

Differentiating instruction in the pre-service science education classroom

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Abstract. In today's increasingly diverse classrooms, instructors must be prepared to use a variety of teaching methods in an attempt at reaching all students. Students enter the classroom with a vast array of experiences, backgrounds, and other diversity markers that can impact their perceptions and skill level in science courses. This is of particular importance in the field of teacher training, where students need to not only study innovative teaching techniques but authentically experience these techniques that are varied. The purpose of this paper is to demystify differentiated instruction in the science methods classroom and provide strategies for assessment, materials access, and activities. Throughout instruction and assessment, students are given voice, the opportunity to provide input regarding what and how they learn, and choice, the opportunity to opt for activities/assessments they find interesting, stimulating, or match their learning preferences. Finally, differentiation is a philosophy of education that not only acknowledges but celebrates diversity and differences in students. As we prepare these students to become teachers, it is imperative that students not only discuss instructional strategies but authentically experience them as well. Differentiation gives the professor the ability to be the "guide on the side" and provide the students a wider range of discussion and demonstration of common goals.

Keywords: differentiation, science instruction, pre-service teachers.

1 Introduction

In today's increasingly diverse classrooms, instructors must be prepared to use a variety of teaching methods in an attempt at reaching all students. This is of particular importance in the field of teacher training, where students must witness innovation in their core classes, and engage in educational experiences that are varied, stimulating, and hands on. The differentiation of teaching and assessment methods offers students a variety of options by which they provide evidence of their learning [1].

Differentiated instruction (DI), an approach in which teachers plan lessons strategically to address the needs of individual students is rooted in the belief that any group of learners is full of diversity and that effective teachers prepare for individual differences [2]. Throughout instruction and assessment, students are given voice, the opportunity to provide input regarding what and how they learn, and choice, the opportunity to opt for activities

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and assessments they find interesting, stimulating, or match their learning preferences. Finally, differentiation is a philosophy of education that not only acknowledges but celebrates diversity and differences in the students we teach [3]; and, “given the changing demographics of United States schools, by ignoring issues of diversity, teachers only serve to perpetuate injustice” [4, p. 173].

This paper looks to simplify the process of differentiation for instructors of the sciences, specifically, those whose students may be preservice teachers, by providing simplified instructions on identifying when to differentiate, offering guidelines for how to easily differentiate and supplying a variety of examples showing how other instructors have used DI in their courses.

2 Methods

In this paper, we used the method of systematic literature review and case studies of pedagogical practices. This allowed us to provide a comprehensive definition of Differentiated Instruction, describe various DI strategies and identify contexts for their application.

We will discuss DI in relationship to rigorous teaching standards according to Bloom’s Revised Taxonomy of Learning (Bloom’s), and interests and preferred learning style as discussed in Gardner’s Multiple Intelligences Theory (MI) [1]. In this manuscript, rigor/rigorous will refer to activities and assessments that ask students to perform on the top three tiers of Bloom’s: Analyzing, Evaluating, and Creating. In contrast, foundation/foundational will refer to the three lower tiers of Bloom’s: Remembering, Understanding, and Applying. Similarly, we will use the term MI to indicate the use of instructional strategies that appeal to a variety of learning styles or preferences, such as Visual/Spatial, Linguistic, Bodily/Kinesthetic. Both of these dimensions will be discussed in relationship to student readiness, skill and concept attainment, materials access and learning activities, and assessment of learning.

3 Results

Due to the very nature of differentiated instruction, which allows students the opportunity to play an active role in their own education, DI is able to meet the needs of every student, even in widely diverse classrooms [5]. Allowing students choice regularly leads to a sense of ownership in their learning and increased motivation toward academic tasks as well as engenders a sense of trust between the teacher and the student [6].

One area of instruction that can be particularly challenging is working with English Language Learners (ELLs) in a fully/primarily English Language setting. Arnold [7] asserts that DI methods of teaching are impactful for use with ELL students in their vocabulary acquisition. An additional concern is that, “English Learners are not a homogenous population [in terms of] language proficiency(ies), cultural backgrounds, prior schooling, and knowledge and skills” [5, p. 1]. This indicates that while differentiation is appropriate to address differences between English Learners and Native English speakers, it is also necessary to differentiate educational experiences among our EL students.

DI can also be vital in a classroom setting with students of mixed academic abilities when “differentiation occurs both downwards for remediation, but also upwards for the extension of those learners who show academic promise” [8, p. 283]. While some may consider the benefits of ability grouping to facilitate accelerated pacing of instruction [9], doing so may lead to a one-size-fits-all academic experience, rather than an environment in which, “learners are recognised in relation to their difference, rather than solely as a

communalised grade cohort” [8, p. 283]. Additionally, continued practice of pullout programs for students with special needs perpetuates deficit thinking and ignores the benefits to mixed ability classrooms [4].

When teachers also consider the intersectionality of factors that impact students’ academic experiences, the argument for DI becomes even stronger. Take for example a student who is both academically gifted and lives in poverty. This student may experience a reality of being “twice oppressed” [3, p. 774] just as might a student who is academically gifted and linguistically diverse. By identifying a student’s multiple dimensions of diversity, teachers are able to allow students to pursue lines of investigation that spark inquiry, higher order thinking skills, and promote 21st century skills such as communication, collaboration, and critical thinking [3, 9].

Researchers do, however, caution that DI be used thoughtfully and appropriately. One caution is to balance the amount of workload on instructors [10]. Medveš [11] cautions that differentiation not be used as “tracking in disguise”, as described of educational reform efforts in post-World War II Yugoslavia, which attempted to offer choices to students but ultimately placed learners into predefined work-readiness or college-readiness tracks.

Others caution when implementing DI that educational leaders not assume all teachers are prepared for and skilled at writing and facilitating differentiated opportunities for their students. Frankling, Jarvis, and Bell advocate not only training, but “appropriate, embedded support and direction” [2, p. 84] while teachers begin to apply their knowledge of differentiation to lesson planning and implementation.

4 Discussion

The following DI strategies have been defined.

4.1 Student readiness

Most teachers understand that students come to class with varying background experiences, including those from their personal lives and ones from previous science classes. Using a pre-assessment tool with students, a professor is able to determine with which knowledge/skills students enter the classroom. With that information, students can be grouped according to their background knowledge and each group can then be offered scaffolded tasks. In this way, all students engage with the requisite materials, but those who need more support can find it in a group of their peers who also lack the background while their more knowledgeable peers work on more rigorous tasks [9]. Additionally, student groups can be based on interest surveys or students can self-select into groups based on content focus, learning needs, academic preferences, or outcome product [1].

One strategy we find useful is the Mini-Library assignment. This strategy requires teachers to collect various informational resources on a single teaching point. The resources should be diverse in formats (eg., academic text/article, political cartoons, children’s books, fiction/nonfiction narratives, YouTube videos) to allow students to choose the format(s) they are most interested in accessing.

4.2 Skill and Concept Attainment

Just as there are a variety of ways to offer students additional background information before beginning a new unit of study, there are a variety of ways to teach students the skills and concepts addressed in the new unit of study. Due to the continuous access to

information and entertainment available, students find it more difficult to accept, digest, and retain content that is delivered without, at the very least, a modicum of variety.

Methods for differentiating students' opportunities for learning include relatively simple ideas like using a Flipped Classroom model [12] or referring students to a more extensive Mini Library on the subject of study. Additionally, students can be placed in heterogeneous or homogeneous groups depending on the purpose of the given task. While some researchers indicate that homogeneous grouping is preferred in product/outcome activities [9], others argue that heterogeneous grouping is preferred because it will raise the academic achievement of all students [13].

4.3 Materials Access and Learning Activities

Once students have been introduced to the skills and concepts they are learning in the unit of study, instructors offer activities that will help grow student knowledge. One way of doing this is to offer options from which students can choose the level of socialization required for their learning activity.

Another way to offer differentiation during the practice/enrichment phase of the learning process is to Jigsaw access to the materials to which each person has access. In this method, each student or small group is given only a portion of the information, materials, or prompts needed to complete a project. This forces collaboration, a 21st century skill, and allows each participant the opportunity to become an expert on the assigned portion of the project as well as gives students more ownership in their learning.

4.4 Differentiated Assessments

The most critical activity in which teachers engage is the assessment of growth and learning in their students. Because the goal of assessment is to give students the opportunity to showcase their growth and learning, offering students voice and choice in how they showcase their knowledge [6] will give them the opportunity to work with their personal strengths, giving the instructor a clearer picture of actual knowledge and skill gained [14-16].

Offering options for assessments is the most accessible form of Differentiated instruction and is often the first step taken by classroom teachers who are interested in updating their pedagogical practices. One of these strategies is offering a menu of choices from which students can choose. "Menus" can come in a variety of formats, for example, setting up options as courses in a meal. Students are asked to choose one item from each course and the number of courses is dependent on the number of skills that need assessing.

Another way to offer options is through an Assignment Matrix, which we ask our students to create for their content area. A simple matrix looks like a Tic-Tac-Toe grid and would ask students to complete any three assignments in a straight line, down, across, or diagonal. The assessment our students complete includes the six levels of Blooms on the x -axis, and six to eight learning-style preferences on the y -axis. In each associated cell is an activity that corresponds with the Bloom's level and MI style. Students are then instructed to complete six activities, making sure that no two activities fall on the same x or y line. The benefits to this style of differentiation include that students are able to choose activities that match their interests and strengths, but are also asked to work outside their comfort zone for a portion of the assessment.

5 Conclusion

Although differentiating classroom instruction can seem to be an overwhelming undertaking for teaching professors, the benefits to providing students with more voice and choice in their learning can lead to more ownership of learning for students. Differentiation gives the professor the ability to be the “guide on the side” and provide them, as well as the students, with a wider range of discussion and demonstration of common goals/objectives.

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