

Teaching Physics to Reflect the 21st Century Skills: A Way Forward for Effective National Leadership.

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Abstract: This study employed the descriptive survey to assess the 21st century skills that are needed in the teaching of physics for effective national leadership. Three research questions were posed and one null hypothesis formulated for analysis at 0.05 level of significance. Sixty (60) Physics Education students comprising of 29 males and 31 females, randomly drawn from the Department of Science Education of Michael Okpara University of Agriculture, Umudike, Umuahia served as sample. The instrument used for data collection was questionnaire. The instrument was validated and its reliability obtained as 0.94 using Cronbach Alpha. Data collected was analyzed using mean to answer the research questions and *t* test to test the hypothesis. Results show that; teaching physics to imbibe knowledge and skills of technology and how to integrate technology in their class work, encouraging students to build new understanding from their prior knowledge, monitoring physics students progress with assessment and accountability measures, encouraging physics students to think critically and logically in order to solve problems, teaching physics students to understand how to use information and communication technology (ICT) tools and many others are agreed by male and female physics students as 21st century skills that are needed in the teaching of physics for effective national leadership. The *t* test analysis show a no significant difference in the responses of male and female physics students. Recommendations were made one of which is the need for physics teachers to teach students physics in such a way that they will imbibe knowledge and skills of technology and technology should also be integrated in physics students class work.

Key words: Physics, Physics Education, Scientific literacy and Leadership Skills

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I. Introduction

Globalization and advancement in science and technology has resulted to societies dominated and driven by ideas and products from science and technology (S&T). It is not out of place for one to conclude that the influence of science and technology in our lives will increase in the future since scientific and technological knowledge and skills had invaded all realms of life in modern society: the workplace and the public sphere are increasingly dependent on new as well as upon more established technologies (Czuiko, Redmond, Sauncy, and Olsen 2014). According to Czuiko et (2014) modern societies need people with scientific and technological qualifications at the highest level as well as a general public which has a broad understanding of the contents and methods of science and technology, coupled with an insight into their role as social forces that shape the future.

For the above dream to be achieved, effective science instruction in general and physics instruction in particular in the classroom will require science/physics teachers to teach students science/physics for them to understand and apply such knowledge in everyday situation. The recent volume *Taking Science To School* (NRC, 2007), identified four strands of proficiency for students and for teachers who are responsible for guiding young science/physics learners. According to it, students and teachers should be able to:

- i. Understand, use, and interpret scientific explanations of the natural world.
- ii. Generate and evaluate scientific evidence and explanations.
- iii. Understand the nature and development of scientific knowledge, and
- iv. Participate productively in scientific practices and discourse.

According to *Taking Science to School* (NRC, 2007), these proficiencies are embodied most clearly in classroom activities such as content-rich inquiries and non-routine problem-solving. The implication is that physics students must be taught physics in such a way they should be able to solve problems in the society they live. The major problem facing school leavers is the problem of unemployment and physics students are not exempted. It is therefore pertinent that physics students must be taught physics in a way that they are prepared for work and citizenship.

According to The Joint Task Force on Undergraduate Physics Programs (2016), preparing students for work, citizenship, and life in the 21st century is complicated. The Joint Task Force on Undergraduate Physics Programs (2016) argued that globalization, technology, migration, international competition, changing markets, and transnational environmental and political challenges add a new urgency to develop the skills and knowledge students need for success in the 21st century context. Wagner (2008) proposed that physics students need seven survival skills to be prepared for 21st century life, work, and citizenship. These skills according to Wagner (2008) are; critical thinking and problem solving, collaboration and leadership, agility and adaptability, initiative and entrepreneurialism, effective oral and written communication, accessing and analyzing information and curiosity coupled with imagination.

These are leadership skills. For a leader to be effective, he must possess skills of communication, creativity, delegation, positivity, trustworthiness, responsibility, flexibility and commitment. Such qualities are not far from the qualities of leaders. Leadership can be defined as the art of getting someone to do something you want done because he wants to do it. Leadership is the ability of an individual or a group of individuals to influence and guide followers or other members of an organization. This means that leadership involves making sound decisions, creating and articulating a clear vision, establishing achievable goals and providing followers with the knowledge and tools necessary to achieve those goals. The implication is that for students to be effective leaders, they must have vision, be creative, thorough, team builders and must be able to take risks. There is therefore a great need to teach physics students skills that will enhance their leadership skills.

Global competences are the core capacity students need for the 21st century and this is the capacity and disposition to understand and act on issues of global significance. Students that are globally competent should be able to investigate the world beyond their immediate environment. recognize perspectives of others and their own, communicate ideas effectively with diverse audiences and take action to improve conditions. The economic rationale is that computers and machines can effectively handle jobs which people with only routine knowledge and skills can do. This means that the workplace need less people with only basic skills and more people with higher – order thinking skills. Also the labor market need people who can add value through applying complex thinking and communication skills to new problems and environments.

For the purpose of creating job for physics students' school leavers, it is imperative to identify these 21st century skills and explore their integration within the teaching of physics in the secondary schools. Supporting this, National Research Council (NRC 2010) and Bybee 2010 stated that these skills should receive priority in today's education system. NRC (2010) went further to argue that the growing base of human knowledge and the need to understand and use modern tools for communicating and sharing what is learned, further increases the imperativeness for these skills. Windschitl (2009) explained that physics education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy especially when instruction addresses the nature of science and promotes use of science practices. Windschitl (2009) went further to assert that these skills not only contribute to the development of a well-prepared workforce of the future but also give individuals life skills that help them succeed. Such life skills enhance effective leadership skills. It is therefore imperative that physics students are taught physics to possess these skills for effective national leadership. Physics students therefore need to be taught quality physics education by teaching them 21st-century skills and making sure that the goals for quality physics education are achieved in the teaching of physics. The National Science Teachers Association (NSTA 2010) proposed that quality physics education and 21st-century skills support each other when

- i. physics leaders cultivate 21st-century skills that best align to good physics teaching;
- ii. students meet the standards for scientific inquiry and technological design (NSTA 2004);
- iii. students have a complete, accurate, and working understanding of the nature of physics (NSTA 2000);
- iv. ongoing professional development opportunities and effective preservice and induction programs for physics educators support the integration of 21st-century skills in classroom teaching (NSTA 2006; NSTA 2007; Windschitl 2009);
- v. quality inquiry-based curricula and support materials promote physics learning and 21st-century skills (NSTA 2004);
- vi. a wide range of technologies serve as tools to engage students with real-world problem solving, conceptual development, and critical thinking and
- vii. instruction includes a variety of opportunities for students to investigate and build scientific explanations, such as laboratory experiences (NSTA 2007).

Promotion of scientific literacy has been recognized as a major goal of quality science education in the world (Mohanty, 2003). A scientific literate person should be able to understand science, the nature of scientific knowledge and the relationship of science with society and environment to know basic scientific concepts, laws, theories and principles, and to use science process skills (Tadesse, 2006). Urevbu, (2001), opined that students who are scientifically literate understand physics concepts and processes that are required to engage in the

digital era society. In this 21st century students should be able to ask questions, have the ability to describe, explain, present and evaluate their arguments based on the evidence they have. All these can only be achieved if physics is taught properly. Through science process skills, students could observe things and use all their senses to gather information about events during experiments (Mohanty, 2003). The use of hands-on activities in physics experiments help students to use different senses by observing, feeling, touching, smelling and even listening which in turn help them to progress from concrete thinking levels to more complex thinking level which promotes higher order thinking skills and 21st century (Partnership for 21st Century Skills P21, 2009). To teach physics effectively using the 21st century skills for national development, the National Research Centre (NRC 2001) opined that;

1. The teaching of physics should imbibe knowledge and skills of technology and how to integrate technology in students' class work;
2. Teachers should encourage students to build new understanding from their prior knowledge;
3. Physics teachers should ensure that students have deep foundation of knowledge, facts and ideas in the context of a conceptual framework and organize knowledge to enable them retrieve and apply it.
4. Physics students should be encouraged to think about how they are learning by taking control of their own learning, monitor their learning progress and improve their achievement.
5. Physics students' progress should be monitored with assessment and accountability measures.
6. Physics students should be encouraged to think critically and logically in order to solve problems.
7. Physics students should be taught science in a way that will enable them apply knowledge gained to new situations, analyze information, comprehend new ideas, communicate, solve problems and make relevant decisions.
8. Physics students should be taught science to understand how to use Information and Communication Technologies (ICT) tools.
9. Physics teachers should help science students to make vital practical, emotional and social connections to relevant life skills by creating 21st century context for learning by
 - i. Making context relevant to students' lives.
 - ii. Bringing the world into the classroom.
 - iii. Taking students out to the world.
 - iv. Creating opportunities for students to interact with each other, with teachers and with other knowledgeable adults in authentic learning experiences.
10. Physics teachers need to use instructional strategies that reflect current research and modern context to engage science students in learning.
11. Physics teachers need to use assessment techniques that effectively measure what students are learning and how they are learning it.
12. Physics must be taught to students to prepare them for 21st century life, work, and citizenship which include:
 - i. critical thinking and problem solving
 - ii. collaboration and leadership
 - iii. agility and adaptability
 - iv. initiative and entrepreneurialism
 - v. effective oral and written communication
 - vi. accessing and analyzing information
 - vii. curiosity and imagination.

Based on the above, the purpose of this study is to survey the views of physics students on the 21st century skills that are needed in the teaching of science for effective national leadership.

Research Questions

The following research questions and hypothesis guided the study

1. What are the mean scores of science students on the 21st century skills that are needed in the teaching of science for effective national leadership?
2. What are the mean scores of male and female science students on the 21st century skills that are needed in the teaching of science for effective national leadership?

Hypothesis

There is no significant difference in the mean scores of male and female science students on the 21st century skills that are needed in the teaching of science for effective national development.

The hypothesis was tested at 0.05 level of significance.

Method

This study employed the descriptive survey design to investigate the views of physics students on the 21st century skills that are needed in the teaching of science for effective national development. Three research questions were posed and one null hypothesis formulated for analysis at 0.05 level of significance. Sixty (60) Physics Education students comprising of 29 males and 31 females, randomly drawn from the Department of Science Education of Michael Okpara University of Agriculture, Umudike, Umuahia served as sample. The instrument used for data collection was questionnaire of the four point Likert type of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The instrument was validated and its reliability obtained as 0.94 using Cronbach Alpha. Data collected was analyzed using mean to answer the research questions and t test statistics to test the hypothesis.

II. Results

Table 1: Mean scores of physics students on the 21st century skills that are needed in the teaching of science for effective national leadership

S/N	ITEM	SA	A	D	SD	X	REMARKS
1	Teaching science to imbibe knowledge and skills Of technology and how to integrate technology in their class work	38	21	-	1	3.60	Agree
2	Encouraging students to build new understanding From their prior knowledge.	40	20	-	-	3.67	Agree
3	Teaching science to ensure that students have deep foundation of knowledge, understand facts and ideas in the context of a conceptual framework and organize knowledge so they can retrieve and apply it.	39	21	-	-	3.65	Agree
4	Encouraging science students to think about how they are learning by taking control of their own learning, monitor their learning progress and improve their achievement.	25	33	2	-	3.38	Agree
5	Monitoring science students' progress with assessment and accountability measures.	29	23	8	-	3.35	Agree
6	Encouraging science students to think critically and logically in order to solve problems.	44	14	2	-	3.70	Agree
7	Teaching students science in a way that will enable them apply knowledge gained to new situations, analyze information, comprehend new ideas, communicate, solve problems and make relevant decisions.	38	20	2	-	3.60	Agree
8	Teaching science students to understand how to use Information and Communication Technology (ICT) tools.	40	19	1	-	3.65	Agree
9	Science teachers helping science students to make vital practical, emotional and social connections to relevant life skills by creating 21 st century context for learning by bringing the world into the classroom.	43	14	3	-	3.67	Agree
10	Science teachers need to use assessment techniques that effectively measure what students are learning and how they are learning it.	31	27	2	-	3.48	Agree

Table 1 above clearly showed that all the items have mean values greater than 2.5 which is the mean value of the four point scale used in the study. This means that all the students agreed that these items are all 21st century skills that are needed in the teaching of physics for effective national leadership.

Table 2: Mean scores of male and female science students on the 21st century skills that are needed in the teaching of science for effective national leadership.

S/N	ITEM	MALE Mean (X)	REMARKS	FEMALE Mean (X)	REMARKS
1	Teaching science to imbibe knowledge and skills Of technology and how to integrate technology in their class work	3.66	Agree	3.55	Agree
2	Encouraging students to build new understanding From their prior knowledge.	3.69	Agree	3.65	Agree
3	Teaching science to ensure that students have deep foundation of knowledge, understand facts and ideas in the context of a conceptual framework and organize knowledge so they can retrieve and apply it.	3.69	Agree	3.61	Agree
4	Encouraging science students to think about how they are learning by taking control of their own learning,	3.52	Agree	3.26	Agree

	monitor their learning progress and improve their achievement.				
5	Monitoring science students' progress with assessment and accountability measures.	3.52	Agree	3.19	Agree
6	Encouraging science students to think critically and logically in order to solve problems.	3.66	Agree	3.74	Agree
7	Teaching students science in a way that will enable them apply knowledge gained to new situations, analyze information, comprehend new ideas, communicate, solve problems and make relevant decisions.	3.52	Agree	3.68	Agree
8	Teaching science students to understand how to use Information and Communication Technology (ICT) tools.	3.69	Agree	3.61	Agree
9	Science teachers helping science students to make vital practical, emotional and social connections to relevant life skills by creating 21 st century context for learning by bringing the world into the classroom.	3.79	Agree	3.55	Agree
10	Science teachers need to use assessment techniques that effectively measure what students are learning and how they are learning it.	3.52	Agree	3.45	Agree

Result in table 2 shows that all the items have mean values greater than 2.5 meaning that all the students, both males and females agreed that the ten items listed above are all 21st century skills that are needed in the teaching of physics for effective national leadership.

Table 3: t- test of difference between the mean scores of male and female physics students on 21st century skills that are needed in the teaching of physics for effective national Leadership

Gender	N	Mean	Standard Deviation	t-calculated	t-tabulated
Male	29	39.78	5.812	0.181	1.98
Female	31	35.29	4.701		

Table 3 clearly showed that t- calculated value of 0.181 is less than the t- tabulated value of 1.98. The null hypothesis of no significant difference is therefore. This therefore means that there is no significant difference in the mean scores of male and female physics education students on the 21st century skills that are needed in the teaching of science for effective national leadership.

III. Discussion:

Tables 1 and 2 showed that all the items have mean values greater than 2.5 which means that all the students both males and females agreed that physics teachers should teach physics to imbibe knowledge and skills of technology and how to integrate technology in their class work, encouraging students to build new understanding from their prior knowledge, teaching physics to ensure that students have deep foundation of knowledge, understand facts and ideas in the context of a conceptual framework and organize knowledge so they can retrieve and apply it.

This result is in agreement with Wagner (2008) who proposed that physics students need critical thinking and problem solving; collaboration and leadership; agility and adaptability; initiative and entrepreneurialism; effective oral and written communication; accessing and analyzing information; curiosity and imagination survival skills to be prepared for 21st century life, work, and citizenship.

This result also agrees with Windschitl (2009) who explained that physics education can offer a rich context for developing many 21st-century skills, such as critical thinking, problem solving, and information literacy especially when instruction addresses the nature of science and promotes use of science practices. Stressing on this, Windschitl (2009) asserted that these skills not only contribute to the development of a well-prepared workforce of the future but also give individuals life skills that help them succeed hence are skills enhance effective leadership skills.

This result also agrees with the National Science Teachers Association (NSTA 2010) which proposed that physics students should be exposed to a wide range of technologies which serve as tools to engage students with real-world problem solving, conceptual development, and critical thinking.

Table 3 showed that the opinion of both male and female physics education students on the 21st century skills that are needed in the teaching of physics for effective national leadership do not differ significantly. This means that both male and female physics education students agree that encouraging physics students to think critically and logically in order to solve problems; teaching students physics in a way that will enable them apply knowledge gained to new situations, analyze information, comprehend new ideas, communicate, solve problems and make relevant decisions; teaching physics students to understand how to use

Information and Communication Technology (ICT) tools; physics teachers helping physics students to make vital practical, emotional and social connections to relevant life skills by creating 21st century context for learning by bringing the world into the classroom and physics teachers need to use assessment techniques that can effectively measure what students are learning and how they are learning it are all 21st century skills that are needed in the teaching of physics for effective national leadership.

IV. Conclusion

The main responsibility of the physics teacher is to assist physics students to learn physics and be able to fit into the society after schooling. The physics teacher can do this by effectively making the teaching of physics stimulating, challenging and dynamic. This means that physics students must be taught physics in such a way that they should be able to solve problems in the society they live. Physics students should acquire skills that will enhance their leadership capabilities. Such skills include creative, communication, critical thinking, flexibility, commitment, positive and trustworthiness skills. These are 21st century skills that are needed by physics education students for effective national leadership and physics education teachers must teach physics to include these skills.

V. Recommendation

For learning physics for effective national leadership, the following recommendations are made;

1. Physics teachers should teach science to students to enable imbibe knowledge and skills of technology and technology should be integrated in their class work.
2. Physics students should be taught physics in a way that will enable them apply knowledge gained to new situations, analyze information, comprehend new ideas, communicate, solve problems and make relevant decisions.
3. Physics teachers should encourage physics students to think critically and logically in order to solve problems.
4. Physics teachers should teach physics to ensure that students have deep foundation of knowledge, understand facts and ideas in the context of a conceptual framework and organize knowledge so they can retrieve and apply it.

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