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# Using Pre-Assessments to Make Decisions about Differentiation in a Detracked High School Biology Classroom

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## Abstract

*This article describes how one teacher used practitioner research to study the role that pre-assessment played when making decisions about student grouping and differentiated instruction within a detracked, honors biology classroom. Much detail is provided in this article describing the study design around a unit on protein synthesis and the steps taken in data analyses to contextualize this study within a practitioner research methodology. The teacher discusses her findings using a claim, evidence, and reasoning framework common in scientific inquiry to illustrate the effectiveness of using pre-assessment to group students for tiered instruction.*

Within my public high school, as of 2013, every ninth grade student takes honors biology. It is common for other secondary schools to engage in academic tracking, placing students into separate, leveled classes based on standardized test scores, IQ measurements, perceived academic ability, prior classroom achievement, and teacher recommendations about student academic potential, motivation, and work ethic (Burris & Garrity, 2008; NASSP, 2006; Oakes, 2005; Tyson, 2013). Several scholars assert that academic tracking reproduces the social and cultural stratification that exists in society (Biafora & Ansalone, 2008; Burris, 2014; Chmielewski, 2014; Fiel, 2013; Oakes, 2005; Tyson, 2013).

Prior to the elimination of academic tracking, we offered two academic tracks in science at my school—honors and general—corresponding with previous standardized test scores in science and reading and achievement in middle school science and math courses. Students enrolled in the honors track took honors biology in their 9<sup>th</sup> grade year, while students enrolled in the general track did not take general biology until their 10<sup>th</sup> grade year. During the 2011-2012 academic year, our state began to administer a state-made, standardized end of course (EOC) exam for all students enrolled in biology. Based on field test results, the curriculum I enacted in the honors level biology course prepared students better for the Biology EOC exam than the curriculum I enacted in the general level biology course. Although 82% of the students enrolled in honors biology passed the Biology EOC exam, only 61% of the students enrolled in general biology passed this standardized achievement test. Even though the percent of students passing the Biology EOC exam in the second year (2012-2013) improved significantly, the pass rate for my students enrolled in general level biology was 85%, which was still considerably lower than the 100% pass rate for my students enrolled in honors level biology. Because of these results, I

proposed to my principal and director that our school eliminate tracking in science for incoming ninth graders beginning in the 2013-2014 school year and instead, enroll every ninth grader in honors level biology. I proposed that we maintain the honors level track for two reasons. First, students who take honors level courses receive a slight increase in their grade point average which is a critical component that college admission's departments consider. Second, of the two tracks, the honors track was more academically rigorous and the better choice of curriculum to provide to all students. Following this change in enrollment practice, my student pass rate on the Biology End of Course Exam (EOC) was 95%. Although extremely pleased with the success of my students following the elimination of academic tracking, upon disaggregation of the data I was disturbed by the picture that emerged. Of the six students who did not pass the exam, all were minority students, and five of these six students were males. Additionally, many of my high achieving students were not scoring at the highest level on this exam, particularly my high achieving females. Although the literature suggests that differences in scores on standardized tests may be a result of cultural biases inherent in the language of test questions (Grotsky, Warren, & Felts, 2014) in addition to the practice of eliminating questions that indicate mastery but do not show differences in student responses (Dalal & Gunderman, 2011; Oakes, 2005), these data still made me question if my instruction was meeting the learning needs of either my students who struggled or my learners who excelled in biology.

Although the larger problem of practice that exists in most American high schools is academic tracking, eliminating this practice results in the emergence of an underlying problem of practice: meeting the learning needs of an increasingly diverse student population. Even though I had established that the elimination of tracking was a much more equitable practice to implement in high school biology, I knew that my next step in making learning more equitable for all of my students was finding ways to address the increase in learner diversity within my detracked course. Thus, the purpose of this study was to examine how formative assessment within the act of teaching could foster decisions about differentiation and grouping for differentiation in order to address an increase in learner variability within my detracked, honors biology classroom. The research question that guided this study was, "*What role can formative assessment play when making decisions about student grouping and differentiated instruction within a detracked, honors biology classroom?*"

One particular type of formative assessment that teachers use is pre-assessment. According to Lazarowitz and Lieb (2006), pre-assessment is a test administered before instruction is given within a unit to ascertain what prior knowledge students may have related to the content of the unit. The purpose of

pre-assessment is to use the results to modify the instruction within the unit based on the varying learning needs of students (Lazarowitz & Lieb, 2006). In this paper, I report the results of my study related to pre-assessments. Additional results can be found in the complete accounting of the larger practitioner research study within which the work reported here is situated (MacDonald, 2016). To contextualize my discussion of pre-assessment, I begin with a brief review of literature related to academic tracking, differentiation, and assessment for learning.

### **Literature**

Advocates of tracking argue that teaching homogeneously grouped students within separate, leveled classes benefits both high-achieving and low-achieving students. Empirical research studies show that academic tracking has no lasting benefit for high-achieving students but has detrimental effects on students placed in low academic tracks (Burriss, 2006; Clark, 2013; Van Houtte, Demanet, & Stephens, 2013; Werblow, Urick, & Duesbury, 2013). In contrast, Rui (2009) asserts that when academic tracking is eliminated, students who are traditionally relegated to the low academic track prosper academically.

Proponents of tracking assert that track placement is based on real differences in student ability and such placements are appropriate and fair. Oakes (2005) argues that track placements resulting from standardized test scores and teacher recommendations legitimize the belief that students earn their placement. Closer examination of such placement reveals flaws in this meritocratic thinking. Werum, Davis, and Cheng (2011) and Sil (2007) showed that parents who were able to negotiate a change in their students' low academic track placements most often came from high-socioeconomic backgrounds. Conversely, students whose parents did not have the networking resources to question their low academic track placement typically came from families of low-socioeconomic backgrounds.

Scholars also question the use of standardized test scores as a legitimate selection criteria for track placement since test questions that show mastery but do not show differences in student responses are often eliminated from final scores because they cannot be used to indicate differences in students' academic ability (Dalal & Gunderman, 2011; Oakes, 2005). Additionally, many standardized test questions contain cultural biases that favor the experiences of White, middle and upper middle class students (Grotsky, Warren, & Felts, 2014).

An additional argument put forth by proponents of tracking is the assumption that teaching is easier when students are homogeneously grouped.

High school teachers who only teach honors level and Advanced Placement (AP) students reportedly find teaching much easier than their peers with other course loads (Grant, 2011). Conversely, according to Worthy (2010), homogeneously grouped low-track classes are the most difficult to teach and hardest to manage (Worthy, 2010).

Opponents of tracking expose the disadvantages that students in low academic tracks frequently experience: teachers who are uncertified or who are not highly qualified, and curricula and instruction that are skills-based (Burris, Wiley, Welner, & Murphy, 2008; Darling-Hammond, 2013; Tienken & Zhao, 2013; Tyson, 2013; Watanabe, 2012; Welner & Carter, 2013); the preservation of racial and class-based inequalities (Carter, 2013; Darling-Hammond, 2013; Powell, 2011b; Powers, 2011; Rothstein, 2013; Tyson, 2013; Watanabe, 2012); and problematic practices by which students are assigned to academic tracks (Carter, 2013; Tienken & Zhao, 2013; Tyson, 2013; Watanabe, 2012). The elimination of tracking has the potential to reduce these inequalities, but randomly assigning students to heterogeneous classes only guarantees an increase in the diversity of learners within the classroom (Burris & Garrity, 2008).

Schools that have effectively eliminated academic tracking have addressed the learning needs of their low-achieving and high-achieving students (Burris & Garrity, 2008; Oakes, 2005; Watanabe, 2012). The Preuss School in San Diego, California, a 6<sup>th</sup>-12<sup>th</sup> grade public secondary school, has achieved success in the elimination of tracking through embedding additional support structures for low-achieving students within the school day and through continuous teacher professional learning around how students learn and how to teach for student understanding (Alvarez & Mehan, 2006). South Side High School in Long Island, New York has also successfully eliminated tracking and attributes the academic success of their students to equally rigorous learning opportunities that all students experience and to the continuous support of students who struggle academically so that they are able to meet the most rigorous curriculum that the school offers (Burris, 2014; Tyson, 2013).

Tomlinson (2014) encourages differentiation as one way teachers can meet the learning needs of both their struggling and advanced students in a mixed-ability classroom. Teachers who use differentiated instruction are able to provide tiered instructional support for students who struggle academically. Within a response to intervention (RTI) or tiered instructional model, three tiers of instruction are used. Fuchs and Fuchs (2006) describe Tier 1 instruction as high-quality, core instruction that all students receive and which includes periodic formative assessments to determine which students are struggling. Once

identified, these students then receive Tier 2 instruction, which is intensive, small group instruction that happens within the regularly scheduled class period targeting specific learning gaps. Within our school's RTI model, Tier 3 instruction is individualized, intensive intervention that occurs outside of the regularly scheduled class period. Richards and Omdal (2007) describe tiered instruction as a research-based differentiation practice that "group[s] students for instruction based on their background knowledge in a given subject area" (p. 425). Within this practitioner research study, I used tiered instruction as a way to differentiate instruction for both my learners who struggled and my learners who excelled.

Stiggins (2005) asserts that teachers who effectively use an assessment *for* learning (AfL) approach to drive their instruction "promote maximum student success" (p. 328). The underpinnings of effective AfL practice include defining clear, achievable learning targets through the deconstruction of state standards, aligning instruction and assessment with the learning targets, embedding multiple opportunities for formative assessment and feedback to students, and modifying instruction based on formative assessment results to meet the changing learning needs of students. Within this practitioner research study, I incorporated AfL principles into the redesign of one unit within my biology curriculum.

### **Practitioner Research and Unit Design**

I used practitioner research to study both the development and implementation of a differentiated unit on the concept of protein synthesis, considered the Central Dogma of Molecular Biology. Several scholars define practitioner research as the systematic study of one's own teaching practice through collaborative discussions and individual reflections around specific data pieces collected throughout the planning, implementation, and analysis phases of the practitioner research study (Campbell, 2013; Cochran-Smith & Lytle, 1993, 2009; Dana & Yendol-Hoppey, 2008, 2009). One of the main reasons that a teacher engages in practitioner research is to take action that leads to improvement in instruction and ultimately student outcomes (Dana & Yendol-Hoppey, 2014).

One structure that can support teachers in instructional improvement efforts is participation in a Professional Learning Community (PLC), defined as a small group of teachers who meet on a regular basis to engage in deliberative dialogue about student learning (Dana & Yendol-Hoppey, 2016). Inquiry into practice is key to the work that a PLC performs; I thus worked within a PLC throughout this practitioner research study. Initially, my PLC work involved the development of the learning targets and proficiency scales for this protein

synthesis unit, two integral components of an AfL approach to practice. Table 1 illustrates the unit's nine learning targets within two overarching learning goals that drove the development of this instructional unit.

Table 1. Learning Targets (LT) by Learning Goals - Protein Synthesis Unit

Learning Goal 1: FL NGSSS Standard SC.912.L.16.5 Explain the basic processes of transcription and translation, and how they result in the expression of genes.

- LT 1 I can compare and contrast the molecular structure of DNA and RNA.
- LT 2 I can model how DNA makes mRNA through the process of transcription.
- LT 3 I can model how mRNA is used to make a polypeptide through the process of translation.
- LT 4 I can describe the roles that mRNA, rRNA, and tRNA play in protein synthesis.
- LT 5 I can describe the relationship of a codon to an anticodon, tell where each is located, and explain how they order the amino acids in a polypeptide.
- LT 6 I can use the genetic code (mRNA codon charts) to determine the amino acid sequences of sample polypeptides.

Learning Goal 2: FL NGSSS Standard SC.912.L.16.5 Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring.

- LT 7 I can demonstrate the significance of mutations in organisms at the level of a chromosome and gene.
- LT 8 I can show how point mutations and frame-shift mutations affect DNA sequences differently, and explain how each mutation affects the synthesis of a protein.
- LT 9 I can contrast the consequences of a mutation in a gamete to that of a body cell.

Tables 2 and 3 illustrate the proficiency scales that my PLC created for each of the overarching learning goals that drove the development of assessment pieces for this unit.

Table 2. Proficiency Scale for Learning Goal 1: Protein Synthesis Unit

Scale	Indicators
Advanced	Student demonstrates the ability to model protein synthesis and to use conceptual understanding through the application of protein synthesis in a real-life scenario.
Proficient	Student can recognize critical elements of protein synthesis and demonstrate the ability to model protein synthesis including <ul style="list-style-type: none"> <li>• distinguishing the similarities and differences between DNA and RNA</li> <li>• modeling how DNA makes mRNA in the nucleus through transcription</li> <li>• modeling how mRNA, rRNA, and tRNA are used to make a polypeptide at the ribosome through translation</li> </ul>
Approaching	Student can recognize critical elements of protein synthesis including: <ul style="list-style-type: none"> <li>• identification of key terms: transcription, translation, amino acid, polypeptide, RNA, DNA , nucleus, ribosome</li> <li>• the relationship between codons and anticodons</li> <li>• the relationship among mRNA, rRNA, and tRNA</li> <li>• how to read a codon chart to identify an amino acid</li> <li>• the similarities and differences between DNA and RNA</li> </ul>
Beginning	Student has limited understanding of protein synthesis and cannot recognize critical elements or complete an accurate model without support.

Table 3. Proficiency Scale for Learning Goal 2: Protein Synthesis Unit

Scale	Indicators
Advanced	Student can select the best argument for the type of mutation (gene or chromosomal) that results in phenotypic changes in organisms and can build a case using evidence to support his/her argument.
Proficient	Student can distinguish between chromosomal and gene mutations within gametes and the effect such mutations have on the synthesis of proteins and can draw conclusions about possible phenotypic changes to organisms.
Approaching	Student can recognize critical elements related to mutations in DNA sequences including: <ul style="list-style-type: none"> <li>• identification of key terms: gene mutation, chromosomal mutation, point mutation, frameshift mutation, substitution, insertion, deletion, gamete, and somatic cell</li> <li>• how to transcribe and translate a DNA sequence</li> <li>• the relationship between a change in DNA and a change in the protein that is expressed</li> </ul>
Beginning	Student has limited understanding of how mutations within gametes affect protein synthesis and possible phenotypic changes within organisms and cannot recognize critical elements related to mutations in DNA sequences without support.

Next, my PLC partners helped me design an initial pre-assessment for the unit to determine which students had either prerequisite knowledge or some understanding of protein synthesis in order to group them for tiered-instructional activities. We used the unit’s learning targets to create the questions for the pre-assessment. Table 4 lists the pre-assessment questions aligned with the learning targets that they assess.

Table 4. Alignment of Pre-assessment Questions with Learning Targets

Pre-Assessment Question	Learning Target(s) Assessed
1. Write 2-3 sentences that illustrate how chromosomes, DNA, genes, and proteins are related.	Prerequisite knowledge about DNA LT1: I can compare and contrast the molecular structure and function of DNA and RNA.
2. The structure of DNA is different from RNA in three significant ways. Describe these three differences.	LT1: I can compare and contrast the molecular structure and function of DNA and RNA.
3. The function of the nucleic acids DNA and RNA is very different. Describe the function of each of these nucleic acids.	LT1: I can compare and contrast the molecular structure and function of DNA and RNA. LT4: I can describe the roles of mRNA, rRNA, and tRNA during protein synthesis
4. Write an analogy to show your understanding of the difference between the processes of transcription and translation.	LT5: I can describe the relationship of a codon to an anticodon, tell what each represents, and explain how they order the amino acids in a polypeptide.
5. Transcribe the following DNA nucleotide sequence into mRNA and translate the mRNA into its polypeptide. Remember that the 3' to 5' strand of DNA is transcribed. I have included the codon chart for you to use in this process. DNA 5' ATG TCG GGT AAA GCG TGA 3' 3' TAC AGC CCA TTT CGC ACT 5'	LT2: I can model how DNA makes mRNA through the process of transcription. LT3: I can model how mRNA is used to make a polypeptide through the process of translation. LT6: I can interpret the genetic sequence of mRNA using mRNA codon charts to determine the amino acid sequences of polypeptides.
6. Given the following DNA nucleotide sequence, model transcription and	LT2: I can model how DNA makes mRNA through the

translation for each type of gene mutation and explain its effect on the resulting protein.

DNA 5' ATG TCG GGT AAA GCG  
TGA 3'  
3' TAC AGC CCA TTT CGC  
ACT 5'

- single base substitution in second codon
- single insertion in second codon
- c.) single deletion in second codon

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	isoleucine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

7. In which type of cell would a mutation be inherited? Explain.

process of transcription.  
LT3: I can model how mRNA is used to make a polypeptide through the process of translation.

LT6: I can interpret the genetic sequence of mRNA using mRNA codon charts to determine the amino acid sequences of polypeptides.

LT7: I can demonstrate the significance of mutations in organisms at the level of a chromosome and gene.

LT8: I can show how point mutations and frame-shift mutations affect DNA sequences differently, and explain how each mutation affects the synthesis of a protein

LT9: I can contrast the consequences of a mutation in a gamete to that of a body cell.

Finally, prior to the implementation of the unit, my PLC partners also helped me develop two types of tiered instructional activities: one for students who needed to build background knowledge and a second one for students when they were ready to practice with and deepen their understanding of this knowledge for each learning goal. For example, for students who needed to build background knowledge to be able to transcribe DNA into mRNA and translate mRNA into a polypeptide chain, we created a foldable that addressed the nucleotide base-pairing rules for DNA and for RNA for students to use as a reference as they were learning these base-pairing rules. Alternatively, for students who already knew the base-pairing rules, we created exercises for these students to practice with and deepen their understanding of the base-pairing rules as they applied these rules to transcribe DNA into mRNA and translate mRNA into polypeptide chains.

### Data Collection and Analysis

Once the unit was designed, I selected ten of my students to follow as I enacted this unit within the class period in which one of my PLC partners provided academic support. Of these ten students, two were scoring at the highest levels on all assessments in biology and had historically scored at the highest level on state standardized reading exams. I refer to these students as “advanced learners” (AL). Four students were high achieving in other classes but not in biology and had scored on grade-level on state standardized reading exams. I refer to these students as “strong learners who struggle in biology” (SLSB). The final four students were struggling learners in biology and in their other classes and had historically scored below grade level on state standardized reading exams. I refer to these students as “struggling learners” (SL). Table 5 shows the breakdown of these learners by gender, race, and socioeconomic status.

Table 5. Gender, Race, and Socioeconomic Status of Ten Biology Students

Type of Learner	Gender	Race	*Socioeconomic Status
AL	Female	Multiracial	2 (between \$39,250 and \$68,999)
AL	Male	Hispanic	2 (between \$39,250 and \$68,999)
SLSB	Female	White	4 (\$97,750 or above)
SLSB	Female	White	4 (\$97,750 or above)
SLSB	Male	White	4 (\$97,750 or above)
SLSB	Male	White	2 (between \$39,250 and \$68,999)
SL	Female	Black	3 (between \$69,000 and \$97,749)
SL	Female	White	4 (\$97,750 or above)
SL	Male	Black	1 (\$39,249 or less)
SL	Male	White	3 (between \$69,000 and \$97,749)

\*Socioeconomic status (SES) categories are federal categories based on a family’s total gross annual income.

I collected multiple data pieces over the course of a four-week unit on protein synthesis related to each of these ten students including:

- (1) student work samples during each instructional activity;
- (2) my thoughts as the unit progressed captured through a practitioner reflection journal;

- (3) formal and informal interviews with students during and after the completion of the unit.

I began the process of data analysis with reading and rereading all of the data pieces and describing what I saw. Because of the abundance of data, I first organized all of the data pieces for each of the ten students in this study to provide a better lens for analyzing how formative assessment and differentiation supported both my learners who struggled in biology and my learners who excelled. I collated all data pieces for each of the ten students making a “data poster” specific to each student which included:

- (1) his/her assessment data for the unit and standardized test scores for the previous academic year;
- (2) the differentiated instructional activities that (s)he completed;
- (3) a compilation of reflections taken from my practitioner reflection journal in which I referred to him/her specifically;
- (4) a transcript from the final student interview;
- (5) his/her responses to an online survey.

Figure 1 shows sample data posters for several of the ten students that I followed within this study.

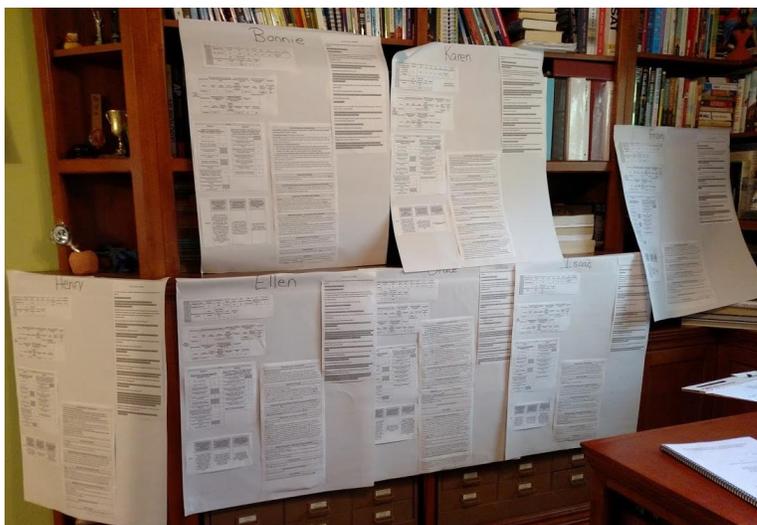


Figure 1: Sample Student Data Posters

To focus my data analysis, I used the three questions that Dana and Yendol-Hoppey (2014) recommend when completing data analysis in practitioner

research: “What did [I] see as [I] inquired?, What was happening?, and What [were my] initial insights into the data?” (p. 169). I wrote statements on large posters entitled “What I see” and included evidence within my data that led me to these statements. I discussed my observations from this initial read of the data with a peer debriefer who was my colleague completing a parallel practitioner research study in her detracked, honors geometry classroom and captured our conversations by writing on sticky notes and placing them on my “What I See” posters. Figure 2 shows the “What I See” posters that I created during the data analyses process.

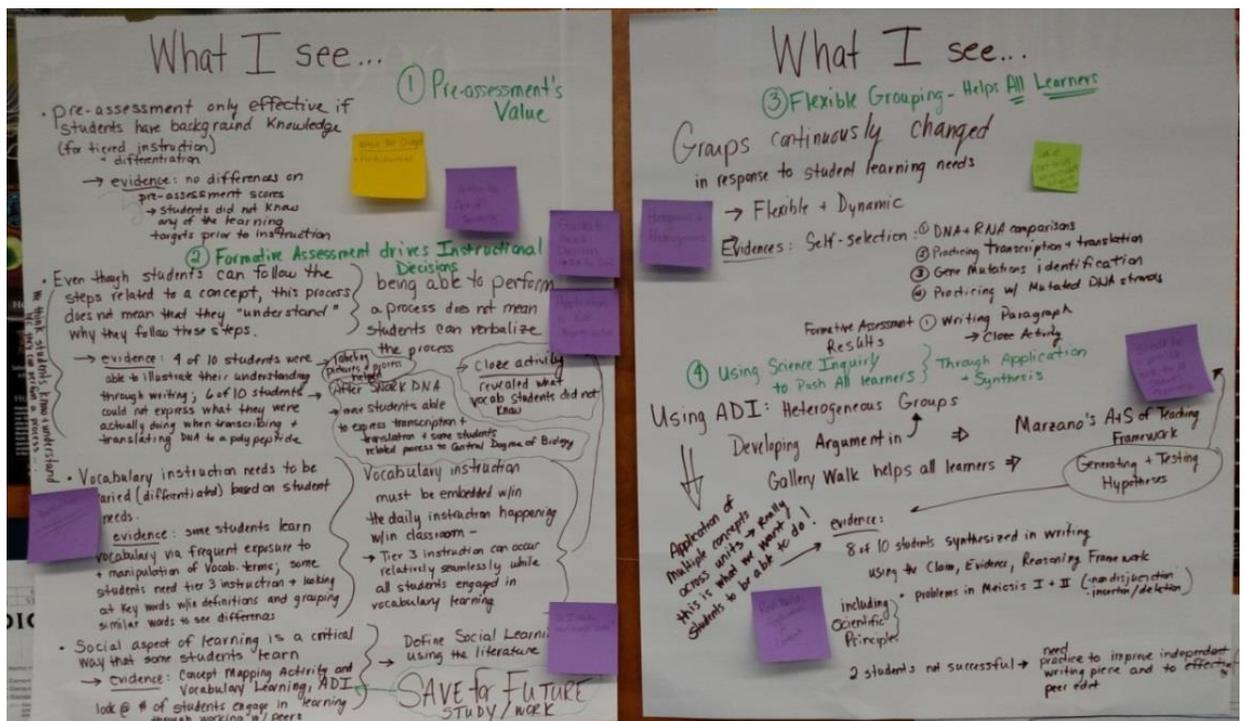


Figure 2: “What I See” Posters

## Findings and Discussion

As I read and reread the data pieces collated on the posters, the student artifacts that I had collected, and the practitioner reflection journal in which I had chronicled critical events during the development and implementation of this unit, I documented my learning using a Claim, Evidence, Reasoning (CER) framework common in scientific inquiry (McNeill & Krajcik, 2011). Within this paper, I share one claim related to the effectiveness of using pre-assessment to group students for tiered instruction. Additional claims can be found in the complete report of this study (MacDonald, 2016).

**Claim: Pre-assessment that is based on Unit Outcomes is not useful for Determining Student Grouping for Tiered Instruction.**

The first step in the implementation of this instructional unit on protein synthesis was determining which students would benefit from tiered instruction that supported building background knowledge to reach mastery of the protein synthesis learning goals and which students would benefit from tiered instruction to develop an advanced understanding of the protein synthesis learning goals. Richards and Omdal (2007) assert that tiering lessons for learners based upon their background knowledge and skill level related to a particular unit of study supports low-achieving students and challenges high-achieving students. By having students take a pre-assessment that measured the knowledge and skills needed for understanding protein synthesis, I intended to use the results of the pre-assessment that I had created to establish groups for tiered instruction. Upon examination, it was evident that these results were not going to be useful for determining homogeneous groups for tiered instruction.

**Evidences**

Students were unable to answer any pre-assessment question at a proficient level regardless of learner category. Thus, the pre-assessment did not distinguish students in need of academic support from students ready for academic challenge. Table 6 shows the proficiency level of each student with respect to each learning target assessed on the pre-assessment. (See Table 1 for a list of learning targets.)

Of the nine learning targets assessed, only one student, Bonnie, who was an advanced learner, was able to articulate a response that moved her to an “approaching proficiency” level for two of the nine learning targets. However, neither of these responses would have placed her understanding of either of the unit’s overarching learning goals at an “approaching proficiency” level.

Several factors contributed to the ineffectiveness of the pre-assessment in determining which students would receive tiered instruction. First, protein synthesis is not a Next Generation State Science (NGSS) standard in any of our state’s middle school science courses, so students have never been introduced to this topic. We cannot expect that students have built background knowledge and skills around a topic with which they have never engaged.

Table 6. Students' Pre-Assessment Proficiency Level Results by Learning Target (LT)

Learner	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9
Bonnie (SL)	*Ap	*B	B	B	B	B	B	B	Ap
Isaac (SL)	B	B	B	B	B	B	B	B	B
Karen (SLSB)	B	B	B	B	B	B	B	B	B
Fran (SLSB)	B	B	B	B	B	B	B	B	B
Daniel (SLSB)	B	B	B	B	B	B	B	B	Ap
Carter (SLSB)	B	B	B	B	B	B	B	B	B
Ellen (SL)	B	B	B	B	B	B	B	B	B
Grace (SL)	Ap	B	B	B	B	B	B	B	B
James (SL)	B	B	B	B	B	B	B	B	B
Henry (SL)	B	B	B	B	B	B	B	B	B

\*B = beginning; Ap = approaching proficiency

Second, the high depth of knowledge (DOK) required for students to meet proficiency of the unit's two learning goals was likely another factor that limited the effectiveness of using this pre-assessment to develop tiered instructional groups. Since both of the unit's learning goals have a Level 3 DOK content complexity rating, to meet proficiency of the learning goals, a high cognitive demand is placed on students with regard to accessing relevant background knowledge, simultaneously processing multiple concepts and skills, and thinking abstractly about a topic they cannot "see." This high cognitive demand collectively limited the efficacy of the pre-assessment to assess differences in student understanding prior to implementation of instructional activities.

Finally, the pre-assessment created to assess differences in students' background knowledge and skills likely was not a valid measure for finding such differences. Rather than measuring the prerequisite knowledge and skills that would support a deeper understanding of these learning targets, it was constructed

to measure learning outcomes following instruction based on the unit's learning targets.

## **Reasoning**

Hockett and Doubet (2013-2014) identify four components critical for developing effective pre-assessments: (1) beginning with clearly articulated learning goals, (2) considering the prerequisite knowledge and skills students must already know to meet the demands of the unit, (3) designing questions that measure student understanding rather than discrete knowledge and skills, and (4) limiting the questions to those that provide the teacher with information to make instructional decisions. Although the pre-assessment I created with my core PLC met three of the four components necessary for developing an effective pre-assessment, it did not measure the prerequisite knowledge and skills that students needed to know to meet the demands of the unit's learning goals. Instead, it was measuring students' knowledge and understanding that was expected upon completion of the instructional unit.

In addition to the four critical components for effective pre-assessment design, Chapman and King (2014) and Tomlinson (2014) suggest using alternative forms of pre-assessment in combination with or instead of a traditional paper-pencil test to gather information about student readiness for a unit. Our pre-assessment looked more like a traditional paper-pencil test and may have intimidated some students. Because each question required an extended response, and because this pre-assessment did not inform students' grades, they likely looked at the pre-assessment format and decided that it was too difficult before they even began.

A better approach in developing this pre-assessment may have been to use the indicators of student learning in the "approaching" level of the proficiency scales (see Tables 2 and 3) rather than the indicators for the "proficient" level. This alternate approach may have garnered differences in student results and subsequent student readiness for this unit as such indicators were more indicative of student background knowledge and skills needed to meet the content complexity of the unit.

Providing alternative question formats, such as selected response for learning targets that measured knowledge and reasoning, and performance assessment for learning targets that measured modeling processes may have been another way to assess student background knowledge on the pre-assessment. It has been my experience that students generally are less intimidated by selected

response and will attempt a hands-on performance assessment more readily than engaging in extended written response.

Additionally, using a less formal format to pre-assess, such as having students create a concept map to show relationships among words that carry conceptual meaning or complete an anticipatory guide in which they agree or disagree with a series of statements to activate prior knowledge regarding protein synthesis, may have been an alternative approach to the traditional paper-pencil pre-assessment that we developed. Using an alternative form of pre-assessment may have given me better insight into student readiness for this unit.

### **Conclusion**

When designing this practitioner research study, I anticipated that the pre-assessment results would allow me to make decisions for grouping students for tiered instruction. In fact, I naively believed that the results of the pre-assessment would allow me to create fixed groups for tiered instruction for the entirety of the unit much like the groups in the tiered instructional study described by Richards and Omdal (2007).

Even though my traditional paper-pencil pre-assessment did not distinguish differences among students in their readiness for this unit and creating groups for tiered instructional activities was thus not an option, these results made me rethink how I would help students build background knowledge related to protein synthesis. These results became the driving force for using the Marzano (2007) Art and Science Teaching Framework to design instructional activities for the purposes of introducing students to new knowledge in order to build their background knowledge and providing students with opportunities to practice with and deepen their understanding of the content.

### **Impact on Future Practice**

Although I initially believed that the pre-assessment for this unit provided me with no useful data for differentiation, upon further examination, I have reconsidered how to design such pre-assessments to garner usable results. Based on what I learned from this cycle of practitioner research, I will continue to examine how pre-assessment can ascertain the learning needs of my students prior to instruction. I will use indicators for approaching proficiency of the learning goals as I develop pre-assessment pieces. To engage students in attempting a pre-assessment, I will try out alternative forms of pre-assessment such as word sorts, anticipatory guides, and performance-based tasks rather than traditional paper-

pencil tests requiring extended, written responses. Finally. I will break down the pre-assessment pieces into smaller tasks to be used throughout the unit prior to introducing new content related to a group of learning targets within a larger learning goal instead of pre-assessing every learning target for all of the learning goals before any instruction occurs for the unit.

As with every cycle of practitioner research with which I have engaged, my learning always leads to new questions about my practice. As a result of this practitioner research cycle, I continue to believe that pre-assessment has the potential to play a pivotal role in making decisions about differentiating instruction within a detracked, high school Biology classroom. My next cycle of practitioner research will include how alternative pre-assessment practices may provide me with usable data with which to differentiate instruction to meet the learning needs of an increasingly diverse student population.

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