English Language Teaching; Vol. 10, No. 10; 2017
ISSN 1916-4742 E-ISSN 1916-4750
Published by Canadian Center of Science and Education

A Systematic Review: The Next Generation Science Standards and the Increased Cultural Diversity

Alaa A. Asowayan[1], Sammar Y. Ashreef[1] & Sozan H. Omar[1]

[1] Curriculum & Instruction Department\KSU, Ryiadh, KSA

Correspondence: Sammar Y. Ashreef, Curriculum & Instruction Department\KSU, Ryiadh, KSA. E-mail: softsnow345@gmail.com

Received: July 27, 2017 Accepted: September 2, 2017 Online Published: September 5, 2017

doi: 10.5539/elt.v10n10p63 URL: http://doi.org/10.5539/elt.v10n10p63

Abstract

This systematic review aims to explore the effect of NGSS on students' academic excellence. Specifically, considering increased cultural diversity, it is appropriate to identify student's science-related values, respectful features of teachers' cultural competence, and underlying challenges and detect in what ways these objectives are addressed by NGSS. Exploring the phenomena of effects, the qualitative evidence is collected. The sample consists of 52 academic entries (empirical researches and case studies) that shed light on the researched question. Summarized data is processed using thematic analysis. The findings reveal that modern students possess such science-related values as social presence, decreased power distance with tutors, simplicity of learning process, multitasking, universal accessibility of learning instruments, readiness to work with big data, readiness to use online software and tools. Simultaneously, teachers are expected to have such cultural competencies as cultural sensitivity, online mentoring, gut feeling about the proper power distance, and social presence. The lack of these competencies results in the emergence of various challenges in an educational setting.

Keywords: NGSS, cultural diversity, science-related values, teachers' cultural competence

1. Introduction

The Next Generation Science Standards (NGSS) is constructed to address thoroughly the needs of the today's youth. This document "seeks to provide students nationwide with an internationally benchmarked education by articulating crosscutting and deeply conceptual science performance expectations" (Haag & Megowan, 2015, p. 416). The credo of NGSS sounds as "all Standards, all Students" (Kahn et al., 2014, p. 38). An important emphasis of NGSS is the necessity to work with culturally diverse population (Rodriguez, 2015). According to the US Census "45% of the school age population under 19 years old are from diverse ethnicities and 21.6% of all US children live in poverty" (Rodriguez, 2015, p. 1035). One expects that the teachers learn how to combine cultural competence with the skills required for teaching scientific subjects. NGSS suggests that it is possible to advance significantly scientific education by arming tutors with the knowledge about science-related values that are typical for the contemporary students.

1.1 Importance of the Problem

Nonetheless, identifying and studying science-related values is a complex and challenging task. For example, technological progress predefines the need to incorporate technology in every aspect of a daily life, including classrooms. Hence, there exists a statement that "engineering and technology are new content areas for most teachers" (Cunningham & Carlsen, 2014, p. 207). Despite this fact, students' values are strongly connected to the computer technologies and online platforms regarding both formal and informal education. In other words, students are expected to be skillful in using devices to accomplish their educational goals.

Thus, one assumes that the students would prefer utilizing technological platforms for studying since this approach is in compliance with the modern popular culture. Similarly, in an academic setting "simulations, online learning environments, and modelling software" and other means gain popularity (Janssen & Lazonder, 2015, p. 910). Undoubtedly, the use of devices and online learning provides the new possibilities (Chen & Wang, 2015). In particular, the students can comprehend scientific material better due to the excessive use of advanced visuals (LaDue, Libarkin, & Thomas, 2015). Utilizing technological platforms assists in maintaining knowledge-in-use principle that is revealed in NGSS (Krajcik et al., 2014). For example, one can use these

means to contract scientific schemata and models to ensure thorough understanding of the learnt concepts (Campbell, Neilson & Oh, 2013). Consequently, tutorial staff should consider learning the new technologies that allow advancing the quality of the visual materials.

Despite the fact that this approach should facilitate teaching, it possesses certain challenges for tutors at the initial stage of implementation (Haag & Megowan, 2015). A recent study reveals that the teachers require more time to learn utilizing the modern technologies in classroom practices (Kennedy, Rhoads, & Leu, 2016). Kennedy et al. (2016) explain that tutors "must develop greater skill with the new technologies that will be used in the classroom and they must develop skill at the new instructional practices that those technologies require" (p. 156). Consequently, tutorial staff should have sufficient amount of time and resources to adjust to the respective changes in NGSS. Furthermore, the teachers should be capable of demonstrating appropriate level of cultural sensitivity while explaining scientific notions.

1.2 Relevant Theoretical Insights

On the other hand, it is advisable to portion the use of technology in the process of learning. In this respect, Durham (2015) educates that using blocks for developing critical thinking in the students of elementary schools is a highly effective means of development. Moreover, this scholar emphasizes that other games, especially while being performed outdoors, significantly increase school success of students (Durham, 2015). These means of education are the proper way to increase students' motivation starting from early age. Consequently, it is a good alternative to scientific tasks that many pupils dislike due to the poor connectedness to those activities. Another consideration that correlates with science-related values is a matter of socio-economic status of students. Specifically, Wong (2015) reveals that ethnical minorities as well as socially vulnerable populations are being mostly excluded from science classes in a post-compulsory education. Consequently, this tendency is adverse; it may create the stereotype threat for the students who belong to the socially vulnerable population. As a result, they may be less self-motivated to excel in the science classes.

In addition, the trend towards using computer-related skills in science and engineering presumes increased expenditure at both individual and public levels. To be more precise, the students from poor families may be deprived of the equal possibilities to use online learning and devices in schooling. Similarly, a lot of schools may struggle to comply with the aforementioned tendency in an academic setting, since providing modern technological means and ensuring adequate readiness of teachers to implement skillfully these means in practice requires considerable financing.

In overall, an unspoken but tangible idea that science is for the rich should be considered as a stumbling block that deteriorates academic performance of the students. In contrast, "the middle-classes often successfully combine economic, cultural, and social capital to produce academic achievement" (Archer et al., 2015, p. 924). This premise promotes a scrutiny that teachers are expected to work in the neighborhoods with diverse capital asset. It means that cultural accentuations and science-related values of students differ from place to place respectfully. In these conditions, the task of the tutors is to detect, acknowledge, and consider those cultural diversities and deploy them in practice to motivate students and enhance their school success.

One can review students' motivation from the perspective of the Self-Determination Theory (SDT). This model is strongly related to students' intrinsic motivation (Hagay & Baram-Tsabari, 2015). The scholars suggest that pupils should have the right to vocalize their preferences regarding "the form, content, and aims of their schooling" (Hagay & Baram-Tsabari, 2015, p. 951). SDT states that students have basic needs, such as "the need for autonomy; the need for competence, and the need for relatedness", which school curricular should freely articulate and fulfill (Hagay & Baram-Tsabari, 2015, p. 952). To a great extent, the notion of competence relates to intrinsic motivation (Jones et al., 2015; Fitzgerald, McKinnon & Danaia, 2015). Fitzgerald et al. (2015) state that the majority of students are not interested in studying science and engineering disciplines because they consider these fields to be boring. These findings emphasize the role of motivation and self-determination in schooling.

Linking this insight to the SDT, it is possible to assume that such a strategy does not satisfy the students' need for relatedness and, thereafter, for autonomy. Jones et al. (2015) argue that it is possible to achieve students' motivation to participate in science and engineering fields using supportive extracurricular activities. Nevertheless, one may rightfully assume that this approach is costly. Thus, the corresponding accomplishment requires significant funding, which may cause inconveniences for many schools.

Moreover, NGSS devotes considerable attention to engineering. In this respect, Cunningham, and Carlsen (2014) studied the ways to increase students' motivation in this field. The scholars reveal results that are similar to the insights that were detected a year later by Fitzgerald et al. (2015) and Jones et al. (2015). Specifically, students

lack motivation to excel in science and engendering. Nevertheless, working on enhancing students' sense of autonomy and competence are effective strategies in increasing their motivation and improve academic performance.

Teachers must consider the role of cultural competence to assist students in developing the positive and benevolent self-determination. Rodriguez (2015) accentuates that "teachers pursuing culturally responsive approach to instruction will need to understand the sense-making practices of particular communities, the science-related values that reside in them, and the historical relationship that exists between community and local institutions of education" (p. 1034). In this respect, the studied question is the compliance of NGSS with science-related values of the contemporary pupils.

To understand the role of the NGSS, it is necessary to review its postulates. In particular, this regulation sets goals of developing "deep exploration of important concepts, as well as time for students to develop meaningful understanding, to actually practice science and engineering, and to reflect on their nature" (Werderich, Farris & McGinty, 2014, p. 66). In this respect, it encourages teachers to elaborate "instructional strategies in language and science can complement one another" (Weinburgh et al., 2014, p. 519). In other words, the Next Generation Science Standards explains that it is impossible to reach scientific and engineering learning objectives without developing corresponding language goals (Miller, Lauffer, & Messina, 2014; Miller et al., 2015). This insight is well-aligned with another study conducted by Palincsar (2013) who claims that it is important to work on the science and language goals synergistically. The rationale to this claim is that to comprehend and explain scientific phenomena, the pupils must have well-developed language skills.

Linking this insight of NGSS, one should state that language skills are necessary to fulfill the needs for autonomy, competence, and relatedness (Hagay & Baram-Tsabari, 2015). Consequently, one supposes that cultural sensitivity should include well-developed communicative skills with the students of different cultural, social, economic, and religious backgrounds. It is important to remember that teachers should not only react to the students' science-related values, but their main task is to find the proper ways of teaching science and engineering in compliance with those values. Moreover, the tutors should be capable of shaping students' values in a way that is advantageous for short- and long-terms academic goals.

2. Research Objectives

The present review article studies the effectiveness of the Next Generation Science Standards (NGSS) identifying the way, in which this regulation addresses the matter of cultural diversity that gains significance in the modern globalized world. In particular, it focuses on such objectives as science-related values of students, cultural competence of teachers, and the challenges of teaching science disciplines in the conditions of cultural diversity.

2.1 Research Gap

The purpose of this paper is to fasten and facilitate teachers' accommodation to The Next Generation Science Standards. Therefore, this systematic review aims to fill the research gap in social and cultural science-related values of the contemporary students and define how the teachers address them (or are expected to address).

2.2 Research Question

What are the main science-related values shared by the today's students? Are these values effectively considered by NGSS?

2.3 Theoretical Background

The sociotransformative constructivism (sTc). sTc is a learning theory that provides a framework that is often deployed by educators to ensure effectiveness of academic processes in the conditions of cultural diversity. This definition implies that the concept sTc is related to the concepts of multiculturalism and social justice (Rodriguez & Zozakiewicz**,** 2017). These notions constitute the theoretical background of the present systematic review. Thus, the theory of sociotransformative constructivism should be emphasized as the theoretical framework.

3. Literature Review

The Next Generation Science Standards (NGSS) is based on premise that authentic science approaches are critical learning objectives, which students should be encouraged to obtain. In particular, this definition incorporates "authentic science investigations, students ask their own scientific questions, derive their own hypotheses, develop methods for testing their hypotheses, and construct logical conclusions as evidence-based arguments to defend their conclusions" (Scogin & Stuessy, 2015, p. 312). Praising and fostering authenticity implies that cultural aspects of learning environment plays an important role and, thus, must be considered by

teachers. Furthermore, it is important to remember that "different fields of science have different criteria for what counts as good evidence, how to conduct experiments, and what sorts of arguments are convincing" (Duncan & Cavera, 2015, p. 70). Hence, the rapid change in a socio-cultural plane of the mankind stipulates short time-related validity of scientific insights in the educational field. Thus, NGSS requires thorough cooperation between educators and scientists to be advance science-related knowledge and keep it constantly updated (Bowman & Govett, 2015). Moreover, given that globalized world enhances diversity, NGSS serves to meet the today's needs of culturally diverse society. In part, authentic academic activities are engaged by the culturally relevant teaching (CRT) (Pang et al., 2014).

Besides, technological progress predefines fast expansion of available knowledge in sciences. For example, nowadays, the field of astronomy heavily relies on processing big data. The field of engineering and biology is based on using online laboratories (Chiu et al., 2015; Plummer & Maynard, 2014). These are only a few examples of the significance of changes that the modern world of science undergoes. Striving to accomplish this purpose it is appropriate to study the science-related values shared by the contemporary youth and link those values to content of NGSS.

3.1 The Role of the NGSS

The role of the Next Generation Science Standards (NGSS) is to increase scientific literacy of the contemporary youth in the conditions of the enhanced cultural diversity. The significance of science literacy is stressed in the modern academic setting (Wendt & Rockinson-Szapkiw, 2014). To align school curricular with the increased demand for scientific skillfulness NGSS "emphasize authentic scientific practices such as developing models and constructing explanations of phenomena" (Chiu, DeJaegher & Chao, 2015, p. 59). Scogin and Stuessy (2015) accentuate that NGSS engages educators to enhance students' motivation in being involved into sciences. This agenda is rather difficult (Pratt, 2014). The fact is that, students should possess high intrinsic motivation that should be guided by strong support and mentoring of teachers. In other words, teachers remain the leaders of educational process and it is rather important for the tutorial staff to know how to portion the level of assistance and involvement in pupils' learning process (Passmore, 2015).

To succeed with the NGSS's goals, one should remember that motivation strongly resonates with the Self-Determination Theory (SDT). Therefore, science-related values of students are discussed through the lens of their psychological needs.

3.2 NGSS Considers Science-Related Values

The Next Generation Science Standards is an educational document; a guide for teachers how to increase scientific literacy of students (Lontok, Zhang &Dougherty, 2015). Pruitt (2015) emphasizes that not all educational establishments have adopted NGSS. Hence, it is clear that most teachers of science partially or completely deploy the notions of the discussed document (Workosky & Willard, 2015). This approach is not surprising given that NGSS possesses tangible improvement that correlate with the rapidly changing and volatile world of science, engineering, and technologies.

In particular, NGSS "provide for consistent science education opportunities for all students—regardless of demographics—with a level of rigor expected in every location and community" (Huff, 2016, p. 30). To be more precise, NGSS provides opportunities for addressing culturally diverse classrooms in the main three ways. Firstly, NGSS engages teachers to create atmosphere for successful performance of students in all aspects of science learning. As a result, students are encouraged to excel in "practices, disciplinary core ideas, performance expectations, and the crosscutting concepts" (McDonald, 2015, p. 13). This approach is expected to embrace diverse level of students' previous knowledge and skills, as well as cover thoroughly their expectations regarding learning outcomes. Secondly, to meet the diversity of students needs, NGSS encourages teachers to utilize various methods and techniques of learning according to the needs of particular classroom. Thirdly, NGSS stands for deep learning that should reflect in-depth understanding of scientific concepts (McDonald, 2015). This task should reduce the gap in education between the poor and rich neighborhoods as well as eliminate the likelihood of gender or race-based biases and/or stereotype threat.

According to Froschauer (2012) NGSS not only engages but also assists teachers in reaching the up-to-date standards in sciences. In terms of engaging educators to use more diverse methods of learning that can complement lecture as a famous means of revealing learning material, NGSS emphasizes the importance of inquiry. To acknowledge the merits of inquiry it is necessary to refer to its definition:

Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already

known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results (Ford, 2015, p. 1042).

Given this definition, it is possible to deduce that inquiry is the proper tool to successfully realize Self-Determination Model, in particular, by increasing students' intrinsic motivation. Therefore, the diverse means of learning are expected to meet the diverse needs of those who are being taught.

Inquiry, as a collective name of a set of activities that are aimed at learning by means of retrieving empirical evidence, should help students achieve the four main goals (standards) that are revealed by NGSS. Specifically, Huff and Yager (2016) point out that students must be skillful in "understanding scientific explanations", "generating scientific evidence", "reflecting on scientific knowledge", and "participating productively in science" (p. 10). These four learning outcomes imply that teachers should align their performance with cultural diversity they face. For example, understanding scientific explanation is the initial step among the aforementioned four stages and it is the most dependent on the cultural background of students. At the same time, the remaining stages can not be reached without meeting students' needs for autonomy, competence, and relatedness.

Moreover, Huff (2016) accentuates that NGSS sets limits in learning standards for students depending on their age developmental stage. This insight means that the discussed document sets fair and unbiased standards in terms of what theoretical and practical knowledge should be instilled into pupils of the same age group. In other words, the demand for social justice is well-addressed by NGSS: students receive all-inclusive scientific education that resonates with to their socio-cultural background, but without any types of discrimination.

3.3 Social Presence

An important component of one's psyche is social presence. This phenomenon is used to define the sense of being content because of defining the self as a meaningful part of a society. Scogin and Stuessy (2015) educate that this positive element of self-concept need to be fostered to feel the wholeness of the individuality. In this regard, participating in scientific activities is an effective means to increase and enjoy one's social presence. In these terms scholars perceive "youth as resources" for current and future scientific development (Maulucci, 2014, p. 1123). Undoubtedly, it is a crucial science-related value. Teachers should be ready to help students expand this notion (Kloser, 2014). Social presence is an element of the Self-Determination Theory. In spite of its immense role in personal and professional development, the youth is often inexperienced in comprehending the merits of social presence. Moreover, the need for social presence may be satisfied in a less productive, benevolent, and healthy ways. Thus, the task of tutors is to assist pupils in acknowledging the role of social presence through participating in scientific activities and likewise. This participation is significantly supported and facilitated by considerable accessibility of learning instruments.

3.4 Universal Accessibility of Tools for Learning (Time and Place)

Computer modeling for scientific and engineering experiments erases the emphasis that these activities should be conducted indoors. What is more, the belief that laboratory experiments need specially accommodated rooms and thorough preparation of the authors is being challenged with "virtual technology tools, software, and simulations" (Chiu et al., 2015, p. 59). Technological development predefined the emergence of a range of instruments that can be accessed anywhere and anytime without any significant preparations. For instance, Scogin and Stuessy (2015) point to the educational program, called Planting Science (PS). They claim that it is "an ideal curriculum for use as an NGSS model is a computer-mediated collaborative learning environment intertwining scientific inquiry, classroom instruction, and online mentoring from scientists" (Scogin & Stuessy, 2015, p. 312). As it can be observed from this definition, NGSS sets high standards that are characterized by inclusiveness of all duties of an educator. That is why, one may naturally deduce that the discussed curriculum assists students' multidirectional and multi-level development.

All-inclusive learning is positively related to the high accessibility of learning tools in terms of time and place. This science-related value is one of the central considerations that must be taking into account while teaching science, engineering and other subjects. What is more, NGSS ensures that the remedies of learning are constructed in a way that matches students' diverse needs. NGSS reveal that "science texts are multimodal, using a mix of words, graphs, diagrams, tables, and mathematics to communicate information" (Huff, 2016, p. 31). Undoubtedly, a possibility to have complete and ongoing access to effective learning tools is a great merit provided by technological progress and stressed by NGSS.

As the recent research depicts this possibility is highly praised not only by students but also by tutorial staff. For instance, Asterhan and Rosenberg (2015) identified a common belief among teachers that employing

technological and online tools provides a great opportunity to expand "learning beyond the classroom" (p. 138). Teachers state that utilizing online platforms facilitates and, thus, increases effectiveness of the process of education. In particular, this approach allows learning more about typical and individual characteristics of pupils (Asterhan & Rosenberg, 2015). Besides, it is believed that online communication improves relations with students and advances the positive image of a teacher (Asterhan & Rosenberg, 2015). These goals can be reached thanks to high accessibility of learning tools.

Moreover, good accessibility of the tools for learning means improved connection between teachers and students. Asterhan and Rosenberg (2015) claim that the majority of researched students wanted to stay in touch with their teachers using online platforms (in particular, Facebook was the object of study). The benevolence of such online connectedness is being greatly argued. Firstly, it evokes concerns because online connection is a relatively new topic and, thus, it is poorly studied by education scientists. Secondly, there is an ambivalence of staying in touch with students through online platforms because of the matters of privacy and power distance between the two sides (Asterhan & Rosenberg, 2015). These concerns are reasonable and, thus, beget the new questions to be studied. Nevertheless, the fact that online tools and materials for learning as well as connectedness to the tutorial staff facilitates studying and teaching is correct.

What is more, discussing accessibility of learning tools, one should refer to cell phones. Exactly as with computer-based programs online learning maintained through online mobile devices is reported to be valuable due to the possibility to access learning materials and instruments outside classrooms and class hours. O'Bannon and Thomas (2015) conducted a research, which indicated that most frequent reason why teachers encouraged students to utilize mobile phones was to connect to Internet with the purpose to conduct researches. This insight is not surprising because as the greatest storage of information Internet is highly useful for educational purposes, for instance, such as collecting different types of evidence. Besides, it is also the fastest way to retrieve, systemize, and synthesize obtained data.

Apart from accessing information Internet is often utilized to create different types of data, which is considered to be a valuable academic experience. For example, creating video and audio materials for studying and reflecting learning outcomes is a popular strategy of studying. Scholars suggest that "student-created podcasts can improve students' reading, writing, and listening skills" (O'Bannon & Thomas, 2015, p. 111). Hakuta, Santos, and Fang (2013) emphasize that these skills are crucial for succeeding with academic goals. Besides, these activities function as indicators of students' academic success. Materials that are posted online are faster to access and estimate for teachers. In a word, good accessibility of online materials created by students is valuable for both tutors and pupils. Furthermore, it I appropriate to stress that accessibility strongly correlates with simplicity.

3.5 Simplicity and Multitasking

Simplicity in learning is another important science-related value of the today's students. Utilizing software allows processing data fast and effectively. In part, online learning tools facilitate constructing and reshaping cognitive schemata of students, which is always relevant since it is an ongoing process (Bartos & Lederman, 2014). Learning materials are based on various kinds of visual and audio materials, which facilitates learning. For example, "virtual laboratory experiences and computer-based visualizations" simplify theoretical insights in the fields of different sciences (Chiu et al., 2015, p. 59). In particular, simplicity is valuable for exploring "unobservable scientific concepts" (Chiu et al., 2015, p. 59). As one may rightfully predict studying sciences contains a lot of such subjects. One example is studying the properties of gas at a molecular-level.

Chiu et al. (2015) educate that a Frame lad instrument is used to conduct such explorations. In this respect, virtual laboratory functions to connect students' intuitive ideas and premises to the real properties of gas (or other substances) that can not be explored without special equipment. Thus, scholars stress that "virtual labs can be designed to enhance science learning and encourage scientific practices as called for in the NGSS" (Chiu et al., 2015, p. 59). In frames of these goals, a significant place is devoted to the discussed science-related value, --simplicity. Studying with the help of a Frame lab or other virtual instruments is easier than comparing to using in-vitro laboratories. Besides, modern tools allow performing several tasks at the same time. The speed of life as a part of a popular culture is imprinted in academic environment that values multitasking. Comprehending that online software and other learning tools simplify studying, the youth develop readiness to work with big data.

3.6 Readiness to Work with Big Data

The evolvement of the humanity is characterized with ongoing learning. This particularity predefines constant expansion of people's cognitions. As a result, there is a need to process, analyze, interpret, and conceptualize large volumes of information. Big pieces of information are known as big data can hardly be managed without

using software. For instance, Plummer and Maynard (2014) reveal that "the NGSS uses this big idea to organize standards towards facilitating student learning of astronomy across K-12 education" (p. 903).

Studying the patterns of celestial motion is only one example of the field and research question that assumes processing big data. Undoubtedly, this necessity means that students should be armed with the skills how to collect and manage big data utilizing modern technologies.

Hence, the central idea is culturally-specific readiness to accept the paradigm of the big data. Scholars define related cognitions as 'computational thinking' (Sneider et al., 2014). This is a relatively new type of thinking that is characterized by students' endeavor and ability to manage large volumes of information while heavily relying on computer technologies. This peculiarity is imprinted in a popular culture not only in the world of science. In other words, the today's children know that big data is being derived constantly with the help of diverse software. They understand that, in many cases, they are the subjects who are being studied and who produce big data.

In addition, they may specify the purpose of each type of data (in which fields and in what ways it may be used, what implications it may have). This realization is rather important because it implies that contemporary youth is taught to seek for the causes and outcomes of working with big data. In this respect, Tofel-Grehl, Litts, and Searle, (2016) accentuate that NGSS engages unique and creative thinking. Readiness to work with big data while being combined with creative thinking may result in the considerable contribution to the world of sciences. Moreover, it is natural for them to make premises about its implacability and limitations. The approach to observe with the purpose to draw conclusions illustrates the essential science-related value, --purposeful and meaningful world cognition. Comprehending students' readiness to work with big data consciously applying to scientific approaches is taken into account and reflected in the UGSS.

3.7 Globalized World--Globalized Ideas

Modern students are well-prepared to establish relational links between different planes in which they exist. The main idea of the NGSS is biodiversity. This notion suggests blending "the crosscutting concept patterns and three fused practices: planning and carrying out investigations, analyzing and interpreting data, and constructing explanations" (Duschl & Bybee, 2014, p. 4). This tendency correlates with the above-discussed expansion of cognition and readiness to adjust to and work with big data.

Specifically, Plummer and Maynard (2014) accentuate that studying astronomy pupils learn to relate obtained insights to climate change. What is more, climate changes are related to current and prospected environmental issues. Besides, environmental changes are connected to economic costs; whereas, the latter is assumed to correlate strongly with social aspects of a human being (Plummer & Maynard, 2014). The ability to construct such complex chains of reasoning hints that the today's youth has globalized thinking. The above-identified skill means that students are naturally and often effortlessly make cross-subject connections. NGSS reveals that this ability is central for learning; therefore, students should be engaged further in establishing cross-subject connections (Bulgren & Ellis, 2015). This science-related value is quite significant for becoming active and conscious learners.

Without a doubt, academic success depends on a student's ability to establish cross-subjects links. In particular, this approach refers to synthesis of information, to usurpation of insights and their meaningful and purposeful transition from one field to another. Scholars emphasize that "students see scientific knowledge consisting of well-tested theories and models that are used to explain and predict natural events" (Duschl & Bybee, 2014, p. 4).

The result of such thinking is expected to be greatly positive for science in general because globalized thinking generates the new ideas and premises to be studied, as well as anticipates the emergence of problems. Thus, it is included in learning objectives of NGSS. Another positive implication of the globalized world is that it has assigned greater value to the individual characteristics of individuals. This trends results in the growing recognition of person-centered approaches in education and other sciences.

3.8 Appreciation that Individual Emotional Needs are Considered

Teachers acknowledge that learning objectives include promotions of students' well-being in all aspects. This idea implies that student's individual particularities should be studied and considered to ensure that educational process is performed in accordance with the principles of cultural sensitivity. Interpreting the content of NGSS, Scogin and Stuessy (2015) emphasize that teachers should acknowledge that the role of being a scholar and the role of being a mentor are synthesized. Consequently, it is important to learn how to succeed in maintaining these both tasks.

In this respect, using online platforms assists in maintaining the appropriate level of power distance and privacy

while being able to address the needs of students and meet their expectations as much as possible. For example, many tutors believe that pupils should be given with a chance to ask questions, which they "may not want to ask during class time or that only came up during homework" (Asterhan & Rosenberg, 2015, p. 138). Students value this approach in studying because it may be more comfortable for many young people. Thus, teachers should take into account that, typically, students are willing to interact aside from classroom using online platforms. Nevertheless, given that such activity imposes a lot of additional duties and responsibilities upon tutors, it needs to be carefully scrutinized and used in accordance to a situation.

Besides, in many cases, teachers use online platforms to monitor the well-being of their students. Despite the fact that this approach is not directly related to sciences, in terms of relevance, preserving the health of children is a priority. Asterhan and Rosenberg (2015) reveal that "sometimes the teacher is exposed to information about or from a student who indicates he or she may be in physical, emotional or social distress" (p. 140). The relevant science-related value is students' expectations that their individual, in part, emotional needs are considered. Teaches must consider these expectations since it is vital for preserving students' health and well-being as well as for constructing productive relations without which accomplishing positive learning outcomes is impossible.

What is more, one should point to the fact that online mentoring correlates simultaneously with two above-identified science-related values: accessibility and desire for individualized teaching approaches. Scogin and Stuessy (2015) point to the benefit on online mentoring claiming that it can be received by students even in a case of remote courses. In this regard, online mentoring may be especially valuable in the rural areas, where the density of population is not high but the necessity for a professional mentor is considerable. Furthermore, a lot of students, who would like to be involved into science-related experiences, belong to a vulnerable population in socio-economic terms (Lee, Miller & Januszyk, 2014). In this respect, it is natural to assume that online mentoring would be rather helpful for vulnerable categories of youth. The discussed role of the online mentoring in an academic setting correlates with the premise that NGSS "addressed issues of diversity and equity" (Lee et al., 2014, p. 223). Furthermore, this insight also resonates with the similar statement by Januszyk, Miller, and Lee (2014) who claim that the authors of NGSS thoroughly addressed the problems connected to poorly acknowledged diversity. In a word, the obtained evidence suggests that the Next Generation Science Standards is constructed in frames of good cultural sensitivity. Besides, science-related values are strongly connected to defined learning objectives.

4. Methodology

4.1 Research Design

This is a systematic review that is aimed to study a phenomenon of the modern world-wide science-related values, their connection to students' motivation, as well as teachers' skillfulness in implementing the dogmas of NGSS for enhancing scientific literacy of pupils. Considering the research purpose and the research question, this systematic review is constructed on qualitative evidence.

4.2 Sample

The sample consists of 52 case studies and empirical researches.

4.3 Sampling Strategy

The choice of the items that will be summarized and analyzed in the present systematic review was done according to the following inclusion criteria. The articles are retrieved from peer-reviewed sources (academic journals in the field of science and education). Secondly, all sources (expect 1) are published within 2014-2017, which means that they are up-to-date and, thus, reflect the actual and topical issues, concerns, challenges, and considerations. Thirdly, 42 entries were found using key words: NGSS, science-related values, cultural diversity. The remaining 10 were concentrated on the standards of NGSS. Besides, it is necessary to stress that the analysis of NGSS is conducted basing on the secondary sources: the scholars' studies and speculations about the discussed document, which is relevant to the research questions of this systematic review.

4.4 Sample Validity

The aforementioned inclusion criteria were developed to ensure sample validity. Hence, it is necessary to stress that quantitative evidence would have provided more rigour data, the nature of research question (exploring a phenomenon) as well as the lack of statistical evidence on this topic make it impossible to conduct meta-analysis. This particularity can be identified as a study limitation. Another consideration is that it is difficult to verify unbiased assessment of reviewed articles. The only step done to ensure reliability of findings is saving hard copies of articles that were retrieved from the Internet databases.

The derived sample matches the targeted population (teachers of sciences and engineering, and students who study these subjects). In terms of generalizability, given the precise frames of inclusion criteria that are stipulated by research question, the finings can not extended to cover other populations. Hence, the knowledge about current science-related values in frames of NGSS can be partially implemented in pre-school science education and post-compulsory science education.

4.5 Sample Setting

This systematic review was done using searching platforms.

4.6 Methods of Data Collection

Qualitative systematic review.

4.7 Methods of Data Analysis

Thematic analysis.

5. Results and Discussion

5.1 Thematic Analysis

5.1.1 Science-Related Values of Students

The significance of using sociotransformative constructivism while teaching sciences and engineering can hardly be overestimated since it provides the ways to effectively address and deploy science-related values of the youth. Increasing scientific literacy of students in the today's globalized world means "develop the science and engineering understanding that they need to live successful, informed, and productive lives" (Krajcik, 2013, p. 27). The present systematic review emphasizes the important of the following science-related values in students: social presence, lesser power distance between pupils and teachers, simplicity and multitasking, and universal accessibility to the instruments of learning.

Social presence is the most important cultural variable. Students are detected to possess high need for inclusion and belonging. Moreover, in terms of functionalism, it is essential for students to feel that they useful members and meaningful members of their community. The satisfaction of this variable leads to significant increase of intrinsic motivation in pupils. Without motivation, studying is hardly possible. Thus, the need for social presence should be considered by teachers as a central science-related value of students. In particular, once being satisfied, it results in the meaningful and motivated participation in science, which is the fourth, and the highest, requirement of NGSS.

Social presence also related to the Self-Determination Model, which means that it helps maintaining the balance of needs for autonomy, competence, and relatedness. The latter two are connected to conscious and motivated participation in science. Besides, the need for autonomy and relatedness are linked to the excessive use of online platforms, including social media to communicate with teachers. This particularity is indicated as another important science-related value. Feeling personal social presence in social nets and connectedness to teachers aside of classrooms stipulate the changes in power distance between the youth and adults. Specifically, power distance becomes lesser. This is a science-related value is identified to be the source of challenge due to value borders of acceptable and appropriate communication.

Furthermore, students are detected to praise universal accessibility of learning tools, in particular, those that are provided by online software. That is why, teachers need to be encouraged to utilize technology support in classrooms as much as possible. Similarly, technology allows realizing the science-related value for simplicity and multitasking. This value is well-addressed in NGSS, which engages providing diverse learning materials. This approach serves to increase students' motivation in learning sciences, in part, but ensuring that materials are easy to be comprehended by students of particular age group. The aforementioned science-related values are typical for the contemporary students; and these notions are taken into account in NGSS. Satisfying and deploying for studying purposes students' science-related values encourages teachers to master cultural competence.

5.1.2 Cultural Competence of Teachers

This systematic review reveals that cultural competence of teachers is extremely complex characteristic. This capability includes a lot of sub-skills each of which is important. To begin with, it is necessary to stress that NGSS incorporates the standards of cultural competency that were relevant in the former decades and remain topical nowadays. Specifically, teachers should anticipate, overcome, and mitigate the interference of a student' socio-economic status (poverty, social vulnerability) into his/her academic performance. Culturally competent

educators strive to find the way to motivate all students for learning and active participation in science despite their socio-economic situation. Another consideration is gender and/or race biases regarding cognitive abilities. Specifically, female students and/or students of the minority may be considered by class as inferior in terms of cognition. Thus, these categories may feel stereotype threat, which should be anticipated by culturally competent teachers. In other words, teachers are expected to organize academic performance on the basis of multiculturalism and social justice.

Apart from previously known elements of teachers' cultural competence, there are several relatively new ones that are considered by NGSS. For example, online social presence of teachers that is closely related to online mentoring. This duty is linked to cultural competence of maintaining the proper power distance with students. Given that this area is relatively unknown, gaining cultural competence in maintaining 'friendship' in social networks, such as Facebook and others, is an important topical task of the today's teachers. In this respect, cultural competence means understanding students' behavior and revealing benevolent and friendly attitude. In particular, the role of online mentoring is the desire to help in miserable or even dangerous life situations that the youth may face either being exposed to cyber threats or to real life challenges.

Moreover, teachers should reveal cultural competence while engaging students to develop cross-subject links and conduct usurpation of evidence. The fact is that students' cultural background will affect the way they derive and interpret evidence. Thus, the same topic may be developed in a different ways by various students. Teachers should be capable of anticipating the possible scientific performance of students in order to help them avoid conflicts that are related to cultural diversity.

5.1.3 Challenges of Teaching Science Disciplines in the Conditions of Cultural Diversity

NGSS sets standards for teachers that should be reached within relatively small period of time. This demand for rapid change is confusing and challenging for many teachers. This systematic review depicts that teachers experience difficulties in learning how to work with the new online software and digital tools. As a result, they struggle to address science-related values of modern students. In particular, the values of simplicity and multitasking, as well as the value of accessibility of learning instruments can not be effectively deployed in an academic setting without relevant teachers' competence. Besides, there is the need to work with big data and teach students working with huge volumes of information. To be capable of teaching students to process big data, teachers should learn how to do that by themselves. This process takes time. Thus, the competence of teachers is not always in compliance with the accepted by school NGSS.

Another difficulty is maintaining the proper level of power distance with student. Many teachers may be uncomfortable being connected to students aside classrooms by means of social networks. This reluctance is stipulated by the level of privacy that differs from person to person. In these terms, teachers struggle to gain cultural competence of keeping the right power distance and being online mentors for their pupils.

What is more, NGSS suggests that students should be able to collect relevant evidence, interpret it, and utilize those insights for participating in science (creating some new concepts on the basis of learnt materials). These requirements are essential. To accomplish these standards, teachers should be skillful in anticipating the conflicts (for example, religious-based) that may emerge at the stage of data retrieval and interpretation. This approach can be challenging for teachers even with good cultural competence.

5.2 Limitations

This systematic review has several limitations. Firstly, collected evidence is the product of scholars and, even though, the credentials of authors were verified in each case study and empirical research, the results may be to an extent biased. In this respect, one may suggest that arranging an observation, focus groups, or in-depth interviews could have provided first-hand information about the researched question. Secondly, the analyzed articles were not limited in terms of geographic, which makes the results too broad. In contrast, it would have been better to concentrate on a particular area. Thirdly, the findings of this systematic review are of a suggestive character. The effectiveness of deploying revealed insights in practice was not verified. Hence, these limitations imply the scope for future research.

5.3 Learning Implications

Considering the increased cultural diversity in today's classrooms, the insights about modern science-related values of students, needed cultural competences of teachers, and respective challenges are valuable for current educators as well as for students of pedagogical educational establishments. In particular, the findings of this systematic review can be useful for teachers of science and engineering who implement or plan to implement NGSS. In addition, the obtained insights can be interesting for teachers of other subjects within pre- and post-

secondary school settings. Acknowledging science-related students' values means that teachers strive to align their professional qualities and performance to align with those accentuations. This approach is expected to increase academic excellence of pupils, advance professional skills of educators, and in general, provide future generations with the skills needed for succeeding in post-compulsory education, and relevant careers. What is more, the findings can be utilized as the basis of future researches related to NGSS, growing cultural diversity, and teachers' competence.

6. Conclusion

NGSS provides recommendations to teachers of science and engendering regarding how to improve the effectiveness of academic performance of both sides (students and educators). An important part of this task is devoted to teacher-student relations in and aside classrooms. A growing cultural diversity should be considered to ensure benevolent and productive teacher-student interactions. The present systematic review aims to detect and topical science-related values of students and identify how they are being addressed in NGSS. The review of 52 scholarly saucers indicates that the main students'science-related values are: social presence, simplicity of studying, multitasking, accessibility of learning instruments, in particular, with the help of online software, and reduced power distance between pupils and educators. Simultaneously, there are resonating teachers' traits of cultural competence needed to acknowledge and successfully deploy students' values while teaching sciences and engineering. These characteristics include respect for cultural diversity, social presence, online mentoring, gut feeling for the proper level of power distance. This review suggests that, in many cases, teachers experience difficulties in learning to deploy online software and digital tools and set the proper power distance with pupils, especially outside classes. In addition, the cases of poor cultural sensitivity in teachers also require precise attention.

References

Archer, L., Dawson, E., DeWitt, J., Seakins, A., & Wong, B. (2015). ''Science capital'': A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching, 52*(7), 922-948. https://doi.org/10.1002/tea.21227

Asterhan, C. S., & Rosenberg, H. (2015). The promise, reality and dilemmas of secondary school teacher-student interactions in Facebook: The teacher perspective. *Computers & Education, 85*, 134-148. https://doi.org/10.1016/j.compedu.2015.02.003

Bartos, S. A., & Lederman, N. G. (2014). Teachers' knowledge structures for nature of science and scientific inquiry: Conceptions and classroom practice. *Journal of Research in Science Teaching, 51* (9), 1150-1184. https://doi.org/10.1002/tea.21168

Bowman, L. L., & Govett, A. L. (2015). Becoming the change: A critical evaluation of the changing face of life science, as reflected in the NGSS. *Science Educator, 24*(1), 51-61.

Bulgren, J., & Ellis, J. (2015). The argumentation and evaluation guide: Encouraging NGSS- based critical thinking. *Science Scope, 38*(7), 78-85. https://doi.org/10.2505/4/ss15_038_07_78

Campbell, T., Neilson, D., & Oh, P. S. (2013). Developing +using models in physics. *The Science Teacher, 80*(6), 35-41. https://doi.org/10.2505/4/tst13_080_06_35

Chen, C., & Wang, C. (2015). Employing augmented-reality-embedded instruction to disperse the imparities of individual differences in Earth science learning. *Journal of Science Education and Technology, 24*, 835-847. https://doi.org/10.1007/s10956-015-9567-3

Chiu, J.L., DeJaegher, C. J., & Chao, J. (2015). The effects of augmented virtual science laboratories on middle school students' understanding of gas properties. *Computers & Education, 85*, 59-73. https://doi.org/10.1016/j.compedu.2015.02.007

Cunningham, C. M., & Carlsen, W. S. (2014). Teaching engineering practices. *Journal of Science Teacher Education, 25*(2), 197-210. https://doi.org/10.1007/s10972-014-9380-5

Duncan, R. G., & Cavera, V. L. (2015). DCIs, SEPs, and CCs, oh my!: Understanding the three dimensions of the NGSS. *The Science Teacher, 82*(7), 67-71. https://doi.org/10.2505/4/tst15_082_07_67

Durham, S. (2015). Blocks: "Standard" equipment for today's primary classrooms. *YC Young Children, 70*(1), 52-58.

Duschl, R. A., & Bybee, R. W. (2014). Planning and carrying out investigations: An entry to learning and to teacher professional development around NGSS science and engineering practices *International Journal of*

STEM Education, 1(12), 1-9.

Fitzgerald, M., McKinnon, D. H., & Danaia, L. (2015). Inquiry-based educational design for large-scale high school astronomy projects using real telescopes. *Journal of Science Education and Technology, 24*, 747-760. https://doi.org/10.1007/s10956-015-9560-x

Ford, M. J. (2015). Educational implications of choosing "practice" to describe science in the Next Generation Science Standard. *Science Education, 99* (6), 1041-1048. https://doi.org/10.1002/sce.21188

Froschauer, L. (2012). Moving toward the next generation science standards. *Science and Children, 50*(1), 6.

Haag, S., & Megowan, C. (2015). Next Generation Science Standards: A national mixed- methods study on teacher readiness. *School Science and Mathematics, 115*(8), 416-426. https://doi.org/10.1111/ssm.12145

Hagay, G., & Baram-Tsabari, A. (2015). A strategy for incorporating students' interests into the high-school science classroom. *Journal of Research in Science Teaching, 52*(7), 949-978. https://doi.org/10.1002/tea.21228

Hakuta, K., Santos, M., & Fang, Z. (2013). Challenges and opportunities for language learning in the context of the CCSS and the NGSS. *Journal of Adolescent & Adult Literacy, 56* (6), 451-454. https://doi.org/10.1002/JAAL.164

Huff, K. L. (2016). Addressing three common myths about the Next Generation Science Standards. *Science and Children, 53*(5), 30-33. https://doi.org/10.2505/4/sc16_053_05_30

Huff, K. L., & Yager, R. E. (2016). The four strands of science learning and the Next Generation Science Standards. *Science Scope, 40*(2), 10-13. https://doi.org/10.2505/4/ss16_040_02_10

Janssen, N., & Lazonder, A., W. (2015). Implementing innovative technologies through lesson plans: What kind of support do teachers prefer? *Journal of Science Education and Technology, 24*, 910-920. https://doi.org/10.1007/s10956-015-9573-5

Januszyk, R., Miller, E., & Lee, O. (2014). NGSS case studies: Economically disadvantaged students developing conceptual models. *Science Scope, 38*(4), 6-11. https://doi.org/10.2505/4/ss14_038_04_6

Jones, B. D., Akalin, S., Fink, J., Evans, M. I., Chittum, J. R., Schram, A. B., … Brandt, C. (2015). Elements of design-based science activities that affect students' motivation. *School Science and Mathematics, 115*(8), 404-415. https://doi.org/10.1111/ssm.12143

Kahn, S., Wild, T., Woolsey, M. L., & Haegele, J. A. (2014). Let's get physical. *Science and Children, 51*(5), 37-43. https://doi.org/10.2505/4/sc14_051_05_37

Kennedy, C., Rhoads, C., & Leu, D. L. (2016). Online research and learning in science: A one-to-one laptop comparison in two states using performance based assessments. *Computers & Education, 100*, 141-161. https://doi.org/10.1016/j.compedu.2016.05.003

Kloser, M. (2014). Identifying a core set of science teaching practices: A Delphi Expert Panel approach. *Journal of Research in Science Teaching, 51* (9), 1185-1217. https://doi.org/10.1002/tea.21171

Krajcik, J. (2013). The Next Generation Science Standards: A focus on physical science. *The Science Teacher, 80*(3), 27-35.

Krajcik, J., Codere, S., Dahsah, C., Bayer, R., & Mun, K. (2014). Planning instruction to meet the intent of the next generation science standards. *Journal of Science Teacher Education, 25*(2), 157-175. https://doi.org/10.1007/s10972-014-9383-2

LaDue, N. D., Libarkin, J. C., & Thomas, S. R. (2015). Visual representations on high school biology, chemistry, Earth science, and physics assessments. *Journal of Science Education and Technology, 24*, 818-834. https://doi.org/10.1007/s10956-015-9566-4

Lee, O., Miller, E. C., & Januszyk, R. (2014). Next generation science standards: All standards, all students. *Journal of Science Teacher Education, 25*(2), 223-233. https://doi.org/10.1007/s10972-014-9379-y

Lontok, K. S., Zhang, H., & Dougherty, M. J. (2015). Assessing the genetics content in the Next Generation Science Standards. *PLoS One, 10*(7), 1-16. https://doi.org/10.1371/journal.pone.0132742

Maulucci, M. S., Brown, B. A., Grey, S. T., & Sullivan, S. (2014). Urban middle school students' reflections on authentic science inquiry. *Journal of Research in Science Teaching, 51* (9), 1119-1149. https://doi.org/10.1002/tea.21167

McDonald, J. (2015). The Next Generation Science Standards: Impact on college science teaching. *Journal of College Science Teaching, 45*(1), 13-14. https://doi.org/10.2505/4/jcst15_045_01_13

Miller, E., Lauffer, H. B., & Messina, P. (2014). NGSS for English language learners. *Science and Children, 51*(5), 55-59. https://doi.org/10.2505/4/sc14_051_05_55

Miller, R. G., Curwen, M. S., White-Smith, K., & Calfee, R. C. (2015). Cultivating primary students' scientific thinking through sustained teacher professional development. *Early Childhood Education Journal, 43*(4), 317-326. https://doi.org/10.1007/s10643-014-0656-3

O'Bannon, B. W., & Thomas, K. M. (2015). Mobile phones in the classroom: Preservice teachers answer the call. *Computers & Education 85*, 110-122. https://doi.org/10.1016/j.compedu.2015.02.010

Palincsar, A. S. (2013). The next generation science standards and the common core state standards: Proposing a happy marriage. *Science and Children, 51*(1), 10-15. https://doi.org/10.2505/4/sc13_051_01_10

Pang, V. O., Lafferty, K. E., Pang, J. M., Griswold, J., & Oser, R. (2014). Culture matters in science education. *Science and Children, 51*(5), 44-49. https://doi.org/10.2505/4/sc14_051_05_44

Passmore, C. (2015). Shifting To NGSS-aligned classrooms. *Leadership, 44*(4), 24-27.

Plummer, J. D., & Maynard, L. (2014). Building a learning progression for Celestial Motion: An exploration of students' reasoning about the seasons. *Journal of Research in Science Teaching, 51* (7), 902-929. https://doi.org/10.1002/tea.21151

Pratt, H. (2014). Implementing NGSS crosscutting concepts: Opportunities for elementary teacher contributions. *Science and Children, 52*(2), 8-11. https://doi.org/10.2505/4/sc14_052_02_8

Pruitt, S. L. (2015). The Next Generation Science Standards. *The Science Teacher, 82*(5), 17-19. https://doi.org/10.2505/4/tst15_082_05_17

Rodriguez, A. J. (2015). What about a dimension of engagement, equity, and diversity practices? A critique of the Next Generation Science Standards. *Journal of Research in Science Teaching, 52*(7), 1031-1051. https://doi.org/10.1002/tea.21232

Rodriguez, A. J., & Zozakiewicz, C. (2017). Using sociotransformative constructivism (sTc) to unearth gender identity discourses in upper elementary schools. *The University of Pennsylvania Graduate School of Education's Online Urban Education Journal*. Retrieved from http://www.urbanedjournal.org/node/169

Scogin, S. C., & Stuessy, C. L. (2015). Encouraging greater student inquiry engagement in science through motivational support by online scientist-mentors. *Science Education, 99* (2), 312-349. https://doi.org/10.1002/sce.21145

Sneider, C., Stephenson, C., Schafer, B., & Flick, L. (2014). Exploring the science framework and NGSS: Computational thinking in the science classroom. *Science Scope, 38*(3), 10-15. https://doi.org/10.2505/4/ss14_038_03_10

Tofel-Grehl, C., Litts, B., & Searle, K. (2016). Getting crafty with the NGSS. *Science and Children, 54*(4), 48-53. https://doi.org/10.2505/4/sc16_054_04_48

Weinburgh, M., Silva, C., Smith, K. H., Groulx, J., & Nettles, J. (2014). The intersection of inquiry-based science and language: Preparing teachers for ELL classrooms. *Journal of Science Teacher Education, 25*(5), 519-541. https://doi.org/10.1007/s10972-014-9389-9

Wendt, J. L., & Rockinson-Szapkiw, A. (2014). The effect of online collaboration on middle school student science misconceptions as an aspect of science literacy. *Journal of Research in Science Teaching, 51* (9), 1103-1118. https://doi.org/10.1002/tea.21169

Werderich, D., Farris, P., & McGinty, A. (2014). Biography as mentor. *Science and Children, 52*(2), 66-69. https://doi.org/10.2505/4/sc14_052_02_66

Wong, B. (2015). Careers "from" but not "in" science: Why are aspirations to be a scientist challenging for minority ethnic students? *Journal of Research in Science Teaching, 52*(7), 979-1002. https://doi.org/10.1002/tea.21231

Workosky, C., & Willard, T. (2015). Answers to teachers' questions about the Next Generation Science Standards. *The Science Teacher, 82*(6), 29-31. https://doi.org/10.2505/4/tst15_082_06_29