

SCIENCE EDUCATION FOR LINGUISTIC AND CULTURAL DIVERSITY IN PHILIPPINE PUBLIC HIGHER EDUCATION (SELC-PhPHiEd)



Educating Science Teachers for All

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Educating Science Teachers for All
Philippine Normal University
The National Center for Teacher Education

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INTRODUCTION



1 Introduction

1.1. Background of the Study

Educating Science Teachers for All (ESTA) is a specially designed project and program that seeks to contribute to the diversity goals emphasized by the European Commission. ESTA envisions science education to be socially sustaining as advanced and posited by the sustainability goals of the United Nations (UN) and the European Union (EU). The project targets to contribute to more equitable, inclusive, and higher quality science teaching by addressing the needs of culturally and linguistically diverse learners. The project conjures that appreciation and deep understanding of cultural diversity and education of teachers for inclusive teaching contribute to the empowerment of and promotion of social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status of learners (UN, 2015).

Global organizations such as the EU promote science education for responsible citizenship in the same manner that the Paris Declaration recommends teaching all students for our better future. As such, project ESTA identified partner countries (e.g., Georgia, Philippines, and Bosnia and Herzegovina) that cater to a large number of youth who do not meet the basic requirements in science as per large scale international assessments such as Programme for International Student Assessment (PISA). In fact, all three countries scored very low in science performance (PISA, 2018). This challenge in science education may be attributed to the plurality of languages and cultures, resulting from conflicts in power relations and major changes in the education system in Georgia, and Bosnia and Herzegovina after the fall of the Soviet Union. In the Philippine education system, such challenges are imprints of colonialism that hamper the country's progress and the people's understanding of their own culture and assertions of their economic resources. Hence, the project asserts that science education in all the three aforementioned countries takes place amidst political and ethnic divides that translate into linguistic and cultural diversity.

ESTA, as a project, envisions to address the aforementioned challenges of linguistic and cultural diversity in science education in all the three countries by building a transnational network of university science teacher educators. The effectiveness of new approaches to science teaching and learning will then be shared and discussed among these countries in order to implement effective and efficient measures.

The Philippine plurality of language and culture is sourced from the cultural and linguistic profile of the Filipino people with about 110 indigenous groups and more than 170 languages



spoken as first languages from a multitude of regional dialects and languages (Philippines, 28 September, 2017). However, only two languages (English and Filipino) are officially recognized in the education system as languages of instruction, specifically in the upper levels of education (The K to 12 Basic Education Program, 2012). Although the new curriculum acknowledges the mother tongue of the learner as the medium of instruction in the K to 3 level, these levels do not particularly register separate science subjects or courses in the curriculum. Science concepts in these levels are embedded in different subjects. Furthermore, the aforementioned curriculum implements Science teaching as a separate subject where English (L2) is used as the medium of instruction. This means that most students still learn science in a second language resulting in difficulty of learning both the language and the content. This linguistic heterogeneity and underlying cultural diversity constitute major challenges for science education in the country. Factors contributory to these challenges include language and content training and proficiency of teachers, and lack of adequate teaching materials (Morales, 2015). In fact, the prevalence of low student performance in international and national assessments indicates that although teacher education is institutionalized in the country, teacher education programs continue to face major challenges on student performance among other things.

ESTA provides a means for premier teacher training institutions in the country such as the Philippine Normal University (PNU) and the De La Salle University (DLSU), the capacity to reach out to as many pre-service and in-service teachers and disseminate science teaching approaches in linguistically and culturally diverse contexts. In particular, PNU, the National Center for Teacher Education, is able to reach out to other government owned State Universities and Colleges (SUCs) and Local Universities and Colleges (LUCs) that comprise about 30% of the total Higher Education Institutions (HEIs) in the country (Commission on Higher Education, 2020). Hence, ESTA foresees science education enhancement by improving the level of teaching competencies in the partner universities. The professional development of university science teacher educators provides an avenue to successfully manage diversity in science classes within the context of the country's language and culture. Consequently, these teacher educators will be able to share their knowledge and skills with in-service and pre-service science teachers and contribute to a more inclusive and higher quality science education in the country.

In focus, the professional learning and development of ESTA targets the core of the project, which is diversity in the overarching goal to improve science achievement of Filipino learners. Hierarchical processes that define the phases of the project include the program universities' holistic support to professionalization and the development of university educators; the enhancement and improvement of science teacher education curriculum of the partner universities in the Philippines; and the professional development and capacity building of pre-



and in-service science teachers. Consequently, with an initial attempt to provide an enhanced curriculum, the core ESTA team of the Philippine Normal University envisions a framework that will serve as guide and major document in all curricular modifications and enhancement leading to inclusion as a way to address diversity.

1.2. Purpose

This document details the processes implemented and the documentation and validation conducted, collected, and analyzed. The blueprint developed shows how the curricular modifications and enhancement of the pre-service and in-service science programs of the university will be enacted. This framework also intends to provide an infrastructure and guide to the development of other products and services derived from the modified curricular programs such as capacity building projects, teacher training programs, culture and language sensitive instructional materials, culture and language sensitive resource materials (for both the teachers and learners), module design and development, and the design and development of culture and language sensitive lesson exemplars along with culture and language sensitive assessment tools.



FRAMEWORK



2 Framework

ESTA presents Science Education for Linguistic and Cultural Diversity in Philippine Public Higher Education (SELC-PhPHiEd) in response to the call for a blueprint on how curricular modifications and enhancement of the pre-service and in-service science curricular programs of the university and teacher trainings will be enacted. SELC-PhPHiEd encompasses the social and political issues that may merit inclusion during learning contextualization, transition of the focus of “A” in STEAM to the “Arts,” and the Appreciative Inquiry as one major principle in the teaching and learning aspect. Additionally, the framework includes the assumptions of the Core ESTA-Philippines-PNU team which underscores how learning may be achieved through complete and deep understanding of the major features of the framework sourced or drawn from analysis of learners and teachers data and documents and the review of literature. The following underlying principles detail how responsive and relevant the pedagogies are in relation to the other features.

2.1. Assumptions

Educating Science Teachers for All [Philippines-PNU] argues that learning of Science concepts, principles and skill can be achieved through deep understanding of the learners, teacher’s knowledge, and of responsive and relevant pedagogies.

2.1.1 Filipino Learners

Learner’s experiences, culture, language, and the way they were socialized by their families and other social institutions are contributors to cognitive development which is central to learning (Bruner, 1966; Demmert, 2001; Demmert & Towner, 2003; Gardner, 1985, 1995; Vygotsky, 1978). This implies that Filipino learners bring with them their distinct cultural background and mental maps to the classroom.

2.1.1.1 Context of Filipino Learners’ Language

In the Philippines, English and Filipino are two of the official languages provided for in the 1987 Constitution (Article IV, Section 7). Following the Bilingual Education policy, these two languages are to be taught and used as media of instruction in specific subjects in the curriculum with the goal of achieving competence in both. The development of Filipino and its continuing intellectualization stand as the linguistic symbol of national identity and unity. English is maintained as an international language for communication and as a non-inclusive language for science and technology. In addition to Filipino and English, the regional languages in the Philippines, of which there are many, are used as auxiliary media of instruction and as the initial language for literacy.



With the implementation of the K to 12, the law on Mother Tongue-Based Multilingual Education (MTB-MLE) was expanded stipulating the use of the mother tongue (MT) as the primary medium of instruction (MOI) in kindergarten and in the first three years of elementary education. Thus, from being an auxiliary MOI, the MT is now framed as central in education further recognizing that Filipino is not necessarily the MT of most Filipino learners. In addition, the role of the local language cannot be ignored considering that both local and international research point out that students learn best when they use language that they are most familiar with (Tupas & Martin, 2016).

The Department of Education (2016) identified nineteen major Philippine languages for use as a learning area and as MOI in the adoption of the MTB-MLE policy. For many teachers however, using these languages as MOI proves challenging if not limiting, given that these may not be their mother tongue nor do they find themselves knowledgeable enough to teach in those languages. As Nolasco (2012, cited in Tupas and Martin, 2016) points out, the implementation of MTB-MLE may not be much different from how teachers have been teaching previously. Despite these concerns, mother tongue which is considered the language most familiar to students, is now a required language of instruction even if limited to the early grades.

2.1.1.2 Language

Academic language, which is cognitively demanding, requires more of the higher order thinking skills (HOTS) such as inferring, classifying, comparing, evaluating, and synthesizing content. It is not enough that students are able to carry out conversational and social skills to be considered equally proficient in the language for academic learning. Cummins & McNeely (1987) distinguishes between two different types of proficiency which he refers to as the Basic Interpersonal Communication Skills (BICS) and the Cognitive Academic Language Proficiency (CALP). BICS are the skills easily acquired by the learner through interaction with others while CALP serves as the baseline for coping with academic demands. Thus, one cannot assume that a high degree of proficiency in everyday spoken language necessarily translates to academic language proficiency.

Being aware of the difference between these two types of proficiency provides for appropriate and sufficient support for second language learners such as those in the Philippines. It is important for the learner to have more opportunity to learn concepts and be exposed to various contexts that are both cognitively demanding, context reduced and undemanding. Equally, these variety of situations challenge the teachers to explore different cultural languages and backgrounds and incorporate these in their daily teaching and curricula.



Cummins (2000) likewise points out that learning one language is beneficial for the learner to develop metalinguistic skills that are useful in learning additional languages. He refers to these skills and knowledge as the common underlying proficiency (CUP) which serves as the base for the development of both the first language (L1) and the second language (L2). Such theory supports the use of the mother tongue as an effective language of instruction. In the Philippine context, this would mean recognizing the viability of MTB-MLE not only for literacy and academic learning but also for celebrating cultural identities.

2.1.2 Teacher Knowledge

Teacher's knowledge adheres to the scholarship of teaching (Boyer, 1990). Teacher's knowledge of the content which is enhanced by reflective teaching, research with peer reviews, knowledge transformation and the teaching-learning process and assessment also contribute to the quality of student learning (Schunk & Rice, 1991; Glassick, Huber, Maeroff & Boyer, 1997). Scholarship of teaching covers construction of knowledge essential in building content knowledge (CK) which when transformed into processes for student learning becomes pedagogical content knowledge (PCK) (Shulman, 1986). Moreover, when teachers use technology to facilitate student learning, the scholarship of teaching expands to technological pedagogical content knowledge (TPCK).

2.1.3 Pedagogies

In building responsive and relevant pedagogies, the learners' contexts will have to be considered. As such, the learners' experiences, language and cultural contexts, and the results of the socialization process by families, communities and other social institutions are important starting points in the teaching-learning process. Thus, the role of the teacher is to bridge student contexts to understanding Science concepts and approaches such as constructivism, social constructivism, experiential learning, culture-based learning, and language learning theory to operationalize teaching strategies and assessment that deepen the understanding of the learners.

2.1.3.1 Principles

Constructivism/Constructivist Approach

Constructivism as an approach to learning holds that "people actively construct or make their own knowledge and reality that is determined by the experiences of the learner" (Elliott et al., 2000, p. 256 cited by McLeod, 2019); and knowledge that is constructed through active learning and mental processes (https://shodhganga.inflibnet.ac.in/bitstream/10603/12730/10/10_chapter%202.pdf). Langer and Applebee (1987) believe that the context created allows students to explore new ideas and experiences. Within this context, the teacher's role in providing information decreases and



is replaced by a strengthened role in eliciting and supporting students' own thinking and meaning-making abilities (cited by Gray, 1997).

Thus, constructivism allows academic freedom to students, encourages cooperative learning and the sharing of thinking among peers. The role of the student changes from 'knowledge acquisition' to 'knowledge construction' within the constructivist paradigm. Likewise, instruction is considered as a process of supporting the individual's construction of knowledge as opposed to the conventional method of transmitting knowledge to the learner. The students negotiate within their minds, reflectively and meta-cognitively and interact with others, socially within the context of a community of learners.

Social Constructivist Theory

Vygotsky (1896-1934) states that knowledge is co-constructed and that individuals learn from one another thus emphasizing the importance of culture and interaction in the development of cognitive abilities. Known for his concept on the Zone of Proximal Development (ZPD), Vygotsky defines ZPD as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Second Language Acquisition Theory

According to Krashen there are two independent systems of foreign language performance: the 'acquired system' and the 'learned system'. The 'acquired system' or '**acquisition**' is the product of a subconscious process very similar to the process children undergo when they acquire their first language. Acquisition requires meaningful interaction in the target language or natural communication where speakers concentrate on the communicative act and not the form of their utterances, The "learned system" or "**learning**," on the other hand, is the product of formal instruction which is the conscious knowledge 'about' the language such as the knowledge of grammar rules. In a teacher-centered setting it is the deductive approach that produces "**learning**", while the inductive approach leads to "**acquisition**".

The **Monitor** hypothesis explains the relationship between acquisition and learning and defines the influence of the latter on the former. The monitoring function is the practical result of the learned grammar.

The **Input** hypothesis which is only concerned with 'acquisition' and not 'learning' is Krashen's attempt to explain how the learner acquires a second language and how second language acquisition takes place.



The **Affective Filter** hypothesis embodies Krashen's view that a number of 'affective variables' play a facilitative, but non-causal role in second language acquisition. These variables include: motivation, self-confidence, anxiety, and personality traits.

Natural Order suggests that the acquisition of grammatical structures follows a 'natural order' which is predictable. For a given language, some grammatical structures tend to be acquired early while others late.

Technological, Pedagogical Content Knowledge (TPCK)

Shulman (1987) argues that teaching requires knowledge of the content, knowledge of pedagogy, and knowledge of students. With the advent of technology which becomes an important aspect in the teaching and learning, PCK merges with technology becoming the TPCK framework.

TPCK focuses on the complex interactions between a teacher's knowledge of the content (CK), pedagogy (PK), and technology (TK). Mishra and Koehler (2006) further claim that a teacher who can navigate between these interrelations acts as an expert far different than a lone subject matter, pedagogy, or technology expert. Moreover, probable categories and profiling of STEAM educators through their TPCK competencies may provide better capacity building (Morales et al., 2019)

Experiential Learning Theory

Kolb, (1984) defines experiential learning as "the process whereby knowledge is created through the transformation of experience and knowledge results from the combination of grasping and transforming experience" presented in a cycle of four elements such as concrete experience reflective observation abstract conceptualization and active experimentation.

2.1.3.2 Second Language Learning

The learning of a second language (L2) entails learning another language after the first language (L1) has been acquired. There are various ways to learn a second language such as the formal setting of a classroom, immersion in a foreign country, or through conversations and exposure with native speakers. The classroom environment appears to be the most efficient with comprehensible input from the teacher on the formal structure of the language that includes vocabulary, grammar, syntax, and discourse. On the other hand, a second language classroom provides a limited, if not unnatural environment, unlike immersion which provides not only a wide range of natural discourse but also the opportunity to interact with native speakers. The downside to immersion is that learning the second language is



unstructured and may be difficult for the language learner. The quality of interaction has a considerable effect in learning a second language.

Research in the second language reveals the cognitive benefits of acquiring a second language regarded as an advantage of bilinguals over monolinguals in such tasks as dealing with ambiguities, conflict resolution, and decision bias. With the addition of an L2, the learner forms new thought processes particularly with such tasks as dealing with ambiguities (Bialystok & Shapero, 2005), conflict resolution (Costa, Hernández, Costa-Faidella, & Sebastián-Gallés, 2009) and decision bias tasks. This experience with more than one language increases metalinguistic awareness making the learner more perceptive and analytical with making decisions and giving judgment.

2.1.4 Visual Framework

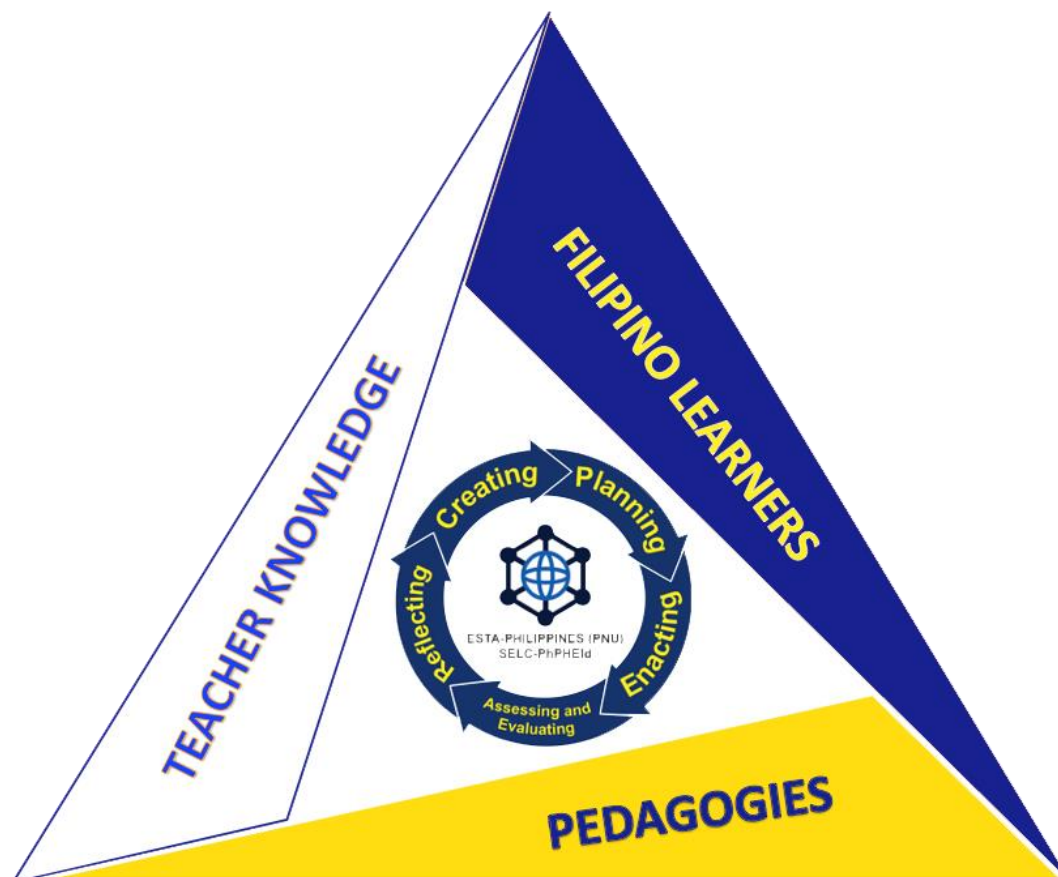


Figure 1. Science Education for Linguistic and Cultural Diversity in Philippine Public Higher Education (SELCP-PhPHEd) Framework.



2.1.5 Features

In context, the Science Education for Linguistic and Cultural Diversity in Philippine Public Higher Education (SELC-PhPHiEd) is a framework that is envisioned to concretize the goals of ESTA. Propelled by its key drivers such as culture and language diversity in the entire country, large scale assessment results, local and national evaluation, the Philippine Professional Standards for Teachers (PPST), and geopolitics and political economy, ESTA as a research endeavor hopes to address linguistic and cultural diversity in Philippine public schools for an inclusive science education. As a research program, ESTA seeks to improve teacher education curricula, teacher training for pre-service and inservice, teacher knowledge and skill that encompass content, context, language and culture to improve science learning.

The framework for Science Education for Linguistic and Cultural Diversity in Philippine Public Higher Education (SELC-PhPHiEd) is visualized to encompass three major components: the Filipino learners, the pedagogies and pedagogical frameworks, and the teachers' knowledge system in terms of enacting the science curriculum. The Filipino learners' attributes and profile primarily encompass their unique culture and language that consists of ethnicity, socialization process, gender, language, and all applicable constructs of culture and language spelled out in the cultural diversity wheel (Appendix A). The other attributes of Filipino learners include cognitive development, technological capability and affordances, and learning styles. Pedagogies spell out how the different frameworks and principles may be able to weave a unique strategy to enact the science curriculum suited to the unique attributes and profile of the Filipino learners. SELC-PhPHiEd emphasizes combining the best features of the different frameworks which include the following: (1) *STEAM approach* (an approach that utilizes all the STEAM fields in discussing a particular science lesson), (2) *CLIL's 4C's* (utilization of both language and content to enhance content and language learning), (3) *7E's* (used in the Philippine school, define the stages and parts in preparing a lesson within the principles of constructivism and inquiry-based approach), and the (4) *Bagong Kadawyan* (an approach used at PNU, the National Center for Teacher Education, to direct transition of learning and modality to an education in the new normal). Specific principles also define learner-centredness of SELC-PhPHiEd in particular, the *Constructivism and Social Constructivism Theory* which adheres to creation and co-creation of knowledge and knowledge systems. In addition, language integration and the learning through experiences are the respective thrusts of *Second Language Acquisition Theory and Experiential Learning Theory*. The teacher's knowledge system specifies the current TPACK system of the teacher that will capably drive meaningful learning of Filipino learners. SELC-PhPHiEd also recognizes the competencies, skills and knowledge that a Filipino science teacher should possess to enact a science curriculum. Teachers should have the skills and competence in multicultural education to match the cultural and linguistic diversity of Filipino learners. The framework also pictures the teachers' soft skills, assessment skills, and language proficiency in communicating science to



prepare them to holistically provide contextual science learning experiences for the diverse learners. SELC-PhPHiEd ideates that the teachers' attitude on change and future skills will shepherd how Filipino teachers address heterogeneity in the classroom to achieve inclusivity and meaningfulness in learning science. It is these idiosyncratic knowledge systems, skills and competencies that will enable the teachers to enact the curriculum according to their distinctive pedagogies influenced by the identified frameworks and principles. Hence, the SELC-PhPHiEd framework sums up a skilled Filipino teacher as someone who has TPACK, multicultural education skills, language proficiency, soft skills assessment and future skills.

SELC-PhPHiEd surmises that a skilled Filipino teacher delivers the science curriculum following the conventional processes of planning, enacting, assessing and evaluating, reflecting, and creating. Within the planning and enacting processes, the Filipino science teacher highly values contextualization, localization and indigenization. Additionally, culture and language sensitive resource materials contribute considerably to a more inclusive science education. These resource materials may be developed within the learners' community thus adopt community traditions, practices, and beliefs to make ethnoscience flourish and enhance the learners' life skills. SELC-PhPHiEd further believes that a complete run through of the teaching and learning processes such as assessing and evaluating and using the outcomes of the process in decision-making, and reflecting enables teachers to become critically reflective. Consequently, these teacher attributes and pedagogies will help Filipino learners develop other attributes such as lifelong learning skills and future skills, a required skill-set in the future industry and job market. Ehler (2020), identifies three important skill categories, namely: 1) subjective component that consists of learning literacy, self-efficacy, ethical competence, self-determination, reflective competence, ambiguity competence, decision competence, and initiative and performance; 2) object dimension that encompasses design thinking competence, innovation competence system competence and digital literacy; and 3) social dimension which comprises communication competence, cooperation competence, sense-making and future and design competence (Ehler, 2020). These competencies are what the skilled Filipino teachers envision for every Filipino learner future-job ready and instilled with the Filipino value system to be *makadiyos, makakalikasan, makatao, at makabansa*.



WAY FORWARD



3 Way Forward

ESTA's SELC-PhPHiEd presents the general constructs of focus in undertaking curricular modifications, enhancements, and enactment. These general constructs outline how the blueprint may also inform the different teacher education processes that inform teacher's knowledge, trainings and research in pedagogies, and the development of products for teaching and learning such as lesson exemplars, modules, and assessment within the bounds of linguistic and cultural inclusivity. SELC-PhPHiEd is PNU's vehicle to concretely advocate transfer of technology and disseminate knowledge on linguistic and cultural inclusivity to other Teacher Education Institutions for higher quality science education in the country.

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The page features a decorative background of overlapping triangles in blue, yellow, and orange. A large blue triangle is positioned in the upper right, with a yellow triangle overlapping its bottom-left corner. Below the yellow triangle is an orange triangle. In the lower right, another yellow triangle overlaps a blue triangle, which in turn overlaps a dark blue triangle. The word "APPENDIX" is centered in the lower-left area, underlined with a yellow horizontal line.

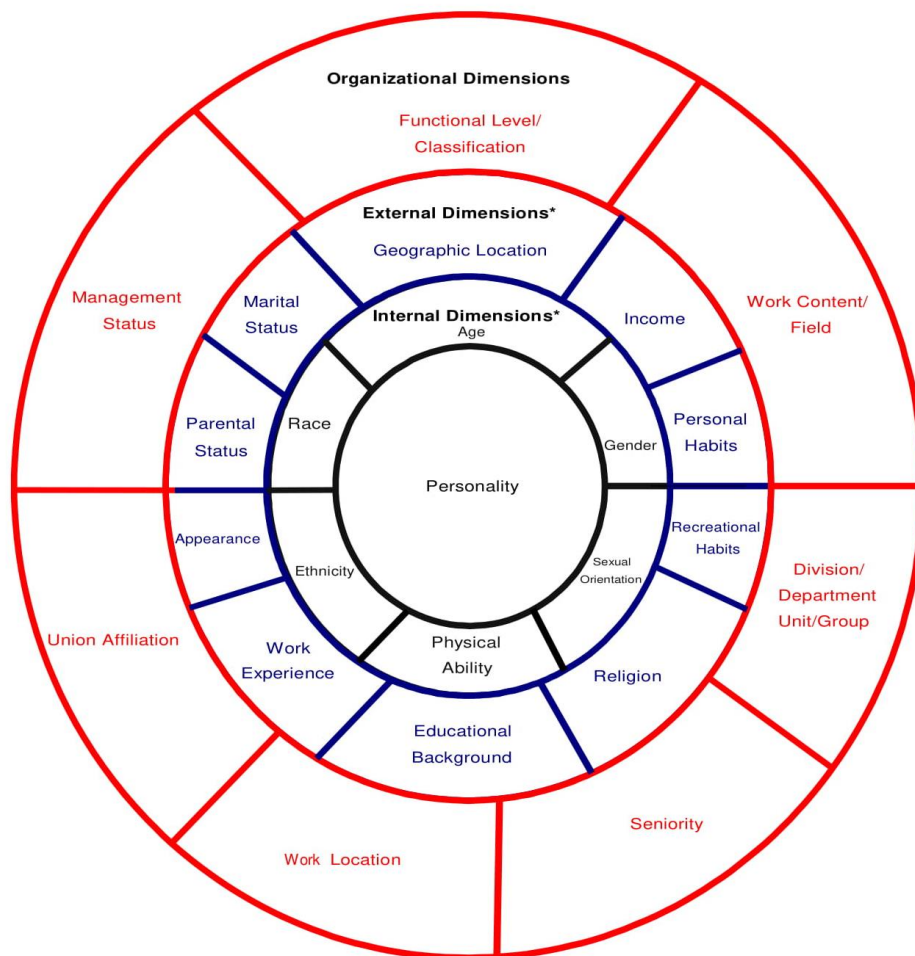
APPENDIX



4 Appendix

Dimensions of Diversity

The “Dimensions of Diversity” wheel shows the complexity of the diversity filters through which all of us process stimuli and information. That in turn leads to the assumptions that we make (usually about the behaviors of other people), which ultimately drive our own behaviors, which in turn have an impact on others. See below diagram for more detail.



The Four Layers Model

1. Personality: This includes an individual's likes and dislikes, values, and beliefs. Personality is shaped early in life and is both influenced by, and influences, the other three layers throughout one's lifetime and career choices.

2. Internal dimensions: These include aspects of diversity over which we have no control (though "physical ability" can change over time due to choices we make to be active or not, or in cases of illness or accidents). This dimension is the layer in which many



divisions between and among people exist and which forms the core of many diversity efforts. These dimensions include the first things we see in other people, such as race or gender and on which we make many assumptions and base judgments.

3. External dimensions: These include aspects of our lives which we have some control over, which might change over time, and which usually form the basis for decisions on careers and work styles. This layer often determines, in part, with whom we develop friendships and what we do for work. This layer also tells us much about whom we like to be with.

4. Organizational dimensions: This layer concerns the aspects of culture found in a work setting. While much attention of diversity efforts is focused on the internal dimensions, issues of preferential treatment and opportunities for development or promotion are impacted by the aspects of this layer.

The usefulness of this model is that it includes the dimensions that shape and impact both the individual and the organization itself. While the "Internal Dimensions" receive primary attention in successful diversity initiatives, the elements of the "External" and "Organizational" dimensions often determine the way people are treated, who "fits" or not in a department, who gets the opportunity for development or promotions, and who gets recognized.

Four Layers Exercises

"The Four Layers of Diversity" is not only a useful model, but can be used as a reflective tool to develop your own understanding of the impact of diversity on your life:

1. Read over the factors on the four dimensions. Think about how the various factors influenced the choices and decisions you made up to this point in your life. Which have had a positive impact? Which have had a negative impact? Which are you proud of? Which do you try to hide from others?
2. Looking at the factors again, think about those you have difficulty in accepting in other people. Which of the factors do you make snap judgments on? Which influence your decisions in a negative manner? What factors cause you to try to avoid contact with others?
3. To explore your values, create a list with the names of individuals you associate with frequently (family, work, community organizations). Next to each person's name, write some of the factors from the dimensions that you are both aware of and those you assume to be true about the person. For example: Jason: white, middle-class, college degree, single, Catholic. You can select different factors for each person. Then ask yourself: how do I treat this person differently, both in a positive and a negative manner, based on what I know, or the assumptions I am making, about the person? Where are my biases coming out?
4. Finally, the "Four Layers" can be used as a team building exercise for organizations, by having each individual work through exercises 1 and 2 individually, and then discussing their responses together.

Sources:

Diverse Teams at Work, Gardenswartz & Rowe

*Internal Dimensions and External Dimensions are adapted from Marilyn Loden and Julie Rosener, Workforce America; Business One Irwin, 1991

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