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Student-Centered Pedagogy: Using Moses' Five-Step Approach as a Scaffolding Framework to Teach Diverse Learners

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Abstract

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Keywords

student-centered pedagogy, scaffolding framework, Moses' Five-Step Approach, teaching diverse students

Disciplines

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**Student-Centered Pedagogy:
Using Moses' Five-Step Approach as a
Scaffolding Framework to Teach Diverse Learners**

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Abstract:

In this article, two teacher educators and three preservice teachers reflect on the critical role Moses' Five-Step Approach (Moses & Cobb, 2001) played as a scaffolding pedagogical framework in preservice teacher and faculty learning. Using Moses' approach to frame their presentations, preservice teachers work in their groups to teach abstract Educational Psychology concepts to actively engage classmates from diverse backgrounds. During this process, the presenters co-construct knowledge with their peers and instructor, applying the framework by putting common activities and everyday language first before teaching abstract concepts and academic language. The authors, including a preservice teacher who also teaches a university biology course, explicate the process of their experience, beginning with conceptualizing a theme, generating engaging activities that represent the concepts and tap into multimodalities of learning, and breaking down key vocabulary to connect to students' prior knowledge in a socially constructed environment. The authors reflect on the power of this student-centered framework as well as its challenges. Ultimately, Moses' approach serves as a liberating framework, allowing diverse learners a common entry point to experience and comprehend complex concepts and vocabulary. This pedagogical framework fosters a rich student-centered environment where students become active agents of their own learning.

Key Words:

student-centered pedagogy, scaffolding framework, Moses' Five-Step Approach, teaching diverse students.

Introduction**Need for Effective Preservice Teacher Preparation to Teach Diverse Learners**

When examining education in the U.S., nurturing critical thinkers in post-secondary education is a more serious challenge today than ever before at a time when our overall international academic standing has persistently been around average or below average (OECD, 2015) and the classroom itself has undergone significant demographic changes. Students today are more diverse than at any point in the U.S. history (Santangelo & Tomlinson, 2009). For example, on the campus where this study was conducted, which is a public university designated as a Hispanic-serving institution where nearly half of the student population are low income, White, Hispanic, Asian/Pacific Islander, and Black students comprise 25%, 30%, 26%, and 3.5% respectively of the entire campus student population (Institutional Statistics, 2016). As these statistics indicate, White students are no longer a majority but are the minority. With increasing diversity, persistent gaps exist such as with retention rates. According to the National Center for Educational Statistics (NCES), the college graduation rates for various groups of students differ markedly: Whereas 71% of Asian and 63% of White students graduated in six years, only 53% of Latinos/Hispanics and 41% of Black/African-American students, both of which comprise traditionally underrepresented groups, accomplished the same within the same time frame (2016). On the campus where this study was conducted, while the overall six-year graduation rate is 51.3%, the same rate for underrepresented minority is 47.9% for the 2008 Cohort.

Similarly, in PK-12 public schools, students of color exceed the number of White students in 11 states (Sensoy & DiAngelo, 2012). In particular, linguistically diverse students or English language learners have increased from 9% to 21% in the U.S. between 1979 and 2008 (Aud et al., 2010). In the State of California alone, the number exceeds over 1.3 million, comprising 22.1% of all the total student enrollment in California public schools (California Department of Education, 2016). Currently, however, teacher education programs in many states do not require all preservice teachers to be sufficiently prepared through such courses as second language acquisition and effective teaching practices to teach linguistically diverse populations. Only 20 states require all prospective teachers have some preparation in teaching the same populations. Furthermore, less than one-sixth of college-based teacher preparation programs require specific instructional methods pertaining to teaching linguistically diverse populations (Ballantyne, Sanderman, & Levy, 2008), adding to the inconsistency in preparing teachers to effectively teach the growing needs of the nation's diverse populations (Sensoy & DiAngelo, 2012). These findings point to a critical need to prepare preservice teachers to effectively teach diverse PK-12 populations, especially English language learners (Vomvori-Ivanovic & Chval, 2014), as well as teacher educators being able to model effective pedagogy in teacher education classrooms (Loughran, 2010; Lunenberg, Korthagen, & Swennen, 2007). Addressing these needs, this paper aims to extend the discussion of the pedagogical framework proposed by Robert Moses (Moses & Cobb, 2001) as a student-centered scaffolding framework supported by preservice teacher and instructor perspectives.

Student Group Presentation as a Way to Enact Teaching

At the heart of teacher education are foundation courses that provide principles of learning and conceptual basis for teaching (Grossman, Hammerness, & McDonald, 2009). In the university where the first author teaches, undergraduate and post-baccalaureate students from Liberal Studies, History, English, Agriculture, Mathematics, Biology, Chemistry, Kinesiology, and other majors take these foundational courses in the teaching credential program. In particular, Educational Psychology is an important course where preservice teachers learn theories of learning, human development, and motivation with pedagogical approaches founded on such theories. This theory-heavy course can be dry, intimidating, and overwhelming. Students tend to skim through the thick textbooks and treat the course just as any other general psychology courses they have taken in the past. Being aware of these pitfalls, the first author intentionally created the course distinctively different through course assignments that are student-centered and socially constructed, focusing on theory into practice (Ahn, Ingham, & Mendez, & 2016).

One such activity that helps prepare future teachers is utilizing the group presentation. Students collaborate with their peers in a triad to create a student-centered lesson for 20 minutes based on course topics they signed up for, such as positive and negative reinforcements under behaviorism, triarchic reciprocal causality under social cognitive theory, three types of knowledge under the information processing theory, to name a few. With guidance by the instructor, students work in groups to conceptualize an original lesson using engaging themes that cohesively put all activities together, enabling participants to experience the abstract concepts first.

Rather than reading from the PowerPoint or simply lecturing, presenters are expected to engage their classmates using multimodalities of learning: Visual, Auditory, Kinesthetic, and Tactile (VAKT). Multimodalities of learning are found to be effective in teaching children with dyslexia (Gillingham & Stillman, 2014) but also with English language learners (Echevarria, Vogt, & Short, 2008). Another integral part of the group presentation is the use of everyday language, as using familiar words to describe the experience adds to conceptual understanding (Moschkovich, 2010). From there, presenters use visual aids and gestures to introduce the academic language by connecting to participants' prior knowledge. Presenters need to attend to other expectations to make the group presentation meaningful and accessible for diverse learners, including small group discussions, appropriate pacing, and slow and articulated speech (Echevarria, Vogt, & Short, 2008), all of which are delineated on the feedback form that presenters use to plan for their presentation (see Appendix). The ultimate challenge for presenters is to make abstract concepts concrete and relevant by applying Moses' Five-Step approach: Providing common experience first before presenting abstract concepts and academic language (Moses & Cobb, 2001), which is contrary to most of their learning experience in PK-12 and university education.

Moses' Five Step Approach as a Scaffolding Framework for Diverse Learners

The Five-Step Approach was created by a civil rights activist Robert Moses, who developed the curriculum for the Algebra Project (Moses & Cobb, 2001). Moses initiated the Algebra Project to support African American students to be successful in mathematics classrooms, especially in algebra, since he saw that traditionally underserved students did not have equal access to advanced mathematics courses and are often directed to lower-level mathematics courses. In his own words, Moses (2001) asserted algebra "once solely in place as the gatekeeper for higher math and the priesthood who gained access to it, now is the gatekeeper for citizenship; and people who don't have it are like the people who couldn't read and write in the industrial age" (p.14). Moses' framework stems from his commitment to provide access to African-American students to provide algebraic and higher mathematical concepts as a way to participate equitably as citizens in our society. Based on the original framework, we (first and second authors) expanded the application to teach other underserved populations, including Latino/Hispanic students and English language learners (Ahn, I, & Wilson, 2011).

The Five-Step Approach starts from building experience through a physical activity and continues to have multiple steps of scaffolding until it reaches formalization of an abstract concept (see Table 1).

Table 1: Overview of the Five-Step Approach created by Robert Moses (Moses & Cobb, 2001).

Steps	Students' actions
1. Physical Event	Students participate in a common physical activity and build an objective-related experience.
2. Pictorial Representation	Students draw a picture or express the experience visually built on Step 1.
3. People Talk	Students discuss and write about what happened during Step 1 in their own words, including their everyday and native languages.
4. Feature Talk	Students discuss and write about the experience in formal (academic) language or mathematical language.
5. Symbolic Representation	Students build and use symbols to express what they found from the experience in the previous steps.

The first step is crucial since the common physical event connects an abstract mathematical concept—which the teacher aims to have students understand—to students' previous experience and knowledge. Common experience also allows students to discuss their experience with their peers in Step 3. Since the other steps must rely on the first step, it is important to create an engaging activity for Step 1 that is aligned with the target concept. Steps 2 through 4 provide multiple scaffolding through both verbal and non-verbal means. After participating in the Step 1 activity, in Step 2, students draw a picture of what they experienced and continue to talk about it in their own words in Step 3. Step 3 involves students' funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992), as students' home and everyday language is an important cultural aspect of learning. Until this step, they do not need to use formal mathematical language or symbols, which is substantially different from traditional mathematics classrooms that begin with teacher-driven input and student-driven applications later. In Step 4, students gradually move to a formalization process. In this step, students are guided by the teacher to use formal academic language, connecting to the same experience that was strengthened through the previous steps. Through Steps 1–4, students build an understanding of the target concept based on concrete experience and various scaffolding approaches. Finally, in Step 5, which is the final process of formalization, students find or create an abstract way to express the concept they understood during the previous steps (Ahn, I, & Wilson, 2011), such as equations with variables, graphs, or combination of symbols.

Due to the multiple steps of scaffolding using verbal and non-verbal means that are student-centered, Moses' framework is considered an effective pedagogical approach, especially when teaching diverse students who do not receive adequate support in the traditional U.S. educational system. Previous research studies support this assertion. First, using a real-world context or a real-life example to teach abstract mathematical

concepts is one of the recommended instructional strategies for diverse students (Anhalt & Cortez, 2015; Chval & Chavez, 2011; Domínguez, 2011). Similar to the experiential learning model created by Kolb (1984), the physical event, Step 1, is one way to integrate real-world situations and provides students with an opportunity to have a common, related experience, especially for those who have different cultural backgrounds and previous experiences from those of the instructor. For example, Moses took middle school students on a fieldtrip for them to experience and learn about the subway and its map, which enabled them to eventually connect to addition of integers using a number line (Moses & Cobb, 2001).

Moreover, the Five-Step Approach has a similar structure to Concrete-Representational-Abstract (CRA) sequence (Flores, 2010). A body of studies has indicated CRA is an effective approach that helps students learn various mathematical concepts (Butler, Miller, Crehan, Babbitt, & Pierce, 2003; Fuchs, Fuchs, & Hollenbeck, 2007; Maccini & Ruhl, 2000). The first step of the CRA sequence, *Concrete* -- much like Step 1 in Moses' framework -- is that the instructor demonstrates the target concept or process with manipulatives. Then, students follow the use of manipulatives until they can independently use them to show the target skill or process themselves. In the next step, *Representational*, manipulatives are replaced by pictures and/or drawings, similar to Step 2 in Moses' framework. During this step, students are asked to perform a kind of translation of mathematical representations (Driscoll, 1999). In the final phase, another transition occurs from the use of pictures or drawings to the use of numbers, which is comparable to Step 5 in Moses' framework. Although the overall structure of CRA resembles three steps in the Five-Step Approach, Moses' framework has unique features that CRA does not have: Moses' framework taps into students' funds of knowledge through using their everyday/home language, gradually providing scaffolding to use the academic language, and ultimately empowering students by having them create their own symbols. All of these features are initiated and are done by students, not by teachers, making Moses' framework a student-centered framework.

Additionally, the Five-Step Approach is congruent with culturally relevant pedagogy (CRP), which is a pedagogy that puts students as subjects, not as objects (Ladson-Billings, 2014), empowering students "intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 2009, p.20). CRP has been widely discussed and used by various researchers and practitioners to be an effective theoretical framework when teaching diverse learners (Brenner, 1998; Lipka, Sharp, Adams, & Sharp, 2007; Powell, Cantrell, Malo-Juvera, & Correll, 2016). Hernandez, Morales, and Shroyer (2013) identified five essential characteristics of CRP: Content integration, facilitating knowledge, prejudice reduction, social justice, and academic development. Moses' framework addresses multiple aspects of these characteristics of CRP: Content integration, facilitating knowledge, and academic development integration, all of which are done through student-centered instruction. Student-centered instruction is defined as "an instructional approach in which students influence the content, activities, materials, and pace of learning" (Collins & O'Brien, 2003, p. 338). Since the Five-Step Approach profoundly relies on students' actions and reactions, its overall structure is essentially student-centered. Although a teacher needs to set up an engaging common physical event closely related to the target concept in Step 1, students are the center of all steps: Students participate in

physical activity, draw, talk in everyday and formal languages, and create their symbols to express their understanding. Thus, consistent with CRP, the Five-Step Approach is a promising framework for culturally and linguistically diverse students not only in mathematics but also in all subjects, as the main focus of this framework is to provide gradual scaffolding for students to become skilled enough to manage their learning as defined by Bruner (1983). The following sections show how Moses' framework was used in a preservice teacher education and a university content course to help preservice teachers to effectively teach diverse learners.

Applying Moses' Framework in Group Presentations: Preservice Teacher Perspectives

Preservice Teacher #1 Perspective as a Student in a Pedagogy Course

By the end of my first day of Educational Psychology, I (Preservice Teacher #1 and third author) had a premonition that I was in for a different sort of learning experience where traditional lecturing would be minimal. As the initial class session concluded, I realized that I would be learning about the actual process of learning, and not just the subject matter itself. While proceeding through the course, I recognized that the group presentations, specifically the implementation of Moses' Five-Step Approach in the presentations, became a critical factor in my deeper understanding of student-centered pedagogy.

After observing several presentations, it was time for my triad to formulate our lesson plan on the topics of "cognitive apprenticeships" and "reciprocal teaching." We aimed to teach students a trade by acting as masters to the student apprentices. We collectively came up with the idea of a Shakespeare theme where students would master the trade of makeup, painting, or paper folding in preparation for a Shakespearean festival. We planned to begin our presentation by first providing a glimpse of the key topics to be covered. We would then introduce the concept of cognitive apprenticeship and the definition through a series of exercises. I was confident in our lesson plan and expected minimal suggestive changes by the instructor.

After submitting our outline, our professor (first author) gave us verbal feedback that we had an engaging theme, but she made it clear that we had structural issues: The presentation order was not effective. The most critical information that she offered was that we should not introduce the academic terminology until *after* students had gone through the shared experience. She was adamant about this detail because she wanted us to use Moses' approach. The actual timing of introducing the new terminology was critical to how the students would process the information, she stated. Our group could not help but find this to be a jarring method, as we were all used to starting with the academic terminology first, and then following through with examples afterward.

Although I initially struggled with Moses' approach, I began to understand that if I was successful with this framework, it could be carried over into my own future classroom. As it turned out, beginning our presentation with a shared experience, visual modeling, and everyday language allowed all students to be on equal footing coming into the new material. It became apparent that our professor did not want us to change *what* we were teaching, but *how* we presented it. She strongly suggested cutting lecture-based sections in favor of allowing students more time with our hands-on

activities. This was crucial to gaining a more meaningful long-term understanding, she explained.

After revising our lesson plan, we chose to begin the presentation with an engaging experience, as outlined by Moses in Step 1. In each group, the master guided their apprentices through a complex task with hands-on and verbal assistance. In my case, I modeled for my group how to fold an origami basket step-by-step and then had students follow. Using this hands-on multimodal experience, I engaged all students regardless of their backgrounds or languages. As the focus was on watching and replicating how I was folding my origami basket, students did not need to fully comprehend what I was saying versus what I was doing. Consequently, the students were provided a common entry point into the lesson that could serve as a foundation for further discussion and reflection. For our particular lesson, we were reluctant to incorporate Step 2 of Moses' framework, as we felt that the student's final origami or painting product could be viewed as a pictorial representation of sorts.

At the end of the activity, before we introduced the terminology, we asked the students to discuss their experience in their own words, which related to Step 3. Students talked about how they were the learners and we were the teachers, and how they completed their task through directing and modeling. When we asked students to think of words that describe learning, the word "cognitive" was brought up. At this point we showed a slide displaying the phrase "cognitive," with a man pointing to his head. We then asked them for phrases for learners. Eventually, one of the students said "apprentice" and we showed a slide with the phrase "apprentice" with a picture of a light saber. To tie the terms together, we directed the class to combine the two words to identify the topic, and it was only seconds before someone said, "cognitive apprenticeship," at which point we showed a slide with the entire phrase, with the picture of the man pointing to his head on, as well as the picture of the light saber.

The students experienced the activity first, and through a discussion of this experience, they collectively analyzed what they had just learned. Only then did we introduce the new terminology. By allowing students to use understandable language, students had the opportunity to converse effectively before learning the academic terminology. Through this framework, the students were given more autonomy to co-construct knowledge, which also created a rich student-based learning environment. Moses discovered this while applying the same framework in his algebra class, "As change began to take place in classrooms, more and more of the pace and scope of students' mathematical studies came under student control. Teachers began acting more as guides and coaches rather than lecturers" (Moses & Cobb, 2001, p. 117).

As we were dealing with complex psychology terminology in this particular class, we felt that it might become overwhelming to the students if we also tasked them with creating a symbolic interpretation of what they learned, so we made a conscious decision to avoid the implementation of Step 5. Instead, we decided to focus on the effectiveness of introducing the experience and common language first, and the academic terminology afterwards. By the time students were introduced to academic terminology, they already had a concrete understanding of the concepts based on what they had experienced, and this directly led to my most valuable presentation feedback from a student in the class, stating the most critical part of our presentation was *how*

and *when* we introduced the academic language. Since the term was taught at the end of the presentation, the topic had a more profound impact on her than if she had been given the terminology prior to the exercise.

Preservice Teacher #2 Perspective as a Student in a Pedagogy Course

My Educational Psychology course was one of the innumerable courses I (Preservice Teacher #2 and fourth author) had taken in my college. Prior to the course, I never enjoyed group work, but the collaboration in Educational Psychology allowed for class discussions that enriched my learning like never before. This newly found appreciation for group work was largely influenced by the implementation of Moses' Five-Step Approach.

For our group presentation, we signed up to teach the behaviorism-based topics of positive reinforcement, negative reinforcement, and the Premack Principle. We had to create a lesson plan utilizing a physical experience with a common theme. Generating a theme for our lesson was challenging at first. We came up with an idea to use a traditional classroom experience. Some of the materials we thought about were to play a pop-culture video on YouTube to incorporate Step 1 into our presentation. Yet, my group felt that this plan was not an actual physical event and would cause our lesson to appear dull. We wanted our lesson to connect to students' prior knowledge and the behaviorism-based topics in order for the experience to be easily comprehensible and highly engaging. I had taken a Physical Education (P.E.) for Teachers course previously, which inspired the idea of using P.E. as a foundation to teach the concepts. Initially we were experiencing a sense of tunnel vision since we were too focused on the academic terms. When we realized how a common experience, such as P.E., could be used to teach these concepts outdoors, the rest of our lesson plan went smoothly.

We repeatedly used Moses' Steps 1, 3, 4, and 5 for each sub-concept in our presentation. For Step 1 my group introduced our lesson by performing a skit of a stretching exercise where one presenter acted as the teacher, and the two other presenters acted as the gym students. Step 1 was used to instruct the students to perform a physical activity whenever a new behaviorism-based topic was introduced. For example, when teaching about positive reinforcement, we asked students to use materials, such as hula-hoops, for about a minute while giving them positive verbal feedback, such as "Great job, you might get a reward if you don't give up!" After stopping the students, we gave them granola bars as a reward for completing the requested task. We decided to omit Step 2 because we felt that the students' verbal reflections and discussions about the experience was an effective way to enrich their learning experiences. For Step 3, we asked the students to discuss amongst their groups the reasoning for giving them all a granola bar. Our goal was to stimulate their thinking; Step 3 aided this process by allowing the students to take ownership of their learning by discussing their thoughts about the activities, like pondering the reason for a reward. After Step 3, we used Step 4 to break down the academic vocabulary. For example, we explained, "When you add something, you can think of it as being positive" to help them link the meaning of the word to the definition. We added that in behaviorism, positive reinforcement is the act of adding something to cause a desired behavior, which is why we rewarded them with the granola bars. We implemented Step 5 using symbolic representations with the students. We used physical gestures as a tool

to help the students remember the knowledge they had just learned. For example, for positive reinforcement, we motioned students to form an addition symbol by crossing arms.

What I enjoyed greatly about our presentation was the use of scaffolding for diverse students. We wanted to help them just enough to understand the behaviorism-based topics but not to give the answers. Discussing within their groups helped the students make sense of our lesson using their own language. What worked well for our presentation was using the academic language (Step 4) after using people talk (Step 3). Students were not front-loaded with information, as typically seen in a traditional lecture. Instead, formal language was used after the topics were introduced. The students had already been provided with the necessary support to guide their learning by means of Steps 1 and 3. When we approached Step 4 using the structured academic language, students had already comprehended the concepts and were likely less confused by the academic language.

Preservice Teacher #3 Perspectives as an Instructor of a University Classroom

After learning about Moses' framework by watching a few presentations in Educational Psychology, I (Preservice Teacher #3 and fifth author) immediately thought about how the concept could be applied to the biology laboratory that I teach at my university. As a Master of Science candidate in Biological Sciences, I am concurrently enrolled in the teaching credential program. I have the unique opportunity to serve as a teaching associate (T.A.) for an undergraduate-level biology lab on campus for non-majors called Life Science, which serves as a required general education course. Each week, I teach two sections of 24 students for three hours, for a total of 48 students and six hours of teaching per week. My students' class standings range from freshmen to seniors and represent a plethora of majors including Business Administration, Fashion and Retail Merchandising, and Liberal Studies. Most, if not all, of these students are likely to have not taken a biology course since high school. Additionally, a majority of the students have not been tasked with running experiments.

For this course, there is not a standardized curriculum, though there are several requirements for the T.A., such as weekly quizzes, which are worth a total of 28% of their final grade. However, there is no requirement regarding the content for each quiz. I am also given several suggestions, such as presenting a 20-minute PowerPoint at the beginning of lab to convey concepts essential to student understanding of the day's experiments. Having served as a T.A. for this course for two consecutive quarters prior to taking the Educational Psychology course, and per written feedback on forms each student completes at the end of each quarter, I have learned that these lectures felt overwhelming. If I stuck with the traditional inundation of facts and academic language first, followed by the application of those concepts second—a pedagogy commonly used in the natural sciences classroom today—then I felt I was directly contributing to student learning hesitation and a fixed mindset dislocating their abilities to do science. *So what should I do?*

After reflecting on my own learning experiences in Educational Psychology using Moses' framework, it was evident to me that learning via completion of an experience

prior to learning academic terms helped better understand concepts. The emphasis was not on knowing the language, but on knowing the deep-rooted application of the covered topics by connecting the concepts to students' prior knowledge and experience. Additionally, Moses' framework was a powerful method in my own learning because it allowed me to collaborate with classmates by consistently sharing my cogitation. I knew I had to incorporate this framework into my own teaching, though admittedly I was initially apprehensive. A slew of questions ran through my head as I attempted to analyze the practicality of Moses' framework: *Would students really understand these highly conceptual biological principles? I am encouraged to teach students 15-30 vocabulary terms each lab. If I cut this number of terms down, would I be doing a disservice to my students or my supervisor? Was each of these terms applicable to their everyday lives?* Although I had a preconceived notion that the framework would be successful in my class, I was frightened that I may make things too easy on the students. Natural scientists tend to praise students who succeed in a traditional framework of lecturing. *Would I be considered an unequipped T.A. if I flipped this framework on its head?*

During Spring 2017, my third quarter of teaching Life Science and while I was concurrently enrolled in Educational Psychology, I decided to slowly incorporate Steps 1, 3, and 4 of Moses' framework into my teaching. For example, during Week 5 the photosynthesis laboratory, I used the framework for a paper chromatography experiment. First, I provided students with the common experience of a class discussion regarding the various color pigments we have seen in leaves and what time of the year they have seen these pigments. Students shared that they had seen red, orange, yellow, and of course, green leaves, which were generally seen during fall and winter. Next, I told students we were going to use a special paper that separates pigments. Students then placed a sample of an unknown plant's pigment on the paper, which appeared green. After waiting 20 minutes, students had colorful, banded paper in front of them. These common experiences of discussing leaf pigments and running the pigment on their papers were related to Moses' Step 1. Next, I asked students to describe what they saw and to think of why various colored bands appeared on their paper from a seemingly green sample. This discussion of a common experience was related to Step 3 of the framework. I then introduced the academic language, which is Step 4. Students learned that the special paper was called "chromatography paper," and that the pigments that appeared red, orange, and yellow were "accessory pigments," which are present year-round in certain plants, but are masked by the presence of dominant, green pigments. Since I had just learned Moses' framework, I tried to implement it in part and slowly, focusing on the experience and discussion. This allowed students to participate in a student-centered classroom; an approach that was so beneficial to my own personal learning.

To my surprise, the students' quiz scores significantly improved on two of the five quizzes where I incorporated Moses' framework. Each week, students are given a ten-question quiz with each question being worth one-point. Approximately seven of the ten questions remain the same each quarter, and I write approximately three new questions, though the level of difficulty remains the same. In the Spring 2017 cohort, where I utilized Moses' framework, students had a 19% increase in their Photosynthesis Lab average quiz score when compared to my Winter 2017 cohort, where Moses'

framework was not utilized. Similarly, the Spring 2017 cohort scored an average of 18% higher than my Winter 2017 cohort on their Central Dogma Lab quiz. Of the questions that remained consistent through the two quarters, I noticed students performed better on what I deemed to be the most difficult quiz questions. For example, with the Photosynthesis Lab, students increased their average quiz score by 20% for the question, "True/False: Accessory pigments are responsible for the green coloration of leaves." Even though this is a factual recall question, it requires students to think deeply about the evidence provided in class to support their decision. My students' improved performance suggested that they were able to analyze the application of a limited number of essential concepts. *Maybe teaching students 15-30 vocabulary terms per lab was not necessary, after all.*

I strongly felt that Moses' framework was helpful in my university teaching. Biology is especially rich in academic language, which can be overwhelming for students. In fact, when I read my end of the quarter comments, students often informed that they entered the class with a dislike for the subject, indicative of their fearful incapacity for understanding biological concepts, but they felt confident by the end of the course. I believe that was, in part, due to Moses' framework that allowed my students to build on their prior knowledge and to learn from each other. Through my facilitator role that enabled them to take a central role in the classroom, my students felt the subject matter was less grueling, and that they already had the tools to succeed in science. To my satisfaction, the students with initial lack of enthusiasm for the subject also stated their changed disposition and willingness to learn biology by the end of the course. Moses' framework is a powerful teaching method that I will continue to use throughout my career as an educator.

Discussion on Moses' Framework: Teacher Educator Perspectives

As these preservice teachers' narratives show, Moses' framework is a promising pedagogical framework in multiple ways: It integrates students' previous experience and knowledge (Ladson-Billing, 2009), provides multi-layered scaffolding (Moschkovich, 2015), and enables rich use of informal and formal languages (Cummins, 2000). By applying this framework, students are supported in language and attain conceptual understanding. These are particularly helpful in teaching underserved populations, including English language learners who need appropriate scaffolding to make their learning meaningful (Walqui, 2001).

One of the greatest strengths of this student-centered framework rests in its adaptability to be used across a wide spectrum of disciplines and grade levels. It transcends discipline specific pedagogy due to its incremental scaffolding applicable to all learning contexts. In our previous study, sixth grade Latino/Hispanic students who were all English language learners benefitted from this framework with significant gains in their mathematics (Ahn, I, & Wilson, 2011). Moreover, in this self-study, three preservice teachers in Educational Psychology course as well as university students in a freshman biology course were positively impacted by the framework. These cases support the benefits of using Moses' Five-Step Approach when teaching students in PK-16.

Perhaps the most salient characteristic of this framework lies in the step-by-step pedagogical scaffolding that is founded on social constructivism. Beginning the lesson with Step 1 provides a non-threatening and common entry point for diverse learners, which lowers down their affective filter that may hinder their learning. Engaging diverse learners through a common activity, followed by expressing their learning non-verbally and verbally with their peers using their own language empowers them to take ownership of their learning. As the fifth author stated, through this approach, students begin to take the central role in the classroom, as the teacher increasingly takes the back stage as a facilitator or guide (Vygotsky, 1986). Students are given access (Moses & Cobb, 2001) to full participation in this socially constructed environment.

Understandably, this method also has challenges, since it is a profound, methodical framework that stretches teachers' thinking about how to teach. One such challenge is the difficulty in spending time to prepare meaningful activities for Step 1. As the fifth author shared, teachers are expected to teach numerous concepts within the discipline. The teacher must be able to identify the essential concepts and sub-concepts and determine which concepts—the most difficult and abstract concepts—to apply the framework, as going through all five steps would take longer time both for the students as well as the teacher to prepare the lesson. Another challenge is the counterintuitive nature of the framework that begins with a shared experience, followed by academic terminology and definitions, which most teachers are not accustomed to. In my own classes, I (first author) constantly fought back the tendency to present the PowerPoint presentation in a linear fashion with all the theoretical concepts in the beginning. This conscious effort to fight back the old habits of mind that was conditioned during the past however many decades of schooling and teaching is a phenomenal challenge, a challenge so enormous that I experienced serious cognitive dissonance (Loughran, 2006) and discomfort. As a result, I was stretched to think deeply about my own pedagogy to consciously model what I taught: Beginning with structuring effective physical activities pertaining to abstract learning theories (Step 1), followed by Step 2 to allow students to express their understanding through pictures, symbols, emojis, and words (Ahn, Ingham, & Mendez, 2016), incorporating small group discussions in their own words (Step 3), connecting students' everyday language to the academic vocabulary and concepts (Step 4), and encouraging students to express their understanding based on Step 4 on the communal notes in their groups as needed (Step 5). After all, as a teacher educator, my ultimate goal is "modeling" (Loughran, 2006 & 2010; Loughran & Berry, 2005; Lunenberg et al., 2007; Santangelo & Tomlinson, 2012) for prospective teachers to learn not only from what I say but also from what I do in the area of effective pedagogy for diverse students.

Through continuous and intentional reflections on these steps, transformation began to take place in my own habits of mind: How can I structure Unit 2 on various functions of the brain in a student-centered manner? How would I break down amygdala, hippocampus, and hypothalamus so that students who are English language learners do not feel overwhelmed by the difficult academic language? How do I help students learn a large number essential functions of the brain in the curriculum in a limited time? How should I model student-centered scaffolding pedagogy to prospective teachers effectively? Following Moses' framework, which learning activity would be a meaningful Step 1 activity? How much time should be allotted for Step 2 and 3? How would I

connect Step 3 to 4? Soon, I found myself applying this lens to look at everyday phenomena.

Another challenge that comes with applying Moses' framework is adhering to each step. As the preservice teachers shared, they omitted Step 2 in their presentations for various reasons, indicating Step 2 might not be as necessary for advanced learners or when there is limited instructional time. One might argue that Step 2 is unnecessary or redundant; however, the Pictorial Representation process is critical for those who do not have fluency in the instructional language (Boakes, 2009; Cankoy & Özder, 2011). The existence of visuals in Step 2 helps them initiate meaningful discussion and explain their reasoning. In my class (first author), I noticed a related issue: Some students preferred to discuss their experience (Step 3) with their group members before expressing their understanding by themselves (Step 2). When I noticed this phenomenon, I gave my students freedom to use these two steps interchangeably, since the order of verbal and non-verbal scaffolding was not as important as the goal to attain conceptual understanding. As I observed their behavior, I further noticed that after talking in their groups (Step 3), which clarified their thinking, some of them went back to Step 2 and made changes on what they drew, resulting in deeper and clearer expressions. These experiences point to the bidirectionality of these steps, as students use verbal and non-verbal means to make sense of their learning as they see fit. This supports Moses' Five-Step Approach is indeed an adaptable framework; depending on the needs of the academic and language levels of students, as well as the amount of instructional time and nature of the activity, some of these steps of scaffolding can be combined, omitted, or used bidirectionally.

In closing, we believe the Five-Step Approach is a liberating pedagogical framework that holds promise to teach today's diverse populations across different grade levels and academic disciplines. It frees students from being passive participants of traditional teacher-centered approach to active agents of their own learning. This is possible when teachers intentionally set up instruction that puts students at the heart of the learning experience, providing full access to knowledge. Students are encouraged and welcomed to express their understanding through multiple means with their peers. Through this liberating framework, students and teachers alike are empowered to be engaged in the co-construction of knowledge grounded in social constructivism.

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Appendix

Educational Psychology Group Presentation Feedback Form

*The presenter must fill out the asterisks ahead of time before making enough copies for the entire class.

*Presenter's Name: _____

Your Name: _____

*1. Describe the essential concepts presented:

Chapter: _____ Target Concept: _____

2. How did the presenter engage all of the learners at the beginning of the presentation ("anticipatory set" or "motivation")?

3. Did the presenter promote student participation by having them discuss and talk with one another?

4. Circle the modalities of learning that the presenter used in the presentation:

Visual Auditory Kinesthetic Tactile

5. Did the presenter communicate effectively to English learners? (Circle)

Clarity/enunciation Volume Speed

Comprehensible vocabulary Pacing/wait time Body language

(use visual aids and body language)

Breaking down vocabulary and connecting to students' prior knowledge

6. How did the presenter do on the following areas?

Planning for the presentation (use of time and materials;

readiness; no notes used during presentation;

e-mail communication;

open to constructive criticism, etc.)

Professional/appropriate attire

Teamwork

(help each other; monitor discussions; speaking time fairly distributed, etc.)

7. Other comments: