td>
<td>88.4</td>
<td>24.8</td>
</tr>
<tr>
<td>Governor Mifflin</td>
<td>Berks</td>
<td>1308</td>
<td>77.5</td>
<td>36.7</td>
</tr>
<tr>
<td>Exeter Township</td>
<td>Berks</td>
<td>1372</td>
<td>84.7</td>
<td>28.1</td>
</tr>
<tr>
<td>Downingtown West</td>
<td>Chester</td>
<td>1460</td>
<td>86.6</td>
<td>14.3</td>
</tr>
<tr>
<td>Owen J Roberts</td>
<td>Chester</td>
<td>1581</td>
<td>90.0</td>
<td>16.1</td>
</tr>
<tr>
<td>Coatesville Area</td>
<td>Chester</td>
<td>2103</td>
<td>52.0</td>
<td>50.6</td>
</tr>
</tbody>
</table>

Note: All data is from PA School Performance as of October 2016.

In 2016, 61% of the graduating class advanced to a four-year college/university, and another 18% continued their studies at two-year college/trade/technical schools. The same year 16% of graduates pursued direct employment, while 1% enlisted in the military (Twin Valley High School Profile). As students work towards graduation, 15.6% receive special education services and 4.6% receive gifted services (PA School Performance). A few students qualify for both learning support and gifted support.

Daily Schedule and Science Sequence

TVHS has operated on a semester schedule since the 2005-2006 school year, when 82-minute blocks were introduced (Twin Valley High School Profile). In addition to four blocks, each day there is a 40-minute callback/remediation/enrichment period. To fulfill the graduation requirements, students must earn a minimum of four credits in science. TVHS’s core science sequence starts with algebra-based physics and then progresses to chemistry (typically during sophomore year) and biology (typically during junior year). Students are required to take at least one semester of the three main branches
of science to graduate, unless an Individualized Education Plan team recommends otherwise. TVHS currently offers year-long Advanced Placement (AP) Chemistry, AP Biology, and AP Physics, as well as a variety of engineering and agricultural science courses each semester.

**Project Overview**

With administrative approval at the building and district levels, the top math and science students were placed together in one section of Honors Physics in the fall of 2016. To determine which students should be grouped together, input was requested from eighth grade math and science teachers. Available standardized test data was also analyzed. Before implementation, I met with the designated cluster teacher to discuss the advantages of homogeneous grouping within the classroom, as well as other instructional strategies that can be used to meet the needs of gifted learners. Together we decided what strategies to implement for the 2016-2017 school year. We then collaborated to develop and/or to locate differentiated curricular materials for the most advanced learners.

The Honors Physics curriculum at TVHS follows the Modeling Instruction approach supported by the National Science Foundation and devised by Arizona State University faculty (Jackson et al, 2008). The first stage, model development, “establishes a common understanding of a question to be asked of nature” (p. 11). Often a new concept will be introduced with a lab or demonstration, followed by a whole class discussion. The second stage, model deployment, requires students “to apply their newly-discovered model to new situations to refine and deepen their understanding” (Jackson et al, 2001, p. 12). Modeling Instruction attempts to formalize the thinking process in how
to approach various problems, emphasizing student collaboration and presentation of findings. One possible drawback of Modeling Instruction for gifted learners is the common pace of instruction; the class typically moves on to new material together and those who finish early wait for others to catch up. Presenting and justifying physics problems and lab results require a significant amount of class time; this practice constitutes another possible drawback for gifted learners. Although the majority of the students may need this time to process the information, gifted students would likely benefit from extension to deepen their understanding.

The TVHS Honors Physics curriculum consists of eight modeling cycles: Scientific Thinking, Constant Velocity Particle Model, Constant Acceleration Particle Model, Balanced Forces Particle Model, Unbalanced Forces Particle Model, Energy, Projectile Motion, and Momentum. To succeed in the later modeling cycles, students must apply their scientific reasoning skills, as well as their knowledge of motion, velocity, and acceleration. For the purpose of this study, our curricular efforts will focus on the Balanced Forces and Unbalanced Forces Particle Models. Specifically, this action research project will address the following focus questions:

1. How do the classroom teacher and students perceive the effectiveness of homogeneous grouping and the Most Difficult First strategy?
2. How does performance-based cluster grouping affect students’ confidence and perception of challenge in ninth grade Honors physics?
3. How does performance-based cluster grouping affect students’ conceptual understanding of Newtonian mechanics in ninth grade Honors Physics?
CONCEPTUAL FRAMEWORK

This section will start by discussing the unique characteristics of gifted learners. Next the historical context for grouping and possible gifted education organization models within the school setting will be examined. Studies will be reviewed that assess the effect of different grouping strategies on the academic achievement of gifted learners, as well as on their attitude and motivation. Finally, beneficial teacher attributes and effective instructional strategies for gifted learners will be discussed.

Characteristics of Gifted Learners

The Intelligence Quotient (IQ) has historically been the primary means of identifying intellectually gifted children. Traditionally, those with IQ scores at or above 130 qualified for gifted services in public education settings. In 2000, the state of Pennsylvania tasked school districts to consider multiple criteria, including demonstrated academic achievement or expertise, when identifying mentally gifted students. School districts are also cautioned to consider if intervening factors, such as English language barriers, play a role in masking gifted ability.

Although the notion of multiple criteria was adopted by the state of Pennsylvania, IQ tests remain important in the identification process. Chapter 16 of the Pennsylvania Code defines mentally gifted as “outstanding intellectual and creative ability…which requires specially designed programs or support services, or both, not ordinarily provided in the regular education program” (p. 1).

Trained teachers may be able to identify intellectually gifted students by their unique characteristics. “Gifted students make intuitive leaps in their thinking, require
fewer repetitions to master new concepts, accelerate through the curriculum at a faster rate, and think more critically and with greater depth and complexity than students of average ability” (Brulles and Winebrenner, 2011, p. 42). Unlike the majority of the population, most gifted individuals prefer to learn from whole-to-part (Sternberg, 1985). In other words, they prefer to learn the details in the context of the overarching concept or universal theme, which helps to increase the depth and complexity of the content. Students who demonstrate giftedness in mathematics often prefer solving unstructured problems as opposed to those following predetermined sequential steps.

Certain personality characteristics also can signify giftedness. Silverman (1993) linked intellectual characteristics of giftedness to personality attributes:

Table 2
Silverman’s Characteristics of Giftedness

<table>
<thead>
<tr>
<th>Intellectual Characteristics</th>
<th>Personality Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional reasoning ability</td>
<td>Insightfulness</td>
</tr>
<tr>
<td>Intellectual curiosity</td>
<td>Need to understand</td>
</tr>
<tr>
<td>Rapid learning rate</td>
<td>Need for mental stimulation</td>
</tr>
<tr>
<td>Facility with abstraction</td>
<td>Perfectionism</td>
</tr>
<tr>
<td>Complex thought processes</td>
<td>Need for precision/logic</td>
</tr>
<tr>
<td>Vivid imagination</td>
<td>Excellent sense of humor</td>
</tr>
<tr>
<td>Early moral concern</td>
<td>Sensitivity/empathy</td>
</tr>
<tr>
<td>Passion for learning</td>
<td>Intensity</td>
</tr>
</tbody>
</table>

Note. If a student displays a number of these characteristics, he/she may be gifted.

Historical Context for Grouping

Historically, the debate between cooperative grouping and ability/achievement grouping has assumed a prominent role among educators. For most of the 20th century, the majority of school districts divided students into different classes, courses, or course sequences based on their academic achievement and/or intellectual ability. This practice
is referred to as tracking. Tracking is a rigid type of full-time ability or achievement grouping, since typically there is very little movement between curricular tracks.

Kulik and Kulik (1982) conducted a meta-analysis of 52 research studies on full-time ability grouping in secondary schools, comparing students in homogeneous classrooms with similar students in heterogeneous classrooms. Calculating effect size, as devised by Glass (1976), they measured the degree of effectiveness of ability grouping on different subgroups, where:

\[
\text{Effect Size (ES)} = \frac{\text{Mean of experimental group} - \text{Mean of control group}}{\text{Standard deviation}}
\]

Full-time ability grouping of gifted and talented students yielded a positive effect on student achievement (mean ES 0.33) (Kulik & Kulik, 1982). However, no significant effect of full-time ability grouping was observed in the academically deficient or control sub-groups. The authors concluded, “High-ability students apparently benefited from the stimulation provided by other high-aptitude students and from the special curricula that grouping made possible” (p. 425). However, critics of tracking have referred to it as anti-democratic, arguing that tracking encourages educational stratification and creates equity issues (Slavin, 1990).

In the 1980’s, cooperative learning emerged, touted as advantageous to all learners. However, Robinson (1990) points out that several disadvantages exist for academically gifted students in cooperative learning models, which “recommend heterogeneous ability or achievement grouping strategies for the bulk of instructional time” (p. 10). For example, peer tutoring is often encouraged; while potentially
advantageous to struggling students, Robinson (1990) argues that this arrangement exploits the brightest students:

The tendency to view talented students as ancillary classroom helpers rather than children with individual needs, curiosity, and desires of their own devalues them. In so far as cooperative learning crystallizes this view of talented children, it becomes exploitation rather than cooperation (p. 21).

If systematic tracking pigeonholes the lowest students and cooperative learning models inhibit the highest students, what alternative grouping strategies exist?

Gifted Education Organizational Models

Rogers (2007) clearly outlines that different school settings will require different organizational models to support gifted learners:

…There is a need to group gifted learners at times for their learning and socialization, along with a need to move them ahead in some form when their learning outstrips the curriculum they are offered….These students need some opportunities, too, to work independently to fully develop their demonstrated talents…But the strongest lesson of all to be gained from the research base in gifted education is that there are many different ways in which these options for gifted learners can be offered in a school. It is completely up to the school to select those that will work best with its current philosophy, staff, and school community (Rogers, 2007, p. 382).

When selecting which grouping model to implement, administration, teacher, and curricular factors must be considered (Rogers, 2006). “In this era of data-driven, results-oriented decision-making…administrators [may] opt for…research-supported options that provide the greatest academic gains” (Rogers, 2006, p.32). Both administrators and teachers need to understand and appreciate the benefits of the chosen model. Before successful implementation can occur, time must be devoted to educating teachers about their expected role within the selected model. In addition, locating and/or developing
differentiated curricular resources must be prioritized and significant time allocated. Teacher investment in the model is critical for a successful implementation.

Cluster Grouping

Purposeful, thoughtful cluster grouping provides a promising alternative to tracking and heterogeneous cooperative learning. The top five to eight students at a grade level are placed together in an otherwise heterogeneous class (Rogers, 2007). This model allows the top students to learn together, while avoiding permanent grouping arrangements for students of other ability levels. According to Brody (2004), “bringing together students with similar instructional needs facilitates delivery of more advanced curricula in an efficient way” (p. xxx). As such, ability/achievement grouping is a tool that allows for appropriate differentiation for gifted learners.

Although the educational research is largely in favor of cluster grouping, the criteria to select which students to group together varies. In ability-based cluster grouping, all students who have been identified as gifted, regardless of their individual areas of strength or current achievement, are grouped together in small clusters. In performance-based cluster grouping, students who are currently excelling in a particular subject area are grouped together, irrespective of identification as gifted. Rogers (2006) distinguishes the two, stating, “Differentiation in performance grouping is based on extending the child’s knowledge and skills beyond the regular curriculum more than developing latent potential” (p. 22). In other words, performance-based cluster grouping is not a model that is geared towards underperforming gifted students. A third option would be to divide identified gifted students into clusters based on similar learning
strengths, preferably with a teacher who shares their strength area (Brulles & Winebrenner, 2011). This blended approach would group students based on ability (identification as academically gifted), as well as performance (achievement).

**Schoolwide Cluster Grouping**

The Schoolwide Cluster Grouping model relies on teacher feedback and performance data to assign each student in a grade level to one of five ability groups: gifted, high average, average, low average, and far below average. A placement team then hand schedules students “to create a balance of ability and achievement levels in all classes in the grade” (Brulles and Winebrenner, 2011, p. 42). Classes either have a gifted cluster or a far below average cluster of students, but not both. This model requires investment from more stakeholders, including administration, sending and receiving teachers, and guidance counselors.

Since eighth grade students are self-selecting into Honors or Academic Physics, the schoolwide cluster grouping model is not feasible at TVHS. Those students who would fall into the “low average” and “far below average” categories likely chose Academic Physics. Whereas, some “average” students selected to take Honors Physics, and others opted for Academic Physics. Therefore, the composition of a ninth grade Honors Physics class should theoretically include “gifted”, “high average”, and some “average” students in science. While the class is still heterogeneous in nature, the range in student ability has been narrowed based on student course selection.
Effect of Grouping on Academic Achievement

After a comprehensive review of historical research regarding gifted education, Rogers (2007) extracted five critical lessons. Regarding grouping gifted learners, she stated a need to “provide opportunities for gifted learners to socialize and to learn with like-ability peers” (p. 388). This lesson stemmed from her calculations on cumulative effect sizes for different grouping strategies. All types of ability grouping, including rigid and flexible arrangements, demonstrated positive effect sizes for gifted learners; of these, cluster grouping (mean ES 0.62) and pull-out groups (mean ES 0.65) were shown to have the largest learning impact. However, peer-tutored dyads, when teachers purposely pair students of significantly different abilities, did not result in any additional academic growth for gifted students (mean ES 0.00).

Table 3
Rogers (2007) Grouping Definitions and Academic Effect Sizes for Gifted Students

<table>
<thead>
<tr>
<th>Type of Grouping</th>
<th>Definition</th>
<th>Academic Effect Size for Gifted Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time Ability Grouping</td>
<td>Providing all academic learning for gifted learners within a self-contained setting</td>
<td>0.33</td>
</tr>
<tr>
<td>Performance Grouping</td>
<td>Sorting and placing students in a classroom with others who are performing at the same level of difficulty in the curriculum</td>
<td>0.34</td>
</tr>
<tr>
<td>With-in Class Grouping</td>
<td>Individual teachers sorting children in their classroom according to their current performance in the curriculum</td>
<td>0.34</td>
</tr>
<tr>
<td>Cluster Grouping</td>
<td>Placing the top five to eight students at a grade level in an otherwise heterogeneous class</td>
<td>0.62</td>
</tr>
<tr>
<td>Like-ability Cooperative Groups</td>
<td>High ability students provided with cooperative learning tasks to be complete jointly</td>
<td>0.26</td>
</tr>
<tr>
<td>Pull-out Groups</td>
<td>Gifted students removed for a consistent set time to a resource room for extended curriculum differentiation</td>
<td>0.65</td>
</tr>
<tr>
<td>Peer-tutored Dyads*</td>
<td>High ability student paired with lower achieving student for collaborative learning of set tasks</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note. *Heterogeneous grouping strategy.
A 2010 action research study compared the academic growth in mathematics for gifted students in cluster classes to that of gifted students in heterogeneous classes (Brulles et al, 2010). The intervention consisted of cluster grouping (5-9 identified gifted students per class), but also continual professional development and accountability for teachers with gifted cluster classes. Teachers were expected to document how they adapted curriculum to meet the needs of the gifted students. Overall, pre and post assessment data was collected for 772 gifted students, ranging from second through eighth grade, and the percentage of change in student achievement was calculated. The results indicated a significant difference in the percentage of change for the two groups of gifted students (clustered vs non-clustered) across all grade levels studied. For example, eighth grade gifted students in cluster classes gained 35.1%, whereas eighth grade gifted students in heterogeneous classes gained only 16.5%. Brulles et al (2010) concluded, “Gifted students in gifted cluster classes with trained teachers experienced greater academic growth in mathematics than those who remained in regular heterogeneous classes with relatively untrained teachers (relative to gifted education)” (p. 328).

A recent Nigerian study compared the impact of homogeneous and heterogeneous within-class grouping in Integrated Science (Adodo & Agbayewa, 2011). All subgroups, including high, average, and low ability students, improved significantly more through homogeneous grouping. For example, the high ability students who were heterogeneously grouped scored 50.30 on the post-test, whereas the high ability students who were homogenously grouped scored 74.90 on the post-test (Adodo & Agbayewa, 2011). There was no significant difference between the pre-test scores of the two groups.
Effect of Grouping on Attitude and Motivation

In their quantitative meta-analysis, Kulik and Kulik (1982) found a significant improvement in attitude toward the subject matter for students who were grouped with others of a similar ability. “Effects were positive in nearly all the studies of attitudes toward subject matter, and in the typical study these attitudinal effects were medium in size…Some students in grouped classes even developed more positive attitudes about themselves and about school” (p. 426). Furthermore, Adodo and Agbayewa (2011) concluded, “Within-class homogeneous ability grouping helps students to develop positive attitude to science subjects, the school and themselves” (p. 53).

Fiedler et al (2002) cautions that “unless gifted students are placed in situations where they can be challenged by intellectual peers, the possibilities that they will develop an elitist attitude might well be expected to increase” (p. 89). This statement further supports the cluster grouping model, which provides regular opportunities for intellectually gifted students to interact with one another.

Grouping can also indirectly affect motivation of gifted students. Feldhusen and Moon (1992) determined that “motivation suffers when new learning tasks are too easy or too difficult” (p. 63). They conclude that, “The level of challenge must be appropriate to students’ level of readiness” (p. 63). Formative assessments help determine student readiness levels, and therefore, should be used to inform pacing and grouping in the classroom. Brulles and Winebrenner (2011) explain the connection between grouping, motivation, and achievement: “Gifted students more readily take advantage of differentiated learning opportunities when others are working at advanced levels. They
may take more academic risks and challenge one another more” (Brulles & Winebrenner, 2011, p. 44).

**Instructional Strategies for Gifted Learners**

Fundamental learning differences necessitate purposeful instructional strategies that are targeted to meet the needs of the gifted population. After a comprehensive review of historical research regarding gifted education, Rogers (2007) concluded, “for specific curriculum areas, instructional delivery must be differentiated in pace, amount of review and practice, and organization of content presentation” (p. 390). In particular, mathematics and science require significant differentiated instruction since gifted individuals in these fields tend to prefer to learn from whole-to-part (Sternberg, 1985). In addition, gifted students learn at an accelerated rate and require less practice and review to master a skill. Often curriculum compaction and differentiation are intertwined when attempting to meet the needs of gifted learners.

One specific instructional approach to meet the needs of gifted students is Most Difficult First, proposed by Winebrenner and Brulles (2008). This strategy gives all students in the class the opportunity to demonstrate mastery with fewer repetitions of a particular skill by completing the most difficult practice problems first. Students who successfully complete the identified problems without teacher or classmate support move on to more challenging replacement problems that are above grade level or other alternative extension tasks within the content area. These students do not have to go back to the beginning of the assignment to complete the easiest problems, yet still receive full credit (Winebrenner & Brulles, 2008). To use this strategy effectively, no more than five
problems should be identified as the most difficult. “Anyone who gets four or five of these problems or examples correct in 15 minutes and whose work is clearly legible… is considered finished with the regular work” (p. 91). Any student who does not demonstrate mastery on the five most difficult problems or who needs to ask the teacher for help must do the entire assignment.

The expectation for educators to differentiate for gifted learners is evident in the standards. The National Association for Gifted Children (NAGC) published gifted education programming standards in 2010. The curriculum planning and instruction standard calls for the following evidence-based practices when teaching gifted learners:

- “Educators adapt, modify, or replace the core or standard curriculum to meet the needs of students with gifts and talents…” (3.1.3., p. 4)
- “Educators design differentiated curricula that incorporate advanced, conceptually challenging, in-depth, distinctive, and complex content for students with gifts and talents” (3.1.4., p. 4)

In addition, the NAGC identifies that critical-thinking strategies (3.4.1.), creative-thinking strategies (3.4.2.), problem-solving model strategies (3.4.3.), and inquiry models (3.4.4.) help meet the needs of students with gifts and talents.

“Justice is achieved not by equality of treatment, but by equality of opportunity” (Feldhusen & Moon, 1992, p. 65). Teachers are more likely to provide appropriate learning opportunities for the highest ability levels if more than one student will benefit (Brulles & Winebrenner, 2011). Rogers (2007) describes five to eight students as a “critical mass” to attract the attention of the teacher. Accordingly, cluster grouping
helps ensure that gifted students experience consistent curriculum compacting and
differentiation opportunities.

For a teacher to radically quicken the pace for gifted learners, eliminate most practice and review, and teach in a whole-to-part fashion by concepts, principles, issues, and generalizations rather than from the base of facts, terms, and parts of a whole idea is almost an impossibility without some form of at least temporary regrouping or clustering of the highest ability or highest performing learners in the classroom and a commitment to spending a proportionate amount of classroom time differentiating instruction accordingly. (Rogers, 2007, p. 391).

Teacher Attributes and Gifted Learners

Successful implementation of cluster grouping includes carefully selecting and supporting the teacher. Hansen & Feldhusen (1994) compared teachers who had taken several graduate courses in gifted education with those who had not received any specific training in gifted education. Trained teachers more skillfully engaged gifted students by using a concept-based approach, encouraging student self-direction, and varying learning experiences. In addition, “trained teachers…fostered high-level thinking in their classes by focusing classroom discussions on in-depth analysis, synthesis, and evaluation of information” and “avoided unnecessary repetition, drill, and use of examples” (Hansen & Feldhusen, 1994, p. 119). Thus, it seems that graduate coursework in gifted education helps to develop effective teaching skills.

Gentry and MacDougall (2008) suggested that the desire and commitment level of the teacher are necessary factors. They outlined key attributes when selecting which teacher to appoint as the gifted cluster teacher:

First, the teacher of the high achieving classroom must want to work with these students and he/she must commit to differentiating curriculum and providing these students with appropriately challenging curriculum and instruction. Second, this
individual must commit to learning about how to work with these students through [professional development] (Gentry & MacDougall, 2008, p. 37).

Perhaps the amount of training a teacher has completed concerning gifted education is not as important as their attitude towards working with this special population, their willingness to devote time to differentiating materials, and their openness to new ideas and approaches.

Mills (2003) found that personality and cognitive style also influence the efficacy of teachers of gifted students. Specifically, “teachers who are judged to be highly effective in working with gifted students prefer abstract themes and concepts, are open and flexible, and value logical analysis and objectivity” (p. 272). Given the Myers-Briggs Type Indicator (MBTI) test, these individuals were more likely to look for patterns when processing information and to imagine future possibilities (82.5% intuition type) than a normal teaching population (44.9% intuition type). In addition, effective teachers of the gifted demonstrated a preference for analytical and logic-based decisions, with 68.9% identifying as the thinking type, compared to only 39.5% of the normal teaching population. Interestingly, the majority of gifted students also identified as the intuition and thinking types (Mills, 2003). It appears that the majority of gifted students and effective teachers of the gifted share a similar style of information processing and decision making.

Mills (2003) also noted the importance of content expertise among effective teachers of gifted students. Of the 65 teachers who were identified as exemplary and chose to participate in the study, only three majored in Education. “The vast majority of these teachers held advanced degrees in their area of expertise” (p. 278). Mills (2003)
comments, “This sample of teachers appears to exemplify the notion of teacher-scholars, where teachers are experts in the area they teach” (p. 278). Because gifted learners crave depth, it is not surprising that effective teachers of gifted students possess extensive knowledge of their fields. Thus, content expertise seems to be a critical factor when choosing the gifted cluster teacher.

Summary

The cluster grouping model most closely aligns with the Twin Valley School District’s philosophy and is thoroughly supported by the research. Cluster grouping has been shown to have a positive effect on academic achievement, attitude towards subject matter, and motivation among gifted learners. However, the literature clearly shows that cluster grouping alone is not sufficient. Cluster grouping must be paired with proper instructional strategies to meet the needs of gifted learners. In addition, careful selection and support of the classroom teacher is critical for the success of the model.

“Although experts in gifted education widely promote cluster grouping gifted students, little empirical evidence is available attesting to its effectiveness” (Brulles et al, 2010, p. 327). Even fewer studies have examined the impact of performance-based cluster grouping (Rogers, 2006). The purpose of this action research project is to add to the surprisingly few research studies that have focused on the effectiveness of this organizational model. More specifically, performance-based cluster grouping was implemented at the secondary level in an 82-minute science block.
METHODOLOGY

Two concurrent sections of ninth grade Honors Physics were compared in this action research study. One section of Honors Physics received the intervention of performance-based cluster grouping with targeted instructional strategies and the other did not. Prior to the intervention, the cluster groups were determined, the cluster teacher was selected, and data collection methods were created. Administrative approval at the building and district levels was obtained to proceed with performance-based cluster grouping. Montana State University’s Institutional Review Board deemed this action research study as “exempt from the requirement of review” in accordance with the Code of Federal regulations, Part 46, section 101. See Appendix A.

Determination of Cluster Groups

To determine which students should be cluster grouped in Honors Physics, relevant and available standardized test data for the class of 2020 was analyzed. Specifically, student scores on the Pennsylvania System of School Assessment (PSSA) in seventh grade mathematics were examined. In addition, eighth grade teacher input was gathered. At the end of the 2015-2016 school year, math and science teachers were given a list of all students who registered for Honors Physics and asked to categorize each student whom they taught as exceptional, highly capable, average, or below average. Exceptional students in math were defined as those who “demonstrate rapid rates of acquisition and retention and very strong analytical thinking skills. They only need a couple repetitions to master a new skill. Often they are creative problem solvers.” Exceptional students in science were described as “highly insightful students who make
connections between concepts. They demonstrate rapid rates of acquisition and retention and very strong analytical thinking skills.” See Math Teacher Input Directions in Appendix B and Science Teacher Input Directions in Appendix C.

There were 11 students who were rated as “exceptional” by their math and/or science teacher and scored in the 95th percentile or above on the seventh grade math PSSA. As such, these 11 were recommended as candidates for performance-based cluster grouping in Honors Physics. The high school principal attempted to hand-schedule these top students into two cluster groups in the fall semester to allow them the option to accelerate in science during their freshman year. However, one of the 11 students withdrew from the Twin Valley School District and three others were unable to be scheduled into one of the two identified Honors Physics sections. There was a lopsided distribution of the remaining students; thus, only one section of Honors Physics contained a cluster group consisting of the minimum “critical mass” of five students.

Participants

The participants in this action research study were exclusively freshmen in the Twin Valley School District who had elected to take Honors Physics. The cluster class (N=26) was slightly larger than the non-cluster class (N=21). The vast majority of students in both classes identified as Caucasian. In addition, there was no significant difference in the composition of the classes in terms of gender or socioeconomic status. When the most recent standardized test data was compared for the two sections of Honors Physics, the cluster class out-performed the non-cluster class in both science and math, as illustrated by Figures 1 and 2.
As seen in Figure 1 above, 65.4% of the cluster class scored in the advanced bandwidth on the eighth grade Science PSSA, whereas only 42.9% of the non-cluster class scored within the same range. The average scale score for the cluster class (M=1516, SD=147.5) was higher than the non-cluster class (M=1448, SD=109.9) on the Science PSSA. This difference was not quite statistically significant, as determined by a two-tailed t test, t(45) = 1.7543, p = .0862.
As seen in Figure 2 above, 88.5% of the cluster class scored in the advanced bandwidth on the Algebra I Keystone Exam, whereas only 71.4% of the non-cluster class scored within the same range. On average the cluster class (M=1600, SD=64.9) scored higher than the non-cluster class (M=1572, SD=44.1) on the Algebra I Keystone exam. This difference was not quite statistically significant, t(45) = 1.6859, p = .0989.

Selection of Cluster Teacher

Having earned a Bachelor of Science in Physics and Secondary Education in 2004 and a Master of Science in Science Education in 2009, the selected cluster teacher is a content expert with 11 years of teaching experience. In addition to ninth grade Physics, he teaches calculus-based Advanced Placement Physics at TVHS. Although he has not received any formal training on gifted education, he is open to learning about and working with this special population.
Two concurrent sections of ninth grade Honors Physics were compared in this action research study. Both sections were taught by the same teacher to minimize instructional variability; however, one section received the intervention of performance-based cluster grouping with targeted instructional strategies and the other did not. Although the cluster group was in place for the whole semester, specific instructional strategies were only implemented during the Balanced Forces and Unbalanced Forces modeling cycles. Therefore, this four-week window will be referred to as the intervention time frame. Figure 3 below illustrates the semester timeline.

Figure 3. Semester timeline.

Purposeful homogeneous grouping within the class was implemented throughout the four-week intervention time period. Eighth grade standardized test scores in science and math were reviewed to confirm the students of the highest ability level. Current academic performance was also considered. On the first day of the intervention students’ assigned seats were changed to create homogeneous table groups, enabling students of similar ability levels to interact consistently. The rationale for grouping was not communicated to students. Students predominately worked with those in their table
group; however occasionally, the cluster teacher would group students differently for labs or classwork.

During the intervention time frame, the cluster teacher was asked to keep a daily log of grouping arrangements within the classroom (i.e. student choice, random, personality-based, heterogeneous, homogeneous, independent work). This log served as an accountability measure for the cluster teacher. See Grouping Arrangement Log in Appendix D.

The Most Difficult First (MDF) strategy was also used to differentiate materials for the top students. Together the cluster teacher and gifted support teacher reviewed the problem sets within the Balanced Forces and Unbalanced Forces Particle Model cycles. Problem sets with repetitive practice and that required a significant amount of class time were selected. A total of three problem sets were chosen. Within each of these problem sets, the cluster teacher identified the most difficult problems. The cluster teacher and gifted support teacher collaborated to locate or to create challenging and engaging replacement work.

Table 4

<table>
<thead>
<tr>
<th>Modeling Cycle</th>
<th>Regular Work</th>
<th>Replacement Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced Forces</td>
<td>Trigonometry Practice Problems</td>
<td>The Derby Car Challenge</td>
</tr>
<tr>
<td></td>
<td>Force Diagrams &amp; Statics</td>
<td>The Static Equilibrium Challenge</td>
</tr>
<tr>
<td>Unbalanced Forces</td>
<td>Kinematics and Newton’s Second Law</td>
<td>The Runaway Cart Challenge</td>
</tr>
</tbody>
</table>
For each challenge students were given a problem statement that required measurements and calculations and involved a hands-on component. For The Derby Car Challenge, students completed their calculations first and then set-up the equipment to scale. The classroom teacher and the gifted support teacher created this particular challenge. See The Derby Car Challenge in Appendix E. The other replacement work challenges were derived from the second edition of Practicums for Physics Teachers. For these challenges students were given the equipment set-up and asked to solve for a specified unknown quantity; to do so, they measured its parameters (i.e. angle, distance, height, mass) and then mathematically solved for the unknown (i.e. time). They then tested their prediction using the equipment set-up. If measurements and calculations were done correctly, students received immediate positive feedback by completing the challenge successfully.

The MDF strategy was carefully introduced to the students in the cluster class. Students were told they had the opportunity to demonstrate mastery of a particular skill with fewer repetitions by completing the most difficult practice problems first. Any student in the class who independently and successfully solved the identified problems within the designated timeframe would move on to more challenging replacement work. All other students would work through the regular work with peer and teacher support available.

On the three days that this instructional strategy was employed, the cluster teacher was asked to keep a log of students who attempted the most difficult problems first, as well as those who successfully completed the most difficult problems and moved on to
replacement work. See Most Difficult First Log in Appendix F. This log served as an accountability measure for the cluster teacher.

**Data Collection Measures**

A variety of data collection measures were utilized, including student surveys, summative assessments, and semi-structured interviews.

**Force Concept Inventory**

The Force Concept Inventory (FCI) was administered within the first week of the semester and then again during the last week of the semester to measure student conceptual understanding of force. Widely recognized by physics teachers, the FCI is a 30 question, multiple choice assessment that “requires a forced choice between Newtonian concepts and commonsense alternatives” (Hestenes, Wells, & Swackhamer, 1992, p. 2). The FCI’s questions cover six major Newtonian concepts, which correspond to six commonsense alternatives. “The Inventory…is not a test of intelligence; it is a probe of belief systems” (Hestenes, Wells, & Swackhamer, 1992, p. 2).

Lasry et al (2011) confirmed the FCI as internally consistent with scores on both halves highly correlated. In addition, “high test-retest reliability shows that FCI total score is a precise metric” (Lasry et al, 2011, p. 912). The test and retest, administered one week apart without any mechanics instruction, showed consistent scores (error of only 1.6%). However, despite the reliability of the total score, “individuals on average [changed] close to a third of their answers” (p. 910) between the initial test and the retest. Therefore, when analyzing FCI data, the focus should not be placed on individual questions, but rather on the total score. There are minimal concerns of a “ceiling effect”,
in which the top students’ growth is masked, as this same tool is administered to college students.

**Student Surveys**

Student surveys were created and administered using Google Forms. The top of each form featured the following disclaimer: “Participation in this survey is voluntary and participation or non-participation will not affect your grades or class standing in any way. Your email address will be recorded when you submit this form.”

All students in the control and intervention classes were asked to complete the Student Attitude and Confidence (SAC) survey before and after the Balanced Forces and Unbalanced Forces modeling cycles. Students were asked questions concerning their understanding of physics, confidence in specific skills, and perception of challenge. Other questions focused on the pace of the course and the grouping arrangements used during class. Most questions utilized multiple choice or a Likert scale with five choices, and two questions asked for open-ended written responses. See Student Attitude and Confidence Survey in Appendix G.

After the 4-week time period students in the cluster class completed a short survey about their perception of efficacy of the intervention. Students were asked to explain why they chose to attempt the most difficult problems first, or alternatively why they choose not to attempt the most difficult problems first. Students who successfully moved onto the challenges were asked to provide feedback on the replacement work. See Most Difficult First Survey in Appendix H.
Summative Assessments

Student scores for the summative assessments for the Balanced Forces and Unbalanced Forces modeling cycles were reviewed. The assessments consisted of multiple choice questions, short answer response, and calculations. Student performance on the assessments, in conjunction with their normalized gain on the FCI, was used to triangulate the data.

Student Interviews

Student interviews were conducted within the two weeks following the intervention time period to probe for richer qualitative data. A semi-structured format was used; several planned questions were asked, including specific and open-ended questions. See Student Interview Questions in Appendix I. Follow-up questions were asked based on the participants’ responses. Participants were encouraged to elaborate and to clarify their initial responses. Students in the cluster class were selected based on the frequency with which they attempted the most difficult problems first. Six Honors Physics students in the cluster class were interviewed, including two who always attempted the most difficult problems first, two who sometimes attempted the most difficult problems first, and two who never attempted the most difficult problems first.

Teacher Interview

After the intervention period the cluster teacher was interviewed at length about his perception of the efficacy of performance-based cluster grouping with targeted instructional strategies. Specifically, he was asked to comment on the effectiveness of the MDF strategy, as well as purposeful homogeneous grouping within the Honors Physics
class. Having implemented the intervention in only one of his two Honors Physics sections, he was asked to reflect on differences between the classes. See Teacher Interview Questions in Appendix J.

Table 5 depicts the different methods that were used to collect data on each action research question.

Table 5

<table>
<thead>
<tr>
<th>Data Triangulation Matrix</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action Research Question</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How do the classroom teacher and the students perceive the effectiveness of homogeneous grouping and the Most Difficult First strategy?</td>
<td>Most Difficult First Student Survey</td>
<td>Semi-Structured Student Interviews</td>
<td>Semi-Structured Teacher Interview</td>
</tr>
<tr>
<td>How does performance-based cluster grouping affect students’ confidence and perception of challenge in ninth grade Honors physics?</td>
<td>Student Attitude and Confidence Survey Initial</td>
<td>Student Attitude and Confidence Survey Final</td>
<td>Semi-Structured Student Interviews</td>
</tr>
<tr>
<td>How does performance-based cluster grouping affect students’ conceptual understanding of Newtonian mechanics in ninth grade Honors Physics?</td>
<td>Force Concept Inventory Pre-Test</td>
<td>Force Concept Inventory Post-Test</td>
<td>Summative Assessments</td>
</tr>
</tbody>
</table>

DATA AND ANALYSIS

The results of the Student Attitude and Confidence Survey, the Force Concept Inventory, and the Most Difficult First Survey were analyzed using Microsoft Excel. Typed notes were taken during the student and teacher interviews and later examined for common themes.

Perception of Homogeneous Grouping

The Student Attitude and Confidence Survey included questions about preferred grouping arrangements in the classroom setting. Students were prompted to reflect on
grouping arrangements that are “the most beneficial to your learning.” There was no significant difference between the non-cluster and cluster classes regarding preferred grouping arrangement. The majority of students in both Honors Physics classes (69.8%, N=30) reported that they prefer working with peers of similar ability level, while 27.9% (N=12) of students reported that working with peers of higher ability level is the most beneficial to their learning. Only one out of 43 students (2.3%) preferred working with peers of lower ability levels. Figure 4 illustrates students’ preferred grouping arrangement.

![Figure 4. Preferred grouping arrangement: peer ability level, (N=43).](image)

The students who were interviewed were asked to elaborate on the grouping preference they indicated on the SAC survey. One student commented, “I get frustrated very easily by people who slow me down. I prefer to work by myself but I also enjoy working with a partner of a similar ability level. You have someone to check your work with.” A second student explained, “If I need help, it is easier to ask someone who is on the same skill level. You can move at the same pace so you are not leaving anyone behind.” A third student expressed that her preference was split between working with a
peer of similar ability level and one of a higher ability level. “It depends on the person. If they are at a higher level and fly through the material and don’t communicate well, then I don’t want to work with them.”

In the semi-structured interview, the cluster teacher was asked to comment on the effectiveness of homogeneous grouping. He responded,

In heterogeneous grouping, there was a leader, and the group deferred to the leader. But with the homogeneous grouping there was more of a conversation going on, which benefited everyone in the group. There was a more even distribution of the workload. Occasionally, homogeneous grouping would lead to a conceptual debate. Also, from a teaching standpoint it was easier to differentiate when students were grouped homogeneously. I could assign the higher level group the more challenging math problem for whiteboarding or the more difficult variable to solve for in the lab. And I was able to target those groups more who I presumed would need the additional support. The weaker homogeneous groups were still able to move at an appropriate pace for an honors class and ultimately achieved the expected level of competency on the content.

Perception of the Most Difficult First Strategy

To assess student attitude towards the Most Difficult First strategy, the following Likert scale question was included in the Most Difficult First Survey: “I like the option of being given the most difficult problems first.” Students chose one of five responses, ranging from strongly disagree to strongly agree. In the cluster class 48% (N=12) of students appreciated the opportunity to complete the most difficult problems first. Only four students (16%) reported that they did not like being given the option to do the most difficult problems first. See Figure 5.
Additionally, the six students who were interviewed, including those who never attempted the most difficult problems first, all agreed that the MDF option should be offered in Honors Physics again next year. The two students who were interviewed and did not attempt the MDF were asked to explain why they felt the option should continue to be offered. One replied, “Some people are farther along than others in the class and they should be able to do the harder problems if they want to.” The other student echoed this sentiment, “I definitely think [the MDF] should be offered. If I thought ‘okay I get this,’ I wouldn’t want to keep doing the same problems over and over again.” Both of the students who never attempted the MDF, showed a surprising empathy for their classmates who did.

When asked if they had anything else to say about the MDF option, four of the six students who were interviewed suggested that more opportunities to complete the most difficult problems first be offered throughout the semester. This common suggestion reinforces the largely positive student attitude towards the most difficult problems first.
One student reflected, “I liked how [the teacher] didn’t single out who he thought should try the most difficult problems first. He gave the option to everyone.”

The Most Difficult First Survey included a close-ended question that asked how often students chose to attempt the most difficult problems first. Student responses were verified using the Most Difficult First Log that the teacher completed. In the cluster class 64.0% of students (N=16) attempted the most difficult problems first at least once, of which 36.0% (N=9) always chose to attempt the most difficult problems first. As seen in Table 6, the most common reasons that students gave for attempting the most difficult problems first were to challenge themselves and to gauge the level of their understanding.

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>To gauge level of understanding</td>
<td>6</td>
</tr>
<tr>
<td>Desire for a challenge</td>
<td>6</td>
</tr>
<tr>
<td>Felt confident</td>
<td>2</td>
</tr>
<tr>
<td>Because the replacement work involved a hands-on component</td>
<td>1</td>
</tr>
<tr>
<td>To test out of easier problems</td>
<td>1</td>
</tr>
</tbody>
</table>

Of those that attempted the most difficult problems first, 62.5% (N=10) were successful in demonstrating mastery for at least one attempt and moved on to replacement work. When asked to comment on the replacement work, one of the top students appreciated that “we were able to move on and not be held back by the remainder of the class.” Another student affirmed this viewpoint, stating, “You can work at your own pace and if you get done faster than others you can move on.” A third student commented, “I liked that [the replacement work] was a little challenging and required thinking outside of the box. I also liked that it was mostly hands-on.” When
asked to clarify what aspect of the replacement work was the most challenging, the student responded, “When we had to figure out how to apply what we were learning in class to the situation that we were given.”

Of those that attempted the most difficult problems first, 37.5% (N=6) were not successful in demonstrating mastery for at least one attempt. These students were instructed to complete the regular work in its entirety. The cluster teacher explained, “Few of the weaker students who attempted the most difficult first were successful but they seemed okay with the opportunity to try and then slow down and work through the whole assignment once they realized they needed more practice.”

In the cluster class 36.0% (N=9) did not attempt the most difficult problems first. The SAC survey included an open-ended question that asked these students to explain why. The most common reason that students gave for not attempting the most difficult problems first was a lack of confidence or understanding. One student wrote, “I felt that even if I knew how to do the problem, I felt like I needed more practice. Just to reassure that I knew how to do it and how good I am at it so I don’t forget how to do it.”

The reasons for why students did not attempt the most difficult problems are displayed in Table 7 below.

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of confidence / understanding</td>
<td>4</td>
</tr>
<tr>
<td>Prefer to do problems in order / Prefer to do easier problems first</td>
<td>2</td>
</tr>
<tr>
<td>Need more practice to fully understand</td>
<td>2</td>
</tr>
<tr>
<td>Fear of failure</td>
<td>1</td>
</tr>
</tbody>
</table>
The two students who were interviewed were asked to elaborate on why they did not attempt the most difficult problems first. The first student explained, “I felt like I wouldn’t understand it. So I wanted to do the stuff we were given first. If I would have understood the problems, then I would have done the MDF.” The second student said, “I wanted more practice. I wanted to understand it more. It took me longer to understand the new problems. I wanted a better foundation before moving on to the hardest problems.” The cluster teacher added, “It was interesting to see how many students (cluster students included) chose not to attempt the most difficult first because they simply wanted to spend their class time working on more practice problems. I think it demonstrated good self-awareness and responsibility.”

Performance and the Most Difficult First Strategy

Students who always attempted the most difficult problems first performed better on summative assessments (M = 90.1%, SD = 13.0) than those who did not attempt the most difficult problems first (M = 81.1%, SD = 6.7). See Figure 6 below. With the relatively small sample size, this difference was not quite statistically significant, $t(16)=1.8462, p=0.0835$. 
Figure 6. Average test performance by frequency of attempting most difficult first.

Student responses were numerically coded according to how often students attempted the most difficult problems first: Always (2), Sometimes (1), and Never (0). Pearson's correlation coefficient (r) was calculated to measure the strength of the linear association between the two variables. A strong positive correlation (r=0.99) was observed between how often students opted to try the most difficult problems first and how well they performed on their summative assessments.

Confidence

Students’ confidence in their math ability improved for the cluster class, whereas it declined for the non-cluster class. More specifically, after the four-week intervention two (8.7%) more students in the cluster class agreed with the statement, “Math comes easily to me,” while three (15.0%) fewer students in the non-cluster class agreed with the same statement. Students were also asked to rate their confidence in solving math-based physics problems, with one being “not confident” and five being “very confident.” After
the intervention four (17.4%) more students in the cluster class rated their confidence as a four or a five, compared to only one (5.0%) more student in the non-cluster class.

Students were also asked how many repetitions they needed in order to feel confident solving a new type of problem. In the cluster class four (17.4%) more students reported that they needed five or less repetitions after the four-week intervention, compared to three (15.0%) fewer students in the non-cluster class after the same time period. See Table 8 below.

Table 8  
**Change in Confidence in Math Ability**

<table>
<thead>
<tr>
<th>Confidence Indicator</th>
<th>Change in Non-Cluster Class</th>
<th>Change in Cluster Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreed or strongly agreed with statement, “Math comes easily to me.”</td>
<td>15.0%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Confident or very confident in solving math-based physics problems</td>
<td>5.0%</td>
<td>17.4%</td>
</tr>
<tr>
<td>Confident in solving a new type of problem with 5 or less practice problems</td>
<td>15.0%</td>
<td>17.4%</td>
</tr>
</tbody>
</table>

The cluster teacher affirmed that the MDF strategy positively affected student confidence in the cluster class, stating,

The kids who successfully completed the replacement work certainly got a sense of accomplishment. And I don’t think it was detrimental to the kids who attempted the most difficult problems first but failed. Generally, the students who failed acknowledged they weren’t ready [for the more challenging problems] yet.

**Perception of Challenge**

To assess their perception of challenge, the SAC Survey asked students to select their degree of agreement with the statement, “The math problems in the Honors Physics course are challenging.” Interestingly, three (13.0%) fewer students in the cluster class
agreed with the statement after the intervention, while two (10.0%) more students in the non-cluster class agreed after the same time period. After the intervention seven (30.4%) more students in the cluster class did not view the math problems as challenging. This difference included a 17.4% ($N = 4$) shift from neutral responses to disagree or strongly disagree. See Figure 7 below.

*Figure 7. Perception of mathematical challenge.*

Interviewed students were asked to elaborate on what aspect of the course was the most challenging. Four of the six students who were interviewed agreed that the concepts were more challenging than the math. Interestingly, the two students who were interviewed that cited the math-based problems as the hardest aspect of the course did not choose to attempt the most difficult problems first.

The SAC survey also included questions about the pace of the Honors Physics course. Students rated their level of agreement with the statement, “Too much time in the Honors Physics course is spent reviewing,” by choosing one of five responses. Student
responses were numerically coded: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). The average score for the non-cluster class and cluster class before and after the four-week intervention timeframe was then calculated. The initial average score in the cluster class increased slightly from 2.04 (SD = 1.11) to 2.26 (SD = 1.14). However, the average score in the non-cluster class started at 2.25 (SD = 0.85) and increased to 2.70 (SD = 0.98). More specifically, five students in the non-cluster class who disagreed or strongly disagreed with the statement initially, changed their responses to neutral after the four-week time period. Thus, a notable shift in the frequency of responses in the non-cluster class was observed. See Figure 8 below.

Figure 8. Perception of pace of course.

Conceptual Understanding of Newtonian Mechanics

Historical FCI data from the 2014-2015 and 2015-2016 school years was reviewed. In total, data was available for four class sections of Honors Physics taught by the selected cluster teacher (N=87 students). The FCI was administered within the first
week of the semester and then again during the last week of the semester. The average normalized gain (G) was then calculated for each individual student and each class section using the following equation:

\[ G = \frac{\text{postscore} \% - \text{pre} \%}{100 - \text{pre} \%} \]

Students who did not take the FCI at both the beginning and end of the semester were excluded from the historical data analysis, since an average normalized gain could not be calculated. Although it is possible that a section contained an accidental (non-intentional) cluster, they did not receive purposeful differentiation. The historical mean normalized gain was 29.84, SD=19.95. The average normalized gain for the cluster class (M=31.16, SD=17.62) was slightly above than the historical G, whereas the average normalized gain for the non-cluster class (M=27.05, SD=18.94) was slightly below the historical G. Thus, there was no apparent effect on student’s conceptual understanding, as measured by the Force Concept Inventory.

In addition, students were asked to rate their level of agreement with the statement, “I almost always understand what we are doing in Honors Physics class.” The average score for the non-cluster class remained the same after the four-week time period (M=3.2); however, the average score for the cluster class increased slightly from 2.96 (SD=1.07) to 3.13 (SD=1.01) after the intervention. This difference was not statistically significant, t(44) = 0.5541, p = 0.5823.

However, within the most advanced table groups, the cluster teacher reported that the conversations were more in-depth; students were asking higher level questions and making interdisciplinary connections. According to the cluster teacher, the weaker
homogeneous groups in the cluster class and the heterogeneous groups in the non-cluster class engaged in discussions that were typical of an Honors freshman class. “The kids were conversing about the content, trying to make sense of it, but there was not significant extension or those “what if” scenarios.”

When asked what other differences he noticed between the cluster and non-cluster class, the teacher commented,

A lot of it was the intangibles. There was a more serious tone to the [cluster] class. Discussions were higher level and typically stayed on-topic. It wasn’t acceptable in the cluster class to complain about the work. The other students didn’t encourage or reinforce the complaints. The standard was kept a little higher.

**INTERPRETATION AND CONCLUSION**

This action research project focused on the effectiveness of performance-based cluster grouping within the context of the 82-minute science block. Surprisingly few research studies have explored the effectiveness of this particular model, especially at the secondary level. The four-week intervention included homogeneous grouping by table, along with opportunities to complete the most difficult problems first.

The results of this action research project highlighted the importance of incorporating purposeful homogeneous grouping into the regular classroom setting. Even within an Honors level course, there is a wide range in ability levels. The majority of students surveyed recognize that they learn best when working with peers of a similar ability level. During the individual interviews, students were able to articulate why they preferred to work with peers of similar ability levels. This result surprised the cluster teacher, who prior to the action research project was not utilizing homogeneous grouping.
Within the homogeneous groups, the cluster teacher observed a more even distribution of the workload and more in-depth conversations among the top students. In his individual interview, the cluster teacher explained a shift in his attitude towards grouping, commenting, “Previously, I was passive about group selection and would group students heterogeneously or randomly. But now I realize that not actively thinking about how you are grouping students is doing a disservice to the high achieving kids.”

In addition, the cluster teacher and the majority of students embraced the MDF strategy. The top performers valued the opportunity to work at their own pace and to test their knowledge and skills. The teacher noted a competitive atmosphere when the MDF option was offered, supporting Brulles and Winebrenner’s (2011) claim that gifted students are more likely to challenge themselves when they are surrounded by intellectual peers. Even those students who never attempted the most difficult problems first displayed empathy for their peers who work at a faster pace. The cluster teacher acknowledged the instructional benefits and affirmed that he would use this strategy for differentiation with his future Honors Physics classes.

On one hand, this action research project provides some evidence that the MDF strategy may have positively affected student confidence in their math ability. On the other hand, the findings of this study suggest that students in the cluster class perceived the Honors Physics class as less challenging after the intervention time period. It is possible that these two findings are linked. Buoyed by their success with the most difficult problems first and the replacement work, students may have perceived the regular work to be less challenging. Alternatively, it is possible that class differences in
math ability, as indicated by standardized test performance, led to differences in math confidence. The complex relationship among the MDF strategy, student confidence in their math ability, and their perception of challenge deserves further research attention.

One of the most compelling findings of this action research study is that students who always attempted the most difficult problems first performed better on summative assessments ($M = 90.1\%, \ SD = 13.0$) than those who did not attempt the most difficult problems first ($M = 81.1\%, \ SD = 6.7$). Although this difference was not quite statistically significant, a strong positive correlation ($r=0.99$) was observed between how often students opted to try the most difficult problems first and how well they performed on their summative assessments. Most likely, this trend can be attributed to self-selection. Students who felt competent with the material were more likely to attempt the most difficult problems first, whereas those who did not understand the teacher’s examples were not likely to try the most difficult problems first. In the SAC survey students primarily cited a lack of confidence or understanding as the reason for not attempting the most difficult problems first. This finding suggests that the students exercised good judgement when choosing whether or not to attempt the MDF.

Limitations of the study include a relatively small sample size ($N=46$). Also, there are inherent differences between the personalities of individuals in the classes that cannot be controlled. The class dynamics may have affected how the cluster class received the intervention. A further limitation was the difference in the time of day; the non-cluster class met during second block (9:14am-10:41am), whereas the cluster class met at the end of the school day (1:30pm – 2:51pm). Student-athletes often leave fourth block early
to attend games and competitions. Thus, they may have received less instructional time than their second block counterparts. Furthermore, I have personally found that students are least attentive at the end of the school day during fourth block. Overall, the difference in time of day may have led to instructional disparities.

VALUE

This action research study demonstrated how the MDF strategy could be an effective tool to promote student engagement. Students were able to work at their own pace and readiness level. The hands-on replacement work provided an incentive for students to attempt the most difficult problems first, and thereby, to apply their knowledge and to test their understanding. Simultaneously, students completing the regular work received additional teacher support without negatively impacting the brightest and most motivated learners.

With future classes, the cluster teacher expressed that he would like to offer the Most Difficult First option more consistently throughout the semester (or once per modeling cycle). To do so effectively, we would need to add extra practice problems to the Honors Physics packets. Currently, some of the problem sets do not contain enough practice problems to warrant the Most Difficult First option. Inserting additional practice problems would help those students who need repetition and reinforcement, while providing time for the most advanced students to deepen their understanding through more challenging replacement work. We plan to develop additional resources for the most advanced learners in the freshmen Honors Physics classes next school year.
Additionally, we agreed that homogeneous grouping should not be the sole grouping arrangement in the classroom setting. Prolonged homogeneous grouping may promote arrogance among the brightest students (Fiedler et al, 2002) and may damage the confidence and self-esteem of the weaker students. Different grouping arrangements serve different functions, and thus, are equally important in the classroom setting. With future classes we would prioritize thoughtfully selecting the grouping arrangement based on the assignment.

Like most teachers at TVHS, the cluster teacher has not taken undergraduate or graduate courses in gifted education. The action research process empowered the cluster teacher with an increased awareness of the needs of gifted learners and specific ways to accommodate their needs in the regular classroom setting. In the words of the cluster teacher, “The big takeaway for me was to be more cognizant of the high achievers in these Honors classes. Usually you take them for granted because they don’t make a lot of noise. I need to cater more to [the higher level kids] and their needs.” At the building level, professional development opportunities in gifted education should be offered for teachers, especially those who teach freshmen and sophomores. It is imperative that teachers not only understand the unique characteristics of gifted learners but also walk away with specific strategies that can be immediately implemented in the classroom setting. It is also important that classroom teachers feel supported as they attempt to incorporate some of the more time-consuming instructional strategies into their teaching repertoire. Ample time should be given for teachers to reflect on their current curricula
with the brightest and most motivated students in mind and to make changes where appropriate.

Personally, I found the action research process to be extremely valuable. This project provided the impetus I needed to start collaborating more with classroom teachers at Twin Valley High School. Having transitioned to the role of gifted support teacher four years ago, I have attended various professional conferences on the instructional strategies that can be employed to meet the needs of the most advanced learners but have not formally shared that knowledge with my colleagues. Moving forward, there is a need for many more honest, purposeful conversations about the unique learning needs of gifted students and the ways that we, as educators, can better serve these students.


APPENDICES
APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL
INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY
960 Technology Blvd. Room 127
E/O Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4301
E-mail: cheryl@montana.edu

MEMORANDUM

TO: Jessica Christman and Eric Brunsell
FROM: Mark Quinn
DATE: October 12, 2016
SUBJECT: “Performance-Based Cluster Grouping in Ninth Grade Honors Physics” [JC101216-EX]

The above research, described in your submission of October 12, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

(b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

(b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

(b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
APPENDIX B

MATH TEACHER INPUT DIRECTIONS
8th Grade Math Teachers,  

Thursday, June 2nd, 2016

The attached list consists of those students who signed up for Honors Physics next year. Your feedback is needed to help ensure that students are appropriately grouped within the Honors level classes.

Please place each of the students you taught during this school year into one of the following categories in terms of their academic aptitude and performance in mathematics:

- **Group 1, Exceptional.** These students demonstrate rapid rates of acquisition and retention and very strong analytical thinking skills. They only need a couple repetitions to master a new skill. Often they are creative problem solvers.

- **Group 2, High Achieving.** These students are highly competent and productive, are working to the fullest extent of their abilities, but are not exceptional.

- **Group 3, Average.** These students achieve in the middle range when compared to others in their grade level.

- **Group 4, Below Average.** These students may struggle and score slightly below grade level but can achieve at grade level with some support.

On the attached list, write the appropriate group number next to the name for each student whom you taught. This information will be kept confidential and will not be shared with parents. Your feedback, as well as PSSA test scores, will be taken into account during the scheduling process for Honors Physics.

Please return the attached list to Barb Lussier in Rm 115 by Thursday, June 9th, 2016.

Thank you for your time!

Sincerely,

Jessica Christman, TVHS Gifted Support Teacher
Barb Lussier, TVMS Gifted Support Teacher
APPENDIX C

SCIENCE TEACHER INPUT DIRECTIONS
The attached list consists of those students who signed up for Honors Physics next year. Your feedback is needed to help ensure that students are appropriately grouped within the Honors level classes.

Please place each of the students you taught during this school year into one of the following categories in terms of their academic aptitude and performance in science:

- **Group 1, Exceptional.** These students are highly insightful and make connections between concepts. They demonstrate rapid rates of acquisition and retention and very strong analytical thinking skills.

- **Group 2, High Achieving.** These students are highly competent and productive, are working to the fullest extent of their abilities, but are not exceptional.

- **Group 3, Average.** These students achieve in the middle range when compared to others in their grade level.

- **Group 4, Below Average.** These students may struggle and score slightly below grade level but can achieve at grade level with some support.

On the attached list, write the appropriate group number next to the name for each student whom you taught. This information will be kept confidential and will not be shared with parents. Your feedback, as well as PSSA test scores, will be taken into account during the scheduling process for Honors Physics.

Please return the attached list to Barb Lussier in Rm 115 by Thursday, June 9th, 2016.

Thank you for your time!

Sincerely,

Jessica Christman, TVHS Gifted Support Teacher
Barb Lussier, TVMS Gifted Support Teacher
APPENDIX D

GROUPING ARRANGEMENT LOG
Directions: Complete this log for each school day during the Balanced Forces and Unbalanced Forces modeling cycles. Use the codes below:

**Grouping Arrangement Codes:**
- **SC** = student choice
- **R** = random
- **Per** = personality-based
- **Hom** = homogeneous (similar abilities)
- **Het** = heterogenous (different abilities)
- **Ind** = independent work

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity Description</th>
<th>Grouping Arrangement</th>
<th># of Students per Group</th>
<th>Activity Time (min)</th>
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APPENDIX E

THE DERBY CAR CHALLENGE
The Derby Car Challenge
(Replacement Work)

Problem Statement:
A derby car is released from the top of a linear track with a 7% grade. Draw a diagram below. Determine the angle of elevation from the bottom of the track. If the vertical distance is 5 meters, what is the length of the track?

Equipment and Set-up:
- Adjustable ramp
- Timer/watch
- Car
- Protractor

Set-up the available equipment so that it represents the above situation to scale. (1m : 1cm)

Measurements:
Measure the time it takes for the car to reach the bottom of the track. Conduct 3 trials. Present your data in table format.

Calculations:
Find the average time it takes for the car to reach the bottom of the track. Then use the kinematics equations to determine the acceleration of the car.

When finished ask teacher to check your work
APPENDIX F

MOST DIFFICULT FIRST LOG
**Most Difficult First Log**

*Cluster Class*

**Directions:** Complete this log for each school day that the Most Difficult First strategy is offered during the Balanced Forces and Unbalanced Forces modeling cycles. Use the codes below:

- **Abs** = student absent when offered
- **Att** = student attempted, but not successfully
- **NA** = student did not attempt
- **Suc** = student successfully completed

<table>
<thead>
<tr>
<th>Student Initials</th>
<th>The Skateboard Challenge</th>
<th>The Static Equilibrium Challenge</th>
<th>The Runaway Cart Challenge</th>
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APPENDIX G

STUDENT ATTITUDE AND CONFIDENCE SURVEY
Background Information
Participation in this survey is voluntary and participation or non-participation will not affect your grades or class standing in any way.
Your email address will be recorded when you submit this form. * Required

1. In terms of work ethic, how would you describe yourself? * Mark only one oval.
   - When given a task, I like to get it done, but more importantly, I like to get it done well. I almost always check my work.
   - When given a task, I like to get it done as quickly as possible. I usually don't check my work.
   - It may take me a while to get started when given a task, but I will eventually get it done.
   - I have difficulty focusing when given a task. Sometimes I don't finish my assignments.

2. Math comes easily to me. * Mark only one oval.
   - 1  2  3  4  5
   - strongly disagree
   - strongly agree

3. In order to feel confident in solving a new type of problem, how many practice problems do you typically need to do? * Mark only one oval.
   - 1-2
   - 3-5
   - 6-8
   - 8-10

   Attitude
4. I find science interesting and enjoy learning about it. * Mark only one oval.
   - 1  2  3  4  5
   - strongly disagree
   - strongly agree

5. In general, how would you describe your attitude towards science? * Mark only one oval.
   - negative
   - neutral
   - positive

6. I like science labs. * Mark only one oval.
   - 1  2  3  4  5
   - strongly disagree
   - strongly agree

7. I find physics interesting and enjoy learning about it. * Mark only one oval.
   - 1  2  3  4  5
   - strongly disagree
   - strongly agree

8. So far what have you enjoyed most about Honors Physics class? Be as specific as possible. *
Knowledge and Skills

9. I almost always understand what we are doing in physics class. * Mark only one oval.

   1   2   3   4   5
   strongly disagree  o  o  o  o  o  strongly agree

10. I wish that we would go in greater depth in certain physics topics. * Mark only one oval.

   1   2   3   4   5
   strongly disagree  o  o  o  o  o  strongly agree

11. How would you rate your confidence in drawing force diagrams? * Mark only one oval.

   1   2   3   4   5
   Not confident  o  o  o  o  o  Very confident

12. How would you rate your confidence in solving math-based physics problems? * Mark only one oval.

   1   2   3   4   5
   Not confident  o  o  o  o  o  Very confident

13. How would you rate your confidence in answering concept-based physics questions? * Mark only one oval.

   1   2   3   4   5
   Not confident  o  o  o  o  o  Very confident

Pace

14. The Honors Physics course moves too fast. * Mark only one oval.

   1   2   3   4   5
   strongly disagree  o  o  o  o  o  strongly agree

15. I wish the teacher would go over more example problems before we practice on our own. * Mark only one oval.

   1   2   3   4   5
   Strongly disagree  o  o  o  o  o  Strongly agree

16. On a typical weekday how much time outside of class did you spend on Honors Physics homework? * Mark only one oval.
0-4 min
5-19 min
20-39 min
40-59 min
60+ min

17. How often did you have to wait for your physics classmates to catch up to you? *
Mark only one oval.
Never
Rarely
Sometimes
Often
Daily

18. Whiteboarding in the Honors Physics course is a productive use of class time. *
Mark only one oval.

19. Too much time in the Honors Physics class is spent reviewing. *
Mark only one oval.

20. Which of the following grouping arrangements do you find the most beneficial to your learning? *
Mark only one oval.
working with peers of higher ability levels
working with peers of similar ability levels
working with peers of lower ability levels

21. Which of the following grouping arrangements do you find the most beneficial to your learning? *
Mark only one oval.
working independently
working with 1 partner
working with a small group

22. I often feel frustrated with the grouping arrangements in physics class. *
Mark only one oval.

23. The math problems in the Honors Physics course are challenging. *
Mark only one oval.
24. When did you start studying for the most recent Honors Physics test? * Mark only one oval.
   ○ I didn't study
   ○ The day before
   ○ 2-3 days before
   ○ The week before

25. So far what has challenged you the most about Honors Physics class?
   Be as specific as possible. *
APPENDIX H

MOST DIFFICULT FIRST SURVEY
Participation in this survey is voluntary and participation or non-participation will not affect your grades or class standing in any way.
Your email address will be recorded when you submit this form. * Required

1. When presented with the option to do the Most Difficult problems first... * Mark only one oval.
   - I did not attempt the Most Difficult problems first.
   - I sometimes attempted the Most Difficult problems first. Skip to question 3.
   - I always attempted the Most Difficult problems first. Skip to question 3.

   Did  ○  Not Attempt

   2. Why didn't you choose to attempt the Most Difficult Problems first? * Skip to question 7.
      
      ……………………………………………………….
      ……………………………………………………….
      ……………………………………………………….

   Attempted

   3. Why did you choose to attempt the Most Difficult Problems first? *
      
      ……………………………………………………….
      ……………………………………………………….
      ……………………………………………………….

   4. Were you successful in demonstrating mastery for at least one of your attempts? (In other words, did you move on to the replacement work?) * Mark only one oval.
      - Yes
      - No Skip to question 7.

   Replacement Work

   5. What did you enjoy the most about the Most Difficult First replacement work? Be as specific as possible. *
      
      ……………………………………………………….
      ……………………………………………………….
      ……………………………………………………….

   6. What challenged you the most about the Most Difficult First replacement work? Be as specific as possible. *
      
      ……………………………………………………….
      ……………………………………………………….
      ……………………………………………………….
Final Questions

7. I like being given the option to do the Most Difficult problems first and to move on to more challenging replacement work. * Mark only one oval.

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<td>1</td>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>Strongly agree</td>
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8. Are there any additional comments you would like to make about the Most Difficult First option? *

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........................................................................................................
APPENDIX I

STUDENT INTERVIEW QUESTIONS
Introduction:
“I am going to ask you a few questions about your Honors Physics class and the Most Difficult First option that was recently offered. Please be honest and open with me. Your responses will not affect your grade or class standing in any way. My goal is to understand what worked well and what could be improved about the Most Difficult First option.”

1. In your own words would you explain the most difficult first option to me?

2. Whenever the most difficult first option was offered to the class, how did you feel?

3. In the Google form that you filled out, you indicated that you always/sometimes/never chose to attempt the MDF. Why?

4. How could we improve the replacement work that was offered?

5. Should we offer MDF as an option to Honors Physics students next year?

6. Is there anything else you would like to say about the Most Difficult First option?

7. Have you felt challenged in Honors Physics this semester? What aspect of the course has challenged you the most? (i.e. concepts, math-based problems, graph interpretation)

8. In the Google form that you filled out, you said that you prefer working with peers of a lower/similar/higher ability level. Would you explain why?
APPENDIX J

TEACHER INTERVIEW QUESTIONS
1. Did it seem as though the “right” students were identified for the performance-based cluster?

2. What differences did you notice between your cluster and non-cluster classes?

3. What differences did you observe between your cluster and non-cluster classes on the specific days that the MDF option was offered?

4. Will you use the Most Difficult First strategy with future classes? Why or why not?

5. How would you change your implementation of the MDF strategy with future classes?

6. Were you surprised by the students who elected to try the Most Difficult problems first?

7. Do you think that the MDF strategy affected student confidence?

8. Will you group students homogeneously in future classes? Why or why not?

9. How would you change your implementation of homogeneous grouping with future classes?

10. How did student interactions during homogeneous grouping compare to those during heterogeneous grouping?

11. How did homogeneous grouping affect students’ confidence in ninth grade Honors physics?

12. What differences did you notice between your cluster and non-cluster classes in terms of students’ conceptual understanding of Newtonian mechanics?

13. As a teacher, what did you learn throughout this process?