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The Next Generation Science Standards and the Quest towards Culturally Responsive Pedagogy: Perceptions of K-12 Educators

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Abstract

The K-12 education system is increasingly becoming more culturally diverse. Due to this change in student population diversity, the public, policy makers, employers, and educators agree on the need to change how science is taught in classrooms. Answering this call, states are rushing to adopt the Next Generation Science Standards (NGSS) in K-12 public schools. However, there is need to assess how culturally responsive teaching (CRT) can be meshed with NGSS to achieve desired results. This study explored teachers' views on the benefits and implications of using CRT in K-12 science education under NGSS. Survey data were collected from K-12 teachers in 18 states in the US using an online questionnaire. Based on our data, 86.36% of the respondents had a positive view of the potential impact of integrating CRT with NGSS. However, connecting CRT and NGSS to the science content emerged as one of the major concerns among the teachers. The study also found that teacher training programs on the awareness and adoption of both NGSS and CRT are still needed.

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Based on these findings, three major recommendations were proposed: 1) phased-adoption and re-assessment of the CRT-NGSS combination on student success; 2) immersive professional development for in-service teachers on how to include NGSS in the existing science curricula; and 3) evaluation of how CRT fits into the new science standards.

Keywords: Next Generation Science Standards (NGSS); science curriculum; culturally responsive teaching (CRT); K-12 science education.

1. Introduction

The concept of culturally responsive teaching (CRT) has been widely discussed in the literature [1, 2, 3, 4, 5, 6, 7]. However, with the adoption of new generation science standards (NGSS) in K-12 public schools, there are concerns about CRT disconnectedness from academic student learning [8]. The arguments for, and against, multicultural education are based on the practicality of developing inclusive pedagogical practices that can respond to, or address, the needs of each student. While the primary purpose of NGSS is to improve the way students learn science in response to the changes in technological advances, there are calls to determine how these standards can serve the needs of all students. Nevertheless, the success of culturally responsive teaching (CRT) will be determined by how much cultural knowledge teachers possess, their view of its impact on learning, its adoptability to new science curricula, and the teachers' ability to embrace it. Therefore, determining and understanding the resources needed and the implications of using CRT along with NGSS are new frontiers that require substantial input from in-service teachers, if the NGSS implementation is to succeed.

In practice, the NGSS are rapidly becoming a national science education policy, replacing the current science education reform efforts [9, 10]. The NGSS are based on the idea that authentic science approaches are critical learning objectives that students should be encouraged to attain. This refers to science investigations which end up with construction of logical conclusions as evidence-based arguments to defend conclusions [11: 33]. There are many students who think who their interests and lives are not connected to the science curriculum [12]. The principle of NGSS sound like all Standards, all Students [13: 38]. Yet, according to the US Census 45% of the school age population under 19 years is from diverse ethnicities and 21.6% of all U.S. children live in poverty [14:1035]. Thus, one would expect that US teachers learn how to combine cultural competence with the skills required for teaching science subjects. The NGSS suggest that it is possible to significantly advance scientific education through teaching science-related values that are suitable for contemporary students. This approach involves learning where students are deriving their own hypotheses, posing their own scientific questions, developing methods for testing their hypotheses, and constructing logical conclusions that are based on evidence-based arguments [11].

The NGSS, therefore, require thorough cooperation between educators and field scientists to keep it constantly updated for validity of scientific insights in the educational field [15]. For globalization enhancement in today's world, NGSS are serving to meet the culturally diverse needs of today's society [16]. In some measure, therefore, CRT is engaging in authentic academic activities [17]. The authors in [18] viewed authentic scientific inquiry as research that is conducted by scientists and that it is a complex activity, employing expensive equipment, elaborate procedures and theories, highly specialized expertise, and advanced techniques for data analysis and modeling [18: 177]. The authors in [19] explained authenticity and link it to systems theory. They noted that systems theory helps us to reconsider what authenticity means in science education. They further argued that the focus on designing and establishing authentic science learning environments and tasks has neglected to ask what authenticity means, to whom, and according to whom [19: 738]. In another study, Brand and Resis [20] viewed authenticity as being problematic with diverse meanings and having implications for science curricula. They suggest having a more authentic school science curricula and pointed out that authentic school science curricula could include experiences that are aligned with activities that reflect real world science. Therefore, it would be great to incorporate authentic science education with CRT since it plays a significant impact in science education.

2. Purpose of the study

The NGSS are new and presently their impact on student success in science education is not well known. Most states and schools are still in the adoption phase, and several views and assumptions have been put forward, one of which is the use of a CRT-NGSS combination. Currently, there are arguments that are both for, and against, the use of CRTs that are mostly based on the current science standards. Therefore the purpose of this study was to examine the views and suggestions of in-service teachers on the use of CRT and NGSS in K-12 science education. The findings from this study will help teacher educators, policy makers, and researchers become more knowledgeable about the benefits and implications of using CRT and the NGSS. The outcome of this study will be used to create science learning experiences that are rigorous enough to help all students to learn in K-12 science education and to close the gaps between CRT and NGSS.

3. Literature Review

Science, Technology, Engineering, and Mathematics (STEM) in science education has become a key topic in technology development and advancement. The need for people who have STEM skills and education has now become a concern worldwide [21]. The benefits for students who choose to major in STEM fields can be significant because of the decrease in availability and an increase in demand in these fields [22]. The NGSS education reform reminds us that in the U.S. science is considered an essential education thread for exerting job creation and leadership innovation. Therefore, the need for STEM education is being understood in terms of creating a better life for individual students and their communities at large.

3.1 The NGSS and Cultural Diversity

In order to align school curricula with the increased demand for scientific skillfulness, NGSS lay emphasis on authentic scientific practices with a focus on generating explanations by using physical occurrences and developing models [23]. The authors in [16] pointed out that the students' involvement and motivation in science was due to their educators' engagement with the NGSS and that teachers should provide strong mentoring, support, and guidance to their students. Studies consistently show that the student population in the United States is increasingly becoming culturally diverse [24, 25, 26, 27], and the trend is not expected to end in the near future [28, 29]. Therefore, educators, policy makers, stakeholders, and researchers have expressed the need to make the necessary adjustments and to put resources in place to support inclusive learning in schools. According to the authors in [26] the practices of CRT can tackle the cultural mismatch and provide an environment where children can thrive and succeed. According to the authors in [30, 31] the meaning of inclusion can be confusing. Ainscow [30] defined inclusion into four different ways: 1) removal of barriers; 2) as a process; 3) the participation, presence, and all students' achievements; and 4) inclusion of groups of learners that have been marginalized, and underachievers that are at risk. The author [32] stated that the concept of inclusion in a curriculum based on "science for all" can be different from a science curriculum for the most able and future scientists. The authors in [32] noted that the issue is addressed in most curricula at both the national and state level. The authors in [33] argued that culturally-based science curricula are not straightforward when developing them and that the definitions of the terms science and culture are subject to simplistic stereotyping. The authors in [33] explained that such problems exist because the issue of culture and its impact on science and science education is not addressed, and culture in everyday practices is not well recognized.

3.2 CRT in Science Education

Gay [34, 35] defines CRT as using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to, and effective for, them [34: 31, 35: 50-51]. Gay [34] noted that many teachers are not adequately prepared when it comes to teaching diverse students. The researcher in [34] also noted the importance of culturally responsive teaching which is also documented by [36]. The concept of CRT was developed based on the assumption that teachers could use critical multicultural awareness skills in the learning process to create equal educational opportunities for all students [37]. According to the authors in [38] the call for reform-based CRT in science education is based on two arguments: 1) engaging all students in the learning of science; and 2) increasing science awareness in different cultural settings. The authors in [39] suggested that the use of CRT in science education is one of the key components of enhancing understanding of science based on students' cultural backgrounds. They further noted that science learning entails student engagement in the culture of science within the culture of school [39: 6] and thus any meaningful educational reform effort aimed at improving science achievement must include multicultural education.

The authors in [36] agreed that by modeling and mentoring CRT, using culturally responsive curricula, obtaining culturally responsive resources, offering professional development programs that incorporate culturally responsive school leadership, retaining and recruiting culturally responsive teachers can help in achieving a culturally responsive school environment. They proposed that school leaders should take the lead in promoting a culturally responsive school environment which highlights the importance of inclusivity, and engages in culturally fitting practices with students, families, and the community. Other studies pointed out that in urban schools, CRT made a difference in the academic achievement of students with different learning needs, and enhanced their empowerment, as well as their emotional and social growth [34, 4, 40].

A study by Harmon [4] showed that both educators and students benefit from CRT. Harmon [4] noted the effectiveness and worth of culturally responsive teaching throughout history. The author in [4] articulated the fact that the early African American schools that used CRT had high attendance, students were more successful, moved quickly through the curriculum, and some of the graduates became leaders and teachers. She further pointed out that: 1) professors should be culturally competent; 2) teacher preparation programs should prepare their teacher candidates to be culturally responsive; and 3) professional development must address cultural competency for teachers in all schools. The author in [34] addressed several CRT characteristics in her work. She noted that CRT is comprehensive, it is validating/affirming, emancipatory, transformative, multidimensional, and empowering. Another study showed that CRT can improve the educational experiences of students from diverse cultural, linguistic, and ethnic groups and lessen educational disparities [1: 151].

Despite the advantages of CRT, linguistic and cultural challenges to science learning remain persistent. For example, Gay [34] noted that many teachers are not adequately prepared when it comes to teaching diverse students. While several advantages of CRT have been identified, other studies have noted some challenges and concerns [41]. Among them: 1) the complexity of adjusting teaching techniques to address all learning styles in large and diverse classes; 2) the practicality of addressing all cultural issues in one classroom setting and the needs of each student [35]; and 3) the problem of over-stretching teachers if they have to learn everything about every student's cultural identity [42].

3.3 Designing and delivering CRT in Science Education

The authors in [39] suggested that aligning reform efforts in science education to the field of multicultural education would make science learning meaningful to all students [39:1]. The authors in [36] suggested that one way of maintaining a culturally responsive school is by having the school Principals play leading roles. The authors in [43] mentioned that several factors must be considered in order to successfully design and deliver CRT and that all teacher preparations should place culture at the core of their teacher education programs. They further recommended that there should be curricular revisions, restructuring of programs, and incorporation of the principles of CRT as a guide for framing the CRT implementation process. Stephens [44] examined a culturally responsive science curriculum and views it as incorporating structures of Western and "native" culture with science topics at the core and having the goal of enhancing the students' science knowledge, skills as well as cultural well-being. According to the authors in [45], a CRT model should take into consideration the teaching performances and dispositions since they are critical in what the teachers are thinking and doing. Disposition can be referred to as ways of acting which can developed over time. Examples may include open-mindedness, respect for others, and perseverance or habits of mind [46]. According to the authors in [45] in order to implement a curriculum that effectively addresses dispositions and behaviors, teacher preparation programs need a robust and comprehensive model to guide instruction and assessment of culturally responsive teaching [45: 807].

The authors in [25] noted that equity and diversity should be addressed in teacher education programs, and by supplementing knowledge with heart, it can help pre-service teachers become culturally responsive teachers. They noted that including equity and diversity in the curriculum, will bring awareness to the pre-service teachers. The author in [47] mentioned that individuals have supported the idea that education should be culturally diverse and equitable; should have assessment practices that are equitable; and a culturally responsive curriculum. Varelas [48] articulated that if we want to achieve equity, we should look at all the structures (ethno-linguistic, race, gender diversity in the scientific communities, assessment rituals, textbooks, instructional approaches, lab space, interactional patterns) that are acting against the students who are left out of science. She noted that efforts are needed to provide places, spaces, and nurturing for students. A study by the authors in [49] showed that in the United States there are issues relating to access and equity in science education that many learners face. They reflected on the NGSS and the problems that are associated with standards-based implementation. The authors in [49] agreed that when learners view what happens in formal science education as being systematically disconnected from their everyday lives, it can result in issues of identity conflict where learners find themselves disinterested in, or unable to, access science-linked identities [49: 4]. Rodrigues [14] explained that according to the NGSS framework, no examples whatsoever are provided for how to make the science content culturally relevant and inclusive (14: 1024]. The author further noted that when aspects of equity, engagement, and diversity dimensions are rooted in NGSS, it could be much easier for individuals that are interested in cross-cultural education especially when they experience pedagogical and ideological changes that may face resistance. The author also suggested that diversity and equity can be vital as NGSS dimensions when they are at the same level. Gilbert [50] suggested four phases involved in the development of a culturally responsive curriculum: 1) introduction, which encompasses inquiry-based learning on a particular subject; 2) using cultural context for further explanation based on traditional teaching techniques; 3) communicating concepts and mastering skills presented in the science textbook through lectures, practical and inquiry based class activities; and 4) combining culture with lectures, laboratory and inquiry-based class activities.

4. Methods

In this study, the first five questions (1-5) used in the survey were developed based on items in the [51] questionnaire. Since the purpose of this research was to determine the understandings and views of in-service teachers on the need for CRT application along NGSS, the items in the validated questionnaire [51] were modified to open reflection questions. The remainder of the reflection questions (6-9) were design to solicit the teachers' suggestions on how to implement CRT in K-12 science curricula. The questionnaire comprised of the following questions: 1) Does your school work collaboratively with all the members of staff and the community to ensure culturally responsive teaching is incorporated in the classroom environment? 2) Do you see a need toward addressing the diverse learning needs of students from culturally and linguistically diverse backgrounds? 3) In your view do you see any benefit in recognizing and valuing the cultures represented by the students in your classroom? 4) Have you used culturally responsive teaching when you are using the Next Generation Science Standards? Why or why not? 5) My teaching approach accommodates the cultural differences in my classroom. Yes/No? 6) Explain your view of the use of culturally responsive teaching and its benefits or disadvantages for student science education; 7) How do you construct scientific explanations when you are using the Next Generation Science Standards? 8) Explain the strategies that you have used to support culturally responsive teaching and the Next Generation Science Standards in K-12 science education; and 9) In your view, what three problems or benefits would be encountered by both teachers and students if culturally responsive teaching techniques are /are not implemented along with NGSS?

An online survey questionnaire along with Institutional Review Board (IRB) requests were sent to randomly selected K-12 public school districts in 18 states and the District of Columbia based on the list on the NGSS website. These states are Arkansas, California, Connecticut, Delaware, Hawaii, Illinois, Iowa, Kansas, Kentucky, Nevada, New Hampshire, New Jersey, New Mexican, Oregon, Rhode Island, Maryland, Vermont, and Washington. In-service teachers were requested to complete an online questionnaire that was sent to randomly selected schools. A voluntary informed consent and at least 18 years of age were the pre-requisites to participate in the survey.

The qualitative data were interpreted through a three-step process: data organization and management, immersive engagement, and writing and representation [52: 238]. The responses to the questionnaire were divided into three classes: 1) Questions 1-3 (*demographic data* - descriptive statistical analysis was performed using SPSS 23 software); 2) Questions 4-6 (*Respondents' views on the use CRT* to enhance NGSS success); and 3) Questions 7-9 (*suggestions* on how CRT could be used along with the NGSS). The major findings are presented below.

5. Findings

5.1 Demographic data

Among the respondents, those with less than 5 years, 5 to 10 years, and over 10 years of teaching experience were 11.36%, 18.18%, and 70.45% (N = 88), respectively. When these teachers were asked about the need to address the diverse learning needs of students, 86.36% thought it was necessary. The remainder (13.64%) did not see the need to use CRT in science education. Similarly, the proportion of those who had and had not piloted the use of CRT stood at 86.21% and 13.79%, respectively (N = 87). One person did not respond.

5.2 Respondents' views on the use of CRT

In this study, 84.7% (N=88) of the respondents indicated that they had used CRT along with NGSS. A similar proportion indicated that they foresee a positive impact of integrating CRT with NGSS. For example, one teacher mentioned, "Our school district has a large Hispanic and Haitian community and we strive to incorporate culture specific activities in our daily routines. We observe Cinco De Mayo as well as hold culture nights where parents and students can come and taste food from their culture. I believe this develops a community of tolerance and understanding of other cultures". Another teacher mentioned, "Yes. We work hard to create a positive classroom community. A component of this is valuing how much we can learn from diverse cultures". Maintaining a positive and well managed classroom environment is important for students and is highly valuable [53]. The authors in [54] articulated that one of the most powerful tools that teachers can use in the classroom to prevent behavioral problems and engage children in learning is to create classroom environments that are engaging and positive. The authors in [54] agreed that other factors such as instructional pacing and classroom management techniques have been used but how the teachers respond and attend to children's behaviors is very important. The authors in [54] noted that creating these positive interactions between a teacher and child is one important way to help build a positive classroom environment [54:18].

Among those who had integrated the CRT into NGSS, some identified the following benefits: shared background knowledge, cultural contributions to scientific knowledge, providing a platform for a common scientific vision, building trust and respect among different cultures, etc. For example, one of the respondents noted: “Science requires a background knowledge that students don’t always come to school ready to use. Culturally responsive teaching helps to respond to this need.” In addition, science and technology advancement have no cultural boundaries. NGSS integrated CRT would help students to understand that advancing science has been a collective effort. In support of incorporating CRT into NGSS education reform, one respondent mentioned: “Students can see that many cultures have contributed to scientific knowledge and we all benefit from these contributions”. In addition, another teacher noted, “Benefits- it helps other students who may not have the opportunity to work with students from other groups to meet someone from outside their culture and build positive relationships. It gives minority students an opportunity to integrate into the mainstream society in a meaningful way, which will help them later in adult life”. Another aspect that came out of the study was that CRT applications have a positive impact on the students’ cultural awareness, “Culturally responsive teaching would be a benefit for student science education because Apache beliefs incorporate a person's surroundings (ecology, biology, astronomy, geography, etc.). Appreciation for these things teaches one to respect and take care of themselves, others, their environment, etc”. Also, building cultural awareness among students helps to promote unity in communities. For example, another teacher said “Culturally responsive teaching develops a community of understanding and respect where all people’s backgrounds, views, etc. are accepted. I think the advantages outweigh the disadvantages greatly. I think if this happened more than the overall school community would be better”.

5.3 Suggestions on how CRT could be used along NGSS

Several respondents in this study indicated that when they are using the NGSS they apply similar strategies when constructing scientific explanations. One teacher said, “When constructing scientific explanations, students use the CER (Claim, Evidence, Reason) strategy. This is done after some STEM related lesson(s). Another teacher said, “We have worked extensively on our CER's - Claim, Evidence, and Reasoning method for writing. I take students into the lab nearly daily to explore and investigate. They follow a rubric for explanations”. Another teacher said, “We use a scaffolded approach of Claim-Evidence-Reasoning. This approach is systematic within all disciplines in our school; therefore, it has become the culture to do a CER for open response questions”. Another teacher said, “Culture of routine talk, scaffolds for discussion”. The use of scaffolding approach that the teachers are using in their class is also reflected in [29] work where it is viewed as providing temporary support to help the child master the task. Scaffolding can be provided by teachers, parents, and others [29].

The strategies used to support CRT and the NGSS include: teamwork, discussions, diverse teaching styles, among others. For example, one of the teachers mentioned, “group collaboration/Inquiry; think-pair-share; sentence starters; use of accountable talk during discussions/discourse; modeling by teachers and by students; annotation when reading”. Another respondent noted, “multiple representations of concepts scale modeling multiple modalities for instruction making and building.” In view of the challenges and benefits encountered by both teachers and students when using CRT with NGSS, one teacher said, “knowledge and quality science work is happening all over the world; people you (students) know, people just like you, and people very different from you are interested in the same science topics and working with the same ideas; recognizing that diverse people are scientists encourages children to think that they, too, could be scientists - there are no cultural limitations to being scientists". Another teacher mentioned, "By not incorporating culturally responsive teaching at this point in time, we are missing a huge opportunity to fully implement the NGSS in an inclusive and equitable manner." Another teacher said, "Lack of equity of mastery".

6. Discussion

6.1 Respondents' views on the use of CRT

Our study has shown that more teachers are incorporating CRT in their curricula, but the use of the CRT-NGSS combination is still in the pilot phase. Gay [34] noted that many teachers are not adequately prepared when it comes to teaching diverse students. In another study, the authors in [36] also posit that teachers are not culturally responsive and that they lack access to training programs that reflect culturally responsive teaching. This was evident in some of the participants' responses. One teacher stated, "we still need to grow in this area". Another teacher noted "I have not heard the term culturally responsive teaching used. My view is you have to determine who the student is and what kind of educational background they have. The only disadvantage is the time it takes to address needs of diverse learners". If teachers do not understand the concepts it can be challenging to incorporate it into the lesson and to help all students learn.

Based on the responses given by the participants in our study, it is evident that CRT needs to be addressed rigorously in pre-service teacher preparation. One of the teachers noted, "Absolutely. Students are eager to learn when connections are made that are relatable to their culture and learning style. My content area is Science. This lends itself to several opportunities to work in groups to investigate, gather data, and solve problems. Cultures cannot be checked at the door. Everyone is encouraged to learn from everyone in a collaborative team-approach manner. Sometimes a team just clicks. Other times not. Just like in the workplace, community, within states, countries, and the globe". Another participant states "Yes. Especially with the language we use and the sometimes lack of emphasis on education (and science in particular) in many of our students' homes". Another teacher mentioned, "Absolutely, class work needs to be relevant to the lives of all students in order to add the important motivation to attend to lessons and learn the material. Anytime we can make school work relevant for students we improve student outcomes". Therefore, it is critical that educators understand CRT and NGSS and help all K-12 science education students to grasp these principles. Supporting the need for CRT in education, [55] mentioned that student teaching experiences expose teacher candidates to a setting that includes cultural, linguistic, racial and ethnic diversity in families and communities [55: 179].

While many respondents noted the positive impact of CRTs, some indicated that they were not aware of, and have not used, them in their classes. One of the teachers noted, "We do not know much about culture, and students do not know how to say". In addition, concerns were raised about the importance and viability of using CRTs in science education. Implementing CRTs would come at an additional cost. As one teacher puts it, "This is hard work on my part (and theirs), but the impact is amazing." Accommodations and modifications for lesson plans required for CRT could be a challenge in large and very diverse classes. One of the teachers noted the frustrations of using CRTs in such cases, “The disadvantage is, I may have up to 10 different cultures. I'm not going to spend time trying to make them all feel good. I'm teaching science, not culture.” Another respondent agreed, “It can be difficult to address certain cultures inside the classroom. For example, at a previous school I worked at, students viewed certain animals and symbols as bad omens and some lessons could not be taught.” In addition, some teachers thought the use of CRT was unnecessary and could distract students from learning the subject content, “… you can be losing the message trying to be all things for every student.” Another view was, “There is no need to accommodate different cultures in a science class. Science is science.” In addition, some teachers questioned the necessity of integrating science and culture. For example, one of the teachers quipped, “Culturally "responsive" teaching is not necessary in the science classroom. Do Newton's laws act differently for different cultures? Do Einstein's laws only work for some cultures? Is a different periodic table for some cultures as opposed to others?” These responses show that there is no general consensus regarding the inclusion of CRT in NGSS.

6.2 Suggestions on how CRT could be used along NGSS

Several researchers pointed out the need to enhance learning through scaffolding [56, 57, 58, 29, 59]. The author in [56] defines scaffolding as adjusting the support offered during a teaching session to fit the child’s current level of performance [56: 223]. This was evident in our findings. One teacher stated, “scaffolding. many examples. many models. etc.” Another teacher mentioned, “Presenting vocabulary in multiple languages Modify vocabulary” and “Offer different options for projects Scaffold work”. The term scaffolding is not new and is used by [60, 61] as a temporary support that is given to children to help them accomplish the task. Ormrod [59] defined scaffolding as support mechanism that helps a learner successfully perform a challenging task (in Vygosky’s theory, a task within the learners’ zone of proximal development) [59:175]. Scaffolding has also been used in playing with children where teachers scaffold children during social interaction and provide different prompts [62]. The author in [2] noted that teachers should use cultural scaffolding. She noted that it can start by the teachers illustrating culturally sensitive care as well as building communities that are culturally responsive. The author in [63] explained seven differentiated instructional strategies (knowing the learner, quality of instructions, teacher quality traits, flexible teaching and learning time, classroom learning environment, best practices and instructional delivery, evaluation, assessment and grading) that address students of diverse cultures. The author [63] also mentioned that it is important to do a comparison between differentiated and traditional classrooms so as to have a better understanding of the instructions.

Incorporating diverse students’ culture and language in the curriculum has been well documented [3, 6, 7, 64]. Jackson [65] noted the little attention that was given to teachers who needed help in recognizing and capitalizing on the strengths that diverse students bring to their classes when the preconceived norms and notions of the teachers are different from the students. Jackson [65] provided seven strategies that can support culturally responsive pedagogy. These include building trust, building a positive home-school relationship, building instructional strategies repertoire, providing effective feedback, becoming culturally literate, analyzing instructional materials, and using effective questions. According to the author in [34], if educators positively embrace these strategies in their curricula, it would help both students and teachers.

Another issue related to the implementation of CRT in the NGSS is that of equity. This involves establishing a "level" playing ground for all students. Equity should be embedded in K-12 science education and our study showed that it would be beneficial to both teachers and students. One of the teachers said, "NGSS is based on the foundation of equity, which mandates that science instruction is provided to all students for mastery". CRT is required for this to occur. The authors in [25] have discussed equity and diversity and noted their importance in teacher preparation programs. In another study, the authors in [66] explained that the education systems have not always been fair and equitable, with some students experiencing exclusion and marginalization from and within school on the basis of personal and social factors such as ethnicity, ability/disability, gender, sexuality, and religion [66: 139].

7. Recommendations and Implications

The findings from this study indicate enthusiasm among many of the teachers on the prospects of integrating CRT and NGSS to improve science learning in K-12 education. However, there is still lack of multicultural knowledge among some teachers to make meaningful positive impact on students. On the other hand, concerns were raised about the viability and importance of implementing NGSS with CRT. One of the major factors pointed out was lack of CRT awareness and training among teachers. In addition, some teachers were concerned that incorporating CRT in the curricula would impose time constraints, especially given that they would be trying to adjust to the new education standards. Another issue was that using CRT in large and very diverse classes would pose lesson planning challenges to teachers. In view of the above, therefore, we propose the following recommendations:

1) There is still a need to train some teachers on the adoption of NGSS. With the impact of NGSS on student success not well-known at present, we propose a phased-adoption and assessment of the CRT-NGSS combination. This will provide a clearer direction on how to successfully achieve the NGSS goals.
2) State and school district materials and financial support are needed to increase and improve teacher professional development initiatives centered on the successful implementation of CRT and NGSS. Professional development activities for in-service teachers could take the form of peer mentoring, immersive and continuous workshops, etc.
3) The adjustment of science teacher education programs to focus directly on CRT-NGSS application as opposed to general multicultural education training would be important since there is an increased demand in the STEM fields, yet teachers in those fields are typically not culturally responsive.
4) When NGSS were developed, the major focus was on improving science learning with little attention to the delivery methods. Re-evaluation of how the current CRT techniques would fit the NGSS would provide proper direction to minimize the concerns and confusion among teachers. In designing these techniques, the issue of CRT must be born in mind and incorporated, since this has been proven to have some significant impact on both the teachers and students.

Based on the above, it is critical that educators understand CRT and NGSS to enable them to help all K-12 science education students to improve their learning outcomes. It is also very important that per-service teachers learn about culturally responsive teaching and how to use it in their teacher education preparation programs.

8. Constraints / Limitations of the study

The first limitation relates to the sample selection and size. The findings reported in this study are based on responses from a sample of 88 respondents, which is relatively small compared to the number of K-12 science teachers in the states where the NGSS have been adopted. This was partly because only the teachers in the school district that authorized the teachers to participate in this study provided their input to this study. In addition, the study did not include data from private school teachers and other stakeholders in the teacher education. Thus, the findings may not be generalizable to all teachers in USA. The second limitation was that in some states, the data were collected at a time when the NGSS had just been adopted. It will, therefore, be more helpful to conduct a similar study a few years after the implementation phase to determine if there would be a shift in teachers' perception of the NGSS. Thus, based on the above-mentioned concerns, the findings in this study are tentative.

9. Conclusion

While a relatively small sample size was used in this study, which could restrict the generalization of the views of K-12 teachers in all public-school districts in the U.S., the results suggest that the adoption of both CRT and NGSS can be problematic although many teachers expressed optimism that they would have positive effects on student understanding of science in K-12 education. Teachers still need direction on how to include both in their new curricula while minimizing teacher and student burn-out. As our results show, there is fear among some teachers that while, theoretically, both CRT and NGSS sound attractive, more work is needed to assist teachers during the transition from the old to the new standards. The form of assistance needed takes various forms, but one major requirement would be an increase in the State and school district financial support and other means of support to increase and improve teacher professional development initiatives centered on the successful implementation of CRT and NGSS, and to cover delivery methods for in-service teacher training. Our study extended the literature on CRT and NGSS and how the importance of equity should be embedded in NGSS. Our study also connected to that of [14] work on how diversity and equity can be vital in the successful implementation of NGSS.

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