



The Effects of Standardized Tests on Incorporating 21st Century Skills in Science Classrooms

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ABSTRACT

Purpose of the study: The aim of this article was to investigate how the unintended side effects of standardized testing cause teachers not to integrate 21st century skills i.e., communication, collaboration, creativity, and critical thinking, into science classes. In addition, this study also cross-examined if certain features of standardized testing have any beneficial impact on the adoption of 21st century skills in science teaching.

Methodology: This paper followed the method of narrative review. 85 papers were initially selected after the primary searches. Finally, 30 papers were used to answer two research questions in this article.

Main Findings: After analyzing the selected papers, this narrative review revealed three unintended outcomes of standardized testing on the practice of 21st century skills, which are: teachers often prioritize testing over teaching, which results in the fact that there is not enough time for innovative instruction, and the time spent on the actual content of the curriculum is often shortened. On the other hand, the review also found that standardized tests can motivate teachers and enable them to offer their students new opportunities to incorporate 21st century skills into science education by following Assessment guidelines and expanding curricular opportunities.

Novelty/Originality of this study: This study revealed how standardized test-based education practices in science teaching can be analyzed and customized to create a space for cultivating 21st century skills for students.

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1. INTRODUCTION

The popularly labeled skills of the 21st century, namely, creativity, critical thinking, collaboration, and communication, are essential for survival in a society undergoing continuous changes. If science graduates do not develop these critical skills during their formal education, they may struggle to participate in society in a meaningful way. A lack of 21st century skills also hampers their ability to compete in the global job market [1], [2]. These cutting-edge skills must be incorporated into education to prepare science graduates before entering the job market, which has a considerable shortage of STEM workforce in the United States [3]. While there is a growing awareness of the value of these 21st century skills among educators and leaders generally, there is at the same time an almost fundamentalist adherence to testing procedures which, according to a range of studies, hamper the development of such practices within classrooms.

A battle between a standardized test and 21st century skills seems obvious. Standardized testing, which is often a state-mandated test, captures the full attention of the teachers and other stakeholders, leaving little

room to focus on other issues. Standardized tests refer to large-scale assessments administered nation-wide. Standardized tests enable educators to compare the progress of classes and students in a wide geographical area and are often regarded as the most fair and objective form of large-scale tests due to the consistency of the questions asked and the scoring style. However, standardized testing has been strongly criticized since the twentieth century for creating obstacles to integrating 21st century skills into lessons [4]. The term "21st century skills" refers to a set of competencies and abilities that are considered essential for success in the modern world. These skills are typically grouped into categories such as critical thinking, problem solving, creativity, communication, collaboration, digital literacy, and global awareness. Partnership for 21st Century Skills (P21) was developed to incorporate skills essential for the 21st century into education [5].

The organization is recognized as the national advocate of 21st century skills and has been founded in partnership with the U.S. Department of Education and several private sector organizations. Skills in the 21st century are crucial to thrive in the workplace, full participation in civic life, and adaptation to new technologies and modes of life. Do standardized tests really create obstacles for science teachers to nurture 21st century skills in their students? Or testing enhances the quality of science teaching rather than degrading it? In this narrative review, I tried to answer the following two research questions, which are: 1) To what extent do standardized tests hamper the adoption of 21st century skills by teachers in the secondary science classroom?; 2) Has it been revealed by the scholars that standards tests can, on the other hand, motivate teachers to adopt 21st century skills in the science classroom?

In the next section, after briefly describing the research method, I discussed the negative impact of standardized tests on the practice of 21st century skills. Then I presented the scholars claim who believe standardized testing supports the incorporation of 21st century skills into science classes. Finally, I recommended some key issues that stakeholders can consider while prioritizing the best strategies to prepare their students for the 21st century job market.

2. RESEARCH METHOD

I used a series of strategies to identify the studies for this paper. First, I selected the key terms used in the common language in the literature and entered them into the following databases, ERIC, EBSCOHost, ProQuest Dissertations, Google Scholar, and WEB of Science. The descriptors for the searches included combinations of the following keywords: standardized text, high-stakes testing, effects, impact, barriers, challenges, supports, advantage, 21st-century skills, science teaching, science learning, science pedagogy science classroom with no restriction on where the terms occur (i.e., title, abstract, descriptor, or full text) or year of publication. Then, I used a snowball literature search methodology to identify relevant articles in reference lists of studies and reviews previously published in the field of interest. Next, I reviewed all the titles and abstracts of the identified articles and rejected irrelevant ones. Given the narrative nature of the review, manual searches are also conducted through the reference lists of included articles. Additionally, I conducted searches in my personal database related to the topic of interest to obtain all articles that had not been identified using the search methodology. All articles considered to have the potential to answer the research questions were downloaded. After reviewing 85 original downloads, 30 potential articles were selected, reviewed, and used.

3. RESULTS AND DISCUSSION

3.1 Results

This narrative review identified the key issues of the battle between preparing students for standardized tests and adopting skills of the 21st century. In this segment, I first discuss the findings of research question 1) how the standardized test limits 21st-century skills' incorporation. Next, I discuss the findings of research question 2) which explored the scholars' view of how standardized tests can guide teachers in integrating 21st-century skills.

3.1.1 Evil Side of Standardized Test: An Obstructive Factor to 21st Century Skills Incorporation

To answer the research question1, this narrative review explored how standardized testing might discourage science teachers in the pedagogical adaptation of 21st-century skills. The argument against standardized testing to instill 21st-century skills is centered on three issues: prioritizing testing over teaching, the lack of instructional time to adopt 21st-century skills, and narrowing the curriculum in K-12 science education. This part of the article aims to elaborate on all three issues with the help of the existing literature.

Prioritizing Testing over Teaching

Teachers and all other stakeholders in K-12 education give a high priority to standardized tests. This results in removing any teaching practices incorporating 21st-century skills from science lessons. Errabo et al. [6], who addressed teachers' attitudes towards this issue, emphasized that test-driven pedagogy is one of the

possible reasons for ignoring 21st-century skills. These researchers sought to determine exactly why teachers prioritize tests over other aspects of education. They found that the demand for 21st-century learning, which promotes 21st-century skills, has potential but is eventually denied by teachers. According to a study conducted by Muhammad et al. (2022) [7], in Nigeria, science teachers and students tend to focus more on obtaining high-stakes exam grades in the last year of their studies than on acquiring knowledge and skills that will benefit their future careers. This is because upgrading the students' mean scores in the summative assessments is more important than integrating other curriculum targets into them. Moreover, students standardized test performance is not only directly related to teacher performance and bonuses but also serves as a criterion to judge the quality of schools and teaching [8]; [9]). Thus, the test emphasis imposed by the school authorities is a pressing issue in the K-12 educational landscape. The article, *Teaching under high-stakes testing, Dilemmas and Decisions of a Teacher Educator* [10], presented a good example of how teaching methods can be altered due to the pressure of standardized tests at school. She narrated how the standardized test focus changed her teaching and cut down the writing activities to accommodate multiple-choice tests within the course she taught as per the school's demand. She clearly showed frustration as the multiple-choice test eliminates the option of considering multiple viewpoints of any matter by imposing a single answer to choose from. This type of change eventually hurts students' comprehension of the content and causes students to lack creativity, critical thinking, communication, and collaboration.

Furthermore, education policies have been built on the test-driven mechanism since the ages. In an article, [11] criticized the NCLB approach (No Child Left Behind) to learning assessment, which conflicts with the pedagogical and leadership behaviors of the 21st-century school movement. Schoen and Fusarelli [11] emphasized that single-minded focus is predominant among teachers, accompanied by fear of adopting anything new. They continued that this fear is directed by NCLB, making teachers unwilling to invest their time in anything new. This discussion clearly showed how the system drives teachers to prioritize testing for remuneration, which aligns with the findings of Muahmmad et al. [7] study. It also imposes schools to bring about significant changes in pedagogical practices by sacrificing creative teaching strategies and creates barriers to bringing 21st-century teaching and learning to science classrooms. Now, if the remuneration/punishment issues are removed, whether teachers will have enough time to embrace the 21st-century skills.

Lack of Instructional Time to Adopt 21st century Skills

Standardized tests create a barrier to 4C integration in education because teachers do not adopt such innovative approaches in teaching due to a lack of time. This is because a large part of the teaching time is spent on preparation for standardized tests. In the past, researchers in the late twentieth century claimed that high-stakes testing reduces the time of ordinary instruction and limits student instructional opportunities [12, 13]. Later, at the beginning of the twentieth century, the same claim that schools and teachers spend considerable time testing students came to the surface [10]. Sutton stated that her students were more interested in discussions promoting collaboration and communication, the two important aspects of 21st-century skills. However, this was avoided due to time constraints. Recently, the claim of a time shortage was also addressed by Lawley et al. [14], who emphasized that implementing the next-generation science standards (NGSS) might close the gap between students with learning needs. But the lack of an adopted science curriculum and teachers' time during the school day to teach the science standards are insufficient to prepare students. Overall, the above discussion pointed out that the time spent on test preparation cutting down the creative instructional time from the teachers' schedule is a century-long issue. This also raises the question of whether a lack of instructional time simultaneously catalyzes a reduction in the science curriculum.

Narrowed Science Curriculum

Some researchers found that standardized/high-stakes tests made teaching science even more challenging by narrowing the curriculum [15]-[18]. Teachers emphasize what is essential for tests, leaving many vital contents important for developing 21st-century skills. One of the previous criticisms was noted in Mathis' study [17], which highlighted the tendency of test-driven teachers to limit the curriculum by minimizing the content of the untested curriculum in the lessons. This directly impacts the quality of the curriculum and leads to the elimination of the embedded skills in the curriculum, for example, communication, collaboration, critical thinking, and creativity (4C), from the learning objectives. The findings are the same as those of Minarechova [15], who stated that due to the primary consequences of standardized tests, the curriculum content got narrowed, and subject area knowledge got fragmented into tests related pieces. In the same vein, Milner [16] criticized that "Scripted and predetermined curriculum, in this sense, robs students from engaging in other disciplines that may allow students to develop creativity and build skills in other areas". These two criticisms clearly showed the barriers the standardized test creates to the incorporation of 21st-century skills in science teaching. The third piece of evidence against standardized tests is an interesting empirical example provided by Collins et al. [19]. Collins and his team supported these arguments by showing the impact of standardized tests on laboratory-based teaching practices. The mixed-method study of these researchers on 600 telephone surveys found that the heavy

test preparation practice narrowed the curriculum. It also reduced many aspects of investigatory science from the science curriculum of England due to the overreliance on the paper-pencil test. The same study claimed that the abolition of national science tests for 11-year-olds positively affected science teaching in Wales. In the same vein, other researchers discussed that because the exam focused on traditional hands-on strategies and focused only on the use of the equipment and since most students use past exam papers for standardized testing [20]).

Standardized tests dictate what is taught; therefore, what appears in the summative assessment potentially influences the teaching methods adopted by teachers [21], [22], [23]; [7]. Furthermore, children are taught to meet the need for standardized testing components, ignoring the condition of the children at school. Unfortunately, education policy has failed to eliminate such a trend for centuries. Therefore, many wonder how long such rigid teaching will continue to remove organic learning from classrooms, leaving science teaching lifeless.

3.1.2 Bright Side of Standardized Test: A Supportive Factor to 21st century Skills Incorporation

Many scholars argue that without standardized testing, quality education cannot be ensured [24], [4], [25]. They claimed that standardized testing is an essential tool to measure students' knowledge and skill gain over time compared to the peer that guides teachers to adopt 21st-century skills. Their findings are associated with four key claims validated by test advocates: standardized tests support 21st-century skills, motivate teachers, provide guidance, and broaden the curriculum. The next part of this paper explored multiple studies that supported the positive impacts of Standardized tests in science teaching.

Supports 21st century skills

Some scholars claim that 21st-century skills are supported rather than inhibited by standardized tests [24]. For example, teachers willingly accept new 21st-century teaching approaches incorporating 21st-century skills when supported by the state mandate test. Yeh's [24] study on 61 teachers and school leaders of four Minnesota school districts revealed that 85% of teachers support the state mandate testing system, which removed parrot learning and installed critical thinking and all types of competencies. This study also revealed that the goal of school practitioners is well aligned with the state-mandated tests. This example supports the claim that incorporating 21st-century skills into the classroom requires a certain level of alignment between testing and curriculum and must be accepted by teachers.

Motivates Teachers

Standardized testing challenges teachers to do their best to ensure student success [4], [25]. The empirical study of Pringle and Martin [25] on 38 science teachers from ten schools in a suburban school district in central Florida captured the change in teachers' attitudes when faced with the challenge of standardized science tests. This changed behavior favored incorporating 21st-century skills when teachers were more careful to teach students to follow science standards. Teachers recognized that teaching must be aligned with standardized testing to avoid their students' failure. This example shows how a standardized test can work to ensure quality science teaching that otherwise may not be possible. McMillan [4] claimed that high-stakes tests in science and other subjects encouraged in-depth teaching, higher-order cognition, and personalized instructions. Well-motivated teachers need to incorporate creativity, critical thinking, collaboration, and communication into science lessons.

Provides Guidance

According to some scholars, standardized tests outline good teaching, which may not be possible without a guide [26]-[28]. Moxey [28] wrote in his article "How I Learned to Stop Worrying and Love Standardized Testing" that before the testing era, he wondered about his ability to reach students to be better thinkers and develop their minds that could solve problems. The standardized test has given him a focus. These scholars believe that standardized tests provide a framework for good teaching without a guide, which may not be possible. Cizek [27], in his book chapter "High-Stakes Testing: Contexts, Characteristics, Critiques, and Consequences," criticized the remark that says unintentional teaching to the test is an unintentional consequence of high stakes of testing. According to him, this is not an unintended consequence. He also clarified that if the students' retention cases are there because some are not prepared for the following year's test, that would be the ideal thing to do. The state should neither believe that unprepared students might be prepared without tests nor plan to push them forward unprepared. That is exactly what tests are supposed to stop. Rather than preparing students to pass the exam, finding a way to help them is needed. Baker et al. [26] found that after having a poor grades, the students received more attention from their teachers. In other words, teachers become more concerned after knowing the students' weaknesses from the standardized test and improving them to help all students, which is undoubtedly a bright side of the standardized test.

Broaden Curriculum

Unsurprisingly, incorporating 21st-century skills into science education is a timely demand. But some studies found a complicated relationship between standardized testing and curriculum and revealed how testing could cause curriculum expansion [28], [29]. This claim is consistent with Jonsson and Leden [28], who argued that teachers include new aspects of science teaching if new content is added by tests, eventually leading to a broadening of the pedagogical practice consciously to ensure the success of their students. His study investigated how, or to what extent, standardized tests influence Swedish science teachers' pedagogical practices. He argued that teachers include new aspects of science teaching if new content is added by tests, eventually broadening the pedagogical approach to ensure their students' success. Furthermore, the standardized test ensures accountability, which is one of the strong arguments presented by Jonsson and Leden [28], who support standardized tests. He eventually denied the claim of a narrow curriculum and its impact on incorporating 21st-century skills. Laden's view was supported by Kong [29], who also denied curriculum reduction due to time constraint issues as a challenge to incorporating 21st-century skills in science. He suggested that a flipped classroom model for teaching science can give teachers the ability to teach the next generation science standards, give students time to work on science and engineering practices of what they are learning, and provide them with time to learn and practice the 21st-century skills [29]. These researchers claimed that it depends on teachers who keep the curriculum narrower and broader.

3.2 Discussion

Let us consider standardized tests creating no barriers for science teachers to incorporate 21st-century skills in classrooms and rather support creative teaching by aligning the aims of the pedagogy with the test system of the state, enhancing the teachers' motivation, presenting a well-guided pathway to following the state standards, and extend the curriculum to fit the 21st-century skills into it. Unfortunately, the structure and learning in many schools worldwide do not meet the needs of the 21st-century job market [30]. Although social changes indicate how far a shift to essential skills is required, the current K-12 summative assessment system lags a lot. After analyzing the findings of both research questions, it can be suggested that careful budget planning and a reformed approach are necessary to foster a favorable teaching environment for science teachers, where they can prepare science graduates for their future careers. This may require substantial changes to adjust the focus of standardized tests to include 21st-century skills in science teaching.

Careful budget planning

The increasing demand for 21st-century skills in science classrooms is directly connected with every country's job market and economy. Therefore, careful budget planning is required. For proper allocation to be addressed. Because it is not uncommon for schools to spend a tremendous amount of time and money on testing preparation [31]. Marassa [32] advocated incorporating skills into the curriculum with adequate financial support. In the paper, Policy Advocacy: Adoption of the 4C's Rubrics into Illinois Vision 20/20, she showed concern about the extra expenses of buying the 4C's rubric and challenges regarding technology readiness for poor school districts. This statement clarifies that a country might need to choose where to spend a significant share of the budget to equip students with essential life skills, such as 21st-century skills for future careers, or to test their ability, even knowing that standardized tests fail to improve student learning. The flexibility of the federal fund is mandatory to achieve this goal.

Reformed-Based Practice

The twenty-first-century school movement or 21st-century skills integration might suggest deleting standardized tests. Some studies showed why such reform is necessary. The empirical findings of the researchers showed that science learning in the class of nontested science subjects practices collaboration, communication, critical thinking, and communication (21st-century skills) compared to the subjects tested through high stakes tests Donnelly [33]; this author strongly supports the reduction of high stakes tests from K-12 education. Donnelly's findings are dovetailed with the outcome of Kivunja's [34] study, which claimed that 21st-century skills require a new learning paradigm, which is not just about 21st-century skills or about learning but making a switch in learning, teaching, assessment, and curriculum development together.

Successful Integration of 21st-century Skills

Some scholars expressed suspicion about the 21st-century school movement, claiming this was an unrealistic approach. For example, Couros [30] points out that "A school with all the latest technology may well be a twenty-first century school and still not offer twenty-first-century learning" (5: 140). He added that with technology, a school might run the risk of increased learning outcomes, which might bring unexpected outcomes. "If we do not understand the learning opportunities we have in front of us because of technology, we run the risk of accelerating learning outcomes that may not be relevant to the learner" (5: 140). Couros [30] emphasized that 'technology itself is not the answer, not a means in and of itself to attaining the 4 C's skills'.

Other possible unwanted consequences were warned in the study of Marassa [32], who agreed that standardized tests while providing knowledge-based results, cannot predict complex skills such as 21st-century skills. Unpredictability is not surprising, especially when research found that many science teachers lack knowledge about 21st-century skills [35]. However, measuring learning growth is less important than helping the student grow as a well-rounded citizen. Here, my views are well aligned with Machado and Laverick [36], who emphasized, to make it possible for every young child to survive and thrive in an increasingly diverse and interconnected world, educators and caregivers must provide young children with an environment in which they think critically, communicate, collaborate, and create within and across physical and virtual spaces.

I would highlight that a central policy-based and well-thought-out plan is needed to design and implement the science lessons integrated into 21st-century skills. To achieve this gap, proper budgetary allocation is essential to support the smooth conduct of 21st-century skills-embedded teaching and learning. A standardized test should not overshadow the importance of integrating 21st-century skills in science teaching.

4. CONCLUSION

The standardized test plays a crucial role in maintaining educational standards by separating well-performing students from those who need additional help and dividing people into social strata. Testing fails to measure the most important life skills required for a science graduate to be career-ready, creating barriers to instilling 21st-century skills in science lessons. The educational contexts for science teaching must be equipped with 21st-century skills. We must establish a thoughtful exam system that allows students to communicate, collaborate, think critically, and practice creativity. Science teachers and educators should take the necessary steps to maintain an updated curriculum, teaching techniques, and sophisticated assessments for science teaching, which is the best way for students to prepare for the future.

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