Webology (ISSN: 1735-188X)
Volume 19, Number 3, 2022

Efficacy Of Dialogic And Vark Pedagogies On Science Students' Self-Efficacy In Biology: Cognitive Ability Level As A Moderator

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Abstract

This study was designed to investigate the moderating effect of cognitive ability level on the efficacy of Dialogic and VARK instructional strategies for improving science students' self-efficacy in Biology. Guided by three research questions and two hypotheses, the study adopted experimental research design, and involved 954 class 5 Biology students in Nigeria secondary (High) schools. A 40-item achievement test was used to determine baseline cognitive ability level of the students, and an adapted self-efficacy scale was used to collect pre-test and post-test self-efficacy data, which was analysed using SPSS v24, to determine the mean, standard deviation and p-values. Results revealed that dialogic and VARK pedagogies were significantly efficacious for improving science students' self-efficacy, with the dialogic pedagogy being more efficacious than the VARK. The study also showed that the influence of cognitive ability on the efficacy of these two pedagogies was not significant. It is recommended that science teachers consider self-efficacy an important factor that influences learning outcomes, and so design their lessons such that would stimulate students' confidence in their ability to grasp the concepts being taught. Adopting dialogic and/or VARK pedagogy which has proven efficacious can help science teachers build up students' self-efficacy.

Keywords: Dialogic pedagogy; VARK; Cognitive ability; Self-efficacy.

Introduction

Science and technology have evolved to become a very important aspect of life and living. The myriads of development noticeable in society today is as a result of practical application of scientific knowledge, ideas, laws, theories and principles – technology. That has made the ways

and methods of doing things easier and faster. Science is considered in part to be a body of knowledge and the systematic process of acquiring new knowledge, but in whole, it is referred to as the systematic, evidence-based pursuit of knowledge and understanding of the natural and social world (Khalil, 2011; Ladiges & Mayo, 2017). Science culminates in a body of verifiable knowledge, and/or the acquisition of skills to seek out such knowledge, or test such. Science could thus be a field of study, a process or an attitude/skill. Globally, science as taught in schools could be categorised into physical and natural or life sciences.

Biology is a life science which studies the existence (evolution, morphology and physiology) of living things, as well as their interactions with non-living components of the earth. Knowledge of Biology prepares students to undertake further studies and eventually build careers in such science fields as medical sciences and allied fields, pharmaceutical sciences, Environmental Biology, Biotechnology, plant and animal sciences/husbandry, agricultural sciences, food sciences, among others.

Nigerian students recognise the importance of Biology, hence its being the most subscribed science subjects in Nigerian secondary schools, with 1, 087, 884 candidates in 2018, as against 728, 998 for Chemistry, 704, 504 for Physics and 495, 920 for Agricultural science (Enebechi, 2016; West African Examination Council Chief Examiner's Report, 2018). Biology is structured to produce individuals with worthwhile knowledge of life processes, who will contribute meaningfully to society. Notwithstanding its importance and continued massive enrolment, achievement in Biology has continued to remain poor. The West African Examination Council (WASCE) Chief Examiner's report (2018) revealed that the mean achievement score of students in May/June WASCE is 30 (with a standard deviation of 9.00). This score is poorer than that of 2017 report of a mean score of 31 and standard deviation of 11.92. This implies that the average score of students who sat for Biology in 2017 and 2018 WASCE was 31 and 30 respectively, and as indicated by the standard deviation rating, the scores that contributed to this average were far apart from each other. Unfortunately, this is the only examination for West African countries that a credit pass and above in Biology permits students' entrance into institutions of Higher learning for pursuance of Biology related courses.

Research endeavours to unravel the cause of consistent poor achievement in Biology have implicated among other factors the teaching strategy adopted by Biology teachers (Farooq, Chaudhry, Shafia & Berhann, 2011; Opara, 2011; Sawa, 2011; Shimbi, 2016; Author et. al., 2019 & 2020b). Biology teachers are saddled with the responsibility of implementing the Biology curriculum at the classroom level. Due to 'packed/overloaded' nature of the Nigerian Biology curriculum, Biology teachers thus resort to the conventional lecture method of teaching, a method which allows for more content to be covered in little time, but increases the tendency for students' attention to wane after 15 – 25 minutes of its use, does not enhance achievement, retention, and renders students passive in the classroom, among others (Elton, 2017). These indicates that although lecture method is useful to teachers covering the curriculum, it has the potential to

negatively impact on students' learning outcomes. Considering these demerits, it is imperative that Biology teachers explore other teaching strategies.

The urge for considering and exploring the two strategies (Dialogic and VARK strategies) adopted in this study arose from Matusov (2009) that teaching is not supposed to be monologic despite that governments around the world and their ministries of education allied give attention to monologue. Secondly, Matusov (2010, p. 7) argues that a dialogic pedagogy emphasizes "questions of immediate concern" that may or may not be answered but will undoubtedly provoke inquiry and debate; while VARK teaching is viewed as an activity that inevitably leads towards prescribed a priori outcomes. Thirdly, Bakhtin the propounder of dialogism, to Tarbu (2007) is a Protomodernist. Mainly because Bakhtin anticipates the future rather than grasping the present in his interpretive quest that takes place between people through debates, negotiation of meanings etc. While Vygotskian in his socio-cultural context of learning as found in VARK (Weggerif, 2008) was a Pragmatist; and sought to understand individual experience by dissecting its cultural and historical significance through activity (Tarbu, 2007). A divergence so to say, of Bakhtin and Vygotsky. This study investigated the moderating effects of ability level on relative efficacy of Dialogic and VARK pedagogies on improving students' self-efficacy in Biology.

Dialogic Pedagogy

Dialogic pedagogy is an interactive discussion approach to teaching, which involves the effective manipulation of classroom conversations to facilitate learning. This pedagogy stems from the word "dialogue" and as University of Cambridge (2019) clearly highlights, teachers can explain concepts, clarify the objectives of instruction and help students come to terms with ways of describing these concepts by engaging students in worthwhile dialogue in the classroom. Through dialogues, teachers can elicit students' basic perspectives and manipulate these ideas to eliminate misconceptions in students' minds, and facilitate learning. Thus, dialogic pedagogy involves on-going/active talk between the teacher and the students, not just a one-way flow of information from the teacher to the students. Alexander (2006) refers to this pedagogy as a manner of communication within the classroom, that deepens thinking and enriches students' understanding. Talking in the classroom is perceived in our contemporary society as an indictment of the teacher's classroom management skills, and his/her level of control over the students, but dialogic teaching strategy carefully harnesses these "talk" to facilitate learning.

Recent literatures suggest an inclination towards dialogic forms of teaching, but there are four (4) key principles underlying it. These principles are: there must be open discussion that includes at least three students reacting to each other's comments; open questions which seek to reveal students' ideas of the concept under study; situations that allow the student(s) build on what student(s) had known and said concerning the concept previously; and teacher providing a more elaborate feedback (not just on the correctness or incorrectness of the students' comments) but as they relate to the content under discussion (Svaricek, Sedova, & Salamounova, 2014). The instructional strategy emphasised in this study for Dialogic strategy authenticates Bakhtin (1981)

For Bakhtin, freedom exists through multiple layers of analysis in relation with others (teacher as facilitator of the learning process and the learners). Bakhtin as cited by Emmerson (1997) maintained that 'word is always half someone else's and there is no one truth to be sourced as a conceptual whole'. Meaning (enhanced learning) comes about only when dialogue is exchanged with others. Emmerson explained the sources of arrival at meanings as self-other; other-self; self-other's creation and self-own creation. The pivotal of Bakhtin's philosophy of learning is on communication (i.e Dialogue) in the classroom and impacts on cognition. Bakhtin concludes that the world for us, that is the world of meaning is essentially Dialogic. This implies that meaning cannot be grounded upon any fixed or stable identities but is the product of difference.

In contrast, the experimental group 2 (VARK) in this study focused on the fact that the end point (meaning) can be achieved through mediated activity. It is based on Vygotsky (1986) socio-cultural theory of learning. For Vygotsky, knowledge is attainable through self-reflection using activity. VARK as a learning strategy is an embodiment of activity. An urge to try out this strategy in comparison with Dialogic arose from Sullivan, Matusov and Smith (2009) observation that while Vygotskian teachers seek to bring about abstract knowledge, Bakhtinian teachers recognize the contestability of truth as central to their pedagogical quest. The findings of this study uphold the tenets of the two theories, Dialogic and VARK pedagogies. From ontological point of view, the classroom application and explanations of the two strategies were adapted by the author from literature already highlighted. Whether Dialogism can really be subsumed within dialectic terrain of Vygotskian theory of learning as suggested by some Educationalists is outside the scope of this study, although Dialogic is often included as part of a sociocultural position and even sometimes sourced to Vygotsky as well as to Bakhtin (Weggerif, 2013).

VARK Pedagogy

The VARK pedagogy builds on Fleming's (1987) theory that there are four (4) main types of learners; Visual learners, Auditory learners, Reading/writing learners and Kinaesthetic learners (VARK). The question as to how students best learn; whether students learn best when teaching strategies match their learning styles and preferences has been an age-long discourse (Kendra, 2019). Students who have preference for pictures, movies, diagrams and other forms of learning that stimulate the sense of sight, are tagged "visual learners." On the other hand, students who learn better via music, discussion, lectures and other teaching-learning processes that appeal to the sense of hearing, are referred to as auditory learners. Reading/writing learners refers to students whose preferred learning style is making lists, reading text material and taking notes, whereas kinaesthetic learners are those who prefer learning via hands-on activities, experiments and movements.

As an instructional strategy, VARK pedagogy puts all these various learners into consideration and designs a lesson that would appeal to all four (4) learning preferences. A visual student would prefer information presented in form of diagrams, charts, maps, circles, hierarchies

and the likes. An auditory student on the other hand would prefer to hear the same information spoken. This could be achieved through listening to lectures, taking part in group discussions, web-chat, or listening to a radio/recorded instruction. The read/write learner however prefers information displayed as words, presented in text and/or similar forms like manuals, reports, and essays. The kinaesthetic students have a preference for gathering information through a combination of experience and practice. This would include experiments, simulations, video instruction, etcetera (Murray, 2019). The VARK teaching strategy provides teachers the opportunity to deliver classroom instruction using all four (4) learning modalities, thus accommodating students who learn best in different ways. This potentially would have immense implications on learning outcome.

A recent study on the impact of dialogic pedagogy (Nouri, Esmaeilli, Seifpour, Talkhabi & Khorami, 2018) reveal that the teaching strategy has significantly positive impact on the achievement of students in social studies, languages skills, and basic science, but not mathematics. However, in the study of the effects of VARK teaching strategy on achievement, Bethel-Eke and Eremie (2017) reports that the strategy had a significant influence on students' overall achievement in chemistry. Despite researches indicating teaching strategy (pedagogy) as partly responsible for the poor achievement of students, as well as recommending the use of novel strategies in teaching (Gambari, Yaki, Gana & Ughovwa, 2014; Nwosu & Ibe, 2014); students' continued poor performance is an indication that there are other variables (factors) at play in determining students' achievement. There is thus the need to consider other variables which exert influence on achievement as much. One such variable is self-efficacy.

Self-efficacy and Learning Outcomes

The belief an individual has in his/her ability to succeed/excel at something is known as self-efficacy. Put in simpler terms, self-efficacy is an individual's belief in their innate ability to achieve goals. Bandura (1982:122) referred to it as a personal judgment of "how well one can execute causes of action required to deal with prospective situations." Much of self-efficacy is formed during childhood, and is built upon feedback from parents, peers, and teachers (Robb, 2019). In the view of Stajkovic & Luthans (1998), individuals with high self-efficacy will exert sufficient effort that, if well executed, results in positive outcomes, whereas those with low self-efficacy are likely to stop trying early and ultimately fail. Belief in one's innate abilities requires valuing one's cognitive strengths, as well as determining to persevere until obstacles that threaten to interfere with applying those innate abilities towards achieving set academic goals are overcome.

Studies on the dynamics of self-efficacy (and lack of it) in diverse settings reveal that the construct impacts every area of human endeavour, including behaviour (Porter, Bigley, Steers, 2003), motivation (Seifert, 2011), and achievement/performance (Stajkovi & Luthans, 1998). As such, determining the beliefs a person holds regarding their ability to overcome challenging situations, strongly influences the person's ability to successfully navigate the challenge

(Luszczynska & Schwarzer, 2005). Applying it to education and achievement, students' belief in their ability to assimilate lessons being taught, as well as to pass tests and post good achievements on such content areas, is in part dependent on the belief they have in their ability to do so. Suffice it therefore to theorise from the foregoing that irrespective of what teaching strategy a teacher adopts in delivering Biology lessons, a student who doesn't have the conviction that he can learn, would by the end of the lesson not have learnt anything. However, considering that teachers play a role in shaping students' self-efficacy (Robb, 2019), the teaching strategy a teacher adopts has the potential to improve students' self-efficacy, or lower it. Although Alegre (2014) reported a positive and significant relationship between academic self-efficacy and academic achievement, it remains imperative to investigate the effects dialogic and VARK teaching strategies have on students' self-efficacy.

Despite a students' level of self-efficacy, the cognitive ability he/she possesses may exert a level of influence on his/her academic achievement. Ispas and Borman (2015) refer to cognitive ability as a general mental capability, involving reasoning, problem solving, planning, abstract thinking, comprehension of complex ideas and learning from experiences. A student with higher level of cognition is expected to achieve better than a counterpart with at a lower cognitive ability level. It is therefore important to isolate the effect of cognitive ability level on perceived self-efficacy of students who will take part in the study. This study generally seeks to determine in experimental conditions, which of dialogic and VARK instructional strategies would prove more efficacious for improving students' self-efficacy. To achieve this, the study was designed to answer the following questions:

1. What is the relative efficacy of dialogic and VARK pedagogies on students' mean self-efficacy?
2. What is the moderating influence of cognitive ability on the mean self-efficacy rating of students taught with dialogic pedagogy?
3. What is the moderating influence of cognitive ability on the mean self-efficacy rating of Biology students taught with VARK pedagogies?

The following null hypotheses were formulated to guide the study and will be tested at 0.05 level of significance.

1. There is no significant difference in the mean self-efficacy scores ratings of Biology students taught with Dialogic pedagogy and those taught with VARK pedagogy.
2. The moderating influence of cognitive ability level on students' self-efficacy is not significant.

Method

Experimental research design was adopted for the study. Some recent similar studies by Ugwuanyi, Gana et al. (2020) Ugwuanyi, Okeke et al. (2020), Ugwuanyi, Ede et al. (2020), Ede et al. (2020),

Ogba et al. (2020), Okide et al. (2020), Ugwuanyi, Okeke. Agboeze et al. (2020), Umoke et al. (2020), Agboeze et al. (2020), Omeje et al (2021), Abiogu et al. (2020), Onyishi et al. (2021), Ugwuanyi, Okeke and Ekwueme (2021), Ugwuanyi et al. (2021) have adopted this kind of design. The study was conducted in two phases. The pre-experiment involved seeking approval for the study from the appropriate authorities of the schools sampled and consent from regular teachers that served as research assistants and students. Approval was also granted by the Research and Ethics Committee of the Faculty of Education, University of Nigeria, Nsukka. The second was the experimental phase, the instructional procedures in the two treatment groups (Dialogic and VARK groups). 954 class 5 Biology students from 29 secondary schools in Nigeria who took part in the experiment, had an average age of 15 years. Fifteen (15) classrooms served as dialogic pedagogy while fourteen (14) classrooms served as VARK classrooms. To ensure that no school received both dialogic and VARK pedagogical intervention, each of the 29 schools provided only one classroom, which was either marked to receive dialogic pedagogy or VARK pedagogy. The teaching materials used in the dialogic and VARK classrooms were based on the curriculum stipulations for the content Genetics. The content covered such units as definition of genetic terms, transmission of characters, Mendel's experiments and laws of inheritance, role of chromosomes in transmission of characters, process of transmission of hereditary characters, and probability in genetics.

One Biology teacher was selected from each school to serve as research assistant. The role of the Biology teachers was to administer the genetics content in line with either dialogic or VARK pedagogy. To prepare the teachers for the task, a 21 days training workshop was organised for the selected teachers. This workshop was used to sensitize the teachers on how to effectively implement the dialogic and VARK pedagogies in line with the lesson plans developed by the researchers and given to the regular teachers. The trainees were split into two groups; group 1 being teachers trained for dialogic pedagogy and group 2 being teachers trained to use VARK pedagogy. Having completed the workshop in their various groups, a mock teaching exercise was organized for each group. This served as an evaluation of the training teachers received, and afforded the researchers the opportunity to make corrections where the teachers somewhat went amiss.

The dialogic pedagogy lesson plan was purely dialogue-based, involving the teacher designing questions specific to Genetics content that will cause the students to interact and provide responses. This thus rendered the students very active and the teacher, a facilitator posing questions, correcting wrong conceptions by students, guiding students to develop the right understanding of genetics concepts and moderating the classroom dialogue. The VARK pedagogy lesson however involved the teacher combining a variety of approaches to ensure that the lesson appeals to the visual, auditory, read/write and kinaesthetic 'senses' of the students. Teachers trained in the use of one pedagogy, were expected to implement that pedagogy in teaching Genetics content in their classrooms.

In the dialogic classroom, the teacher had the students in groups of five per group. The teacher used probing questions related to the unit of Genetics being taught to stir up dialogue among the students, and then listened to the ongoing dialogue, agreed and/disagreed with one another's response/opinion of the question raised. The dialogue occurred within groups, and then proceeded between groups when the teacher demanded that groups share their responses to the questions posed. The teacher ensured a decorum in the classroom, even while the dialogue proceeded and when the time allotted for dialogue on a given question elapsed, the teacher summed up all that students said, pointed out wrong responses/standpoints, and reinforced correct ones.

For the introductory lesson during the first week of the experiment, the content heredity and transmission of characters was taught. Some of the probing questions used by the teacher to trigger dialogue among students included:

1. Is every member of your group physically alike?
2. Why do you think members of your group are physically similar or dissimilar?
3. What makes individuals physically similar or dissimilar?
4. Where do the characters possessed by individuals come from?
5. Can all characters an individual possesses be transmitted to his/her child/offspring?

The students deliberated on the questions as they were raised by the teacher in their respective groups. Members of groups then responded to the questions when mandated to do so by the teacher. The teacher allowed other groups to critique the response made by every group, and then informed students that every individual possesses features/attributes that makes them unique, pointing out (for instance) that these features could be similar with or different from those possessed by another person. Teachers corrected some misconceptions that arose from the dialogue in the class. Students also provided justifications for each response they gave. The teacher acted as moderator of the dialogue going on within and between groups, properly 'pacing' the questions, and allowing groups to critique, disagree or agree with the responses provided by other groups. At the end of the dialogue, students had collaborated with one another by sharing ideas and questioning each other's ideas, and the teacher summarized all the responses that were given by reinforcing correct responses and correcting erroneous conceptions.

Generally, the VARK teacher used pre-designed charts to facilitate understanding of the explanations he gave. The teacher intermittently instructed students to read specific information from their textbooks and share the understanding they got from it. Students took part in activities that related to the unit taught. Teacher ensured that the kinaesthetic component of the VARK pedagogy comes to fore. Essentially, the students observed the visual materials presented by the teacher, they listened to explanations given by the teacher, they read materials as instructed and explained the knowledge gathered from it, and took part in the activities designed by the teacher.

In the VARK classroom, the teachers trained to implement the VARK pedagogy taught the genetics content. The VARK pedagogy warranted teachers being more active than the dialogic teacher. The lesson was designed such that at every step, the visual, auditory, read/write and kinaesthetic components of the lesson crystalized.

The teacher got students attention as he explained that every individual possesses features/attributes that makes them unique, however, these features could be similar with or different from those possessed by another person. The teacher asked students to identify similarities and differences in features among students in the classroom. Teacher reinforced the responses provided by students. The teacher defines genetics as "the study of heredity and variation," variation as "the transmission and expression of traits inherited by offspring from their parents" and heredity as "the differences in traits among organisms of the same species". Teacher repeated the definition so as to ensure that every student grasp it (auditory). Using charts/diagrams, showing variation in height, and skin colour among family members on a family tree, the teacher explained the definitions further, and gave practical examples of the terms variation and heredity (visual). Teacher summarised key definitions and points on one part of the chalkboard, and instructs the students to read the definitions on the chalkboard (read/write and kinaesthetic).

A 40-item achievement test was developed and administered to the subjects to establish their cognitive ability levels. Students whose scores were >30 were classed as having high cognitive ability, those with scores between 16 – 30 were considered to have moderate cognitive ability, while students who score below 16 were classed as low cognitive ability students. Students placement in dialogic or VARK experimental groups was not based on their cognitive ability levels, thus creating a random blend of students in each experimental group. A 40-item self-efficacy scale adapted from the academic self-efficacy scale constructed by Abdul and Ashraf (2006) was also administered before the experiment to ascertain baseline self-efficacy of the students before the study. Both groups served as control for each other.

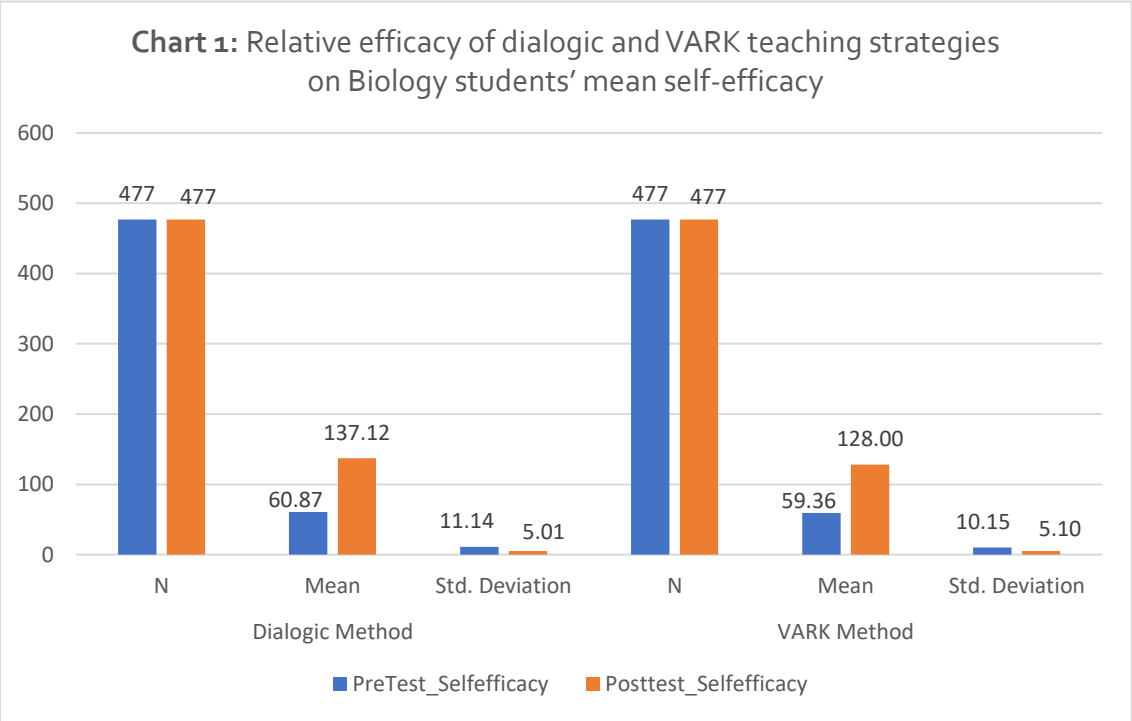
The experimental phase spanned 60 – days, with the self-efficacy scale re-administered to ascertain the post-test self-efficacy. Following the administration of the post-test self-efficacy, the researcher randomly interviewed six (6) students from the dialogic pedagogy classroom to ascertain what they enjoyed about dialogic pedagogy. Data was collected and analysed accordingly. Pre-test and post-test self-efficacy scores for the dialogic and VARK groups were analysed to determine the mean responses for each group, and the mean self-efficacy according to cognitive ability levels initially established prior to the start of the experiment. Results are presented in charts and tables.

Results

Findings from the study are presented in charts, tables and figures, in line with the research questions and hypotheses that guided the study.

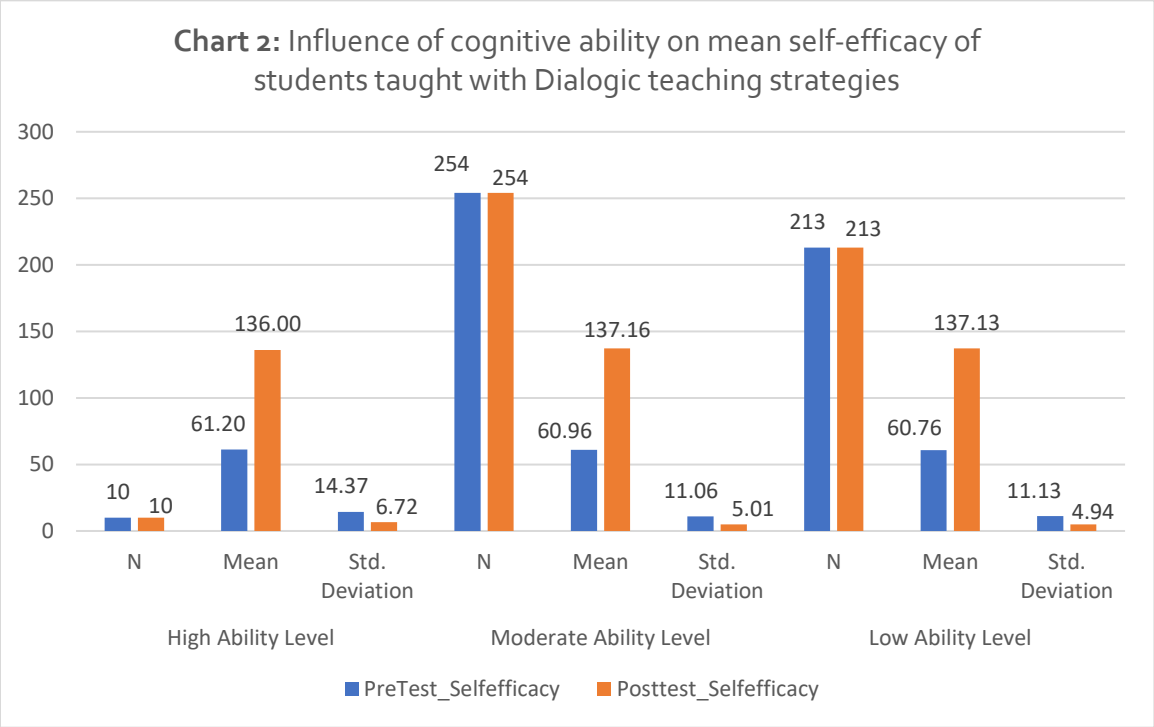
Research Question 1

Research question 1 was posed to determine the relative efficacy of dialogic and VARK pedagogies on Biology students' mean self-efficacy. Chart 1 shows the pre-test and post-test mean and standard deviation self-efficacy of students taught Biology content with Dialogic and VARK pedagogies. The chart shows that 477 students took part in both experimental groups. The dialogic pedagogy proved efficacious in improving Biology students' self-efficacy from a pre-test mean rating of 60.87 to 137.12. the VARK teaching strategy also significantly improved Biology students' self-efficacy from 59.36 to 128.00. Comparatively, the dialogic teaching strategy, with a mean gain of 76.33 between pre-test and post-test is considered more efficacious than VARK teaching strategy, with a mean gain of 68.64.



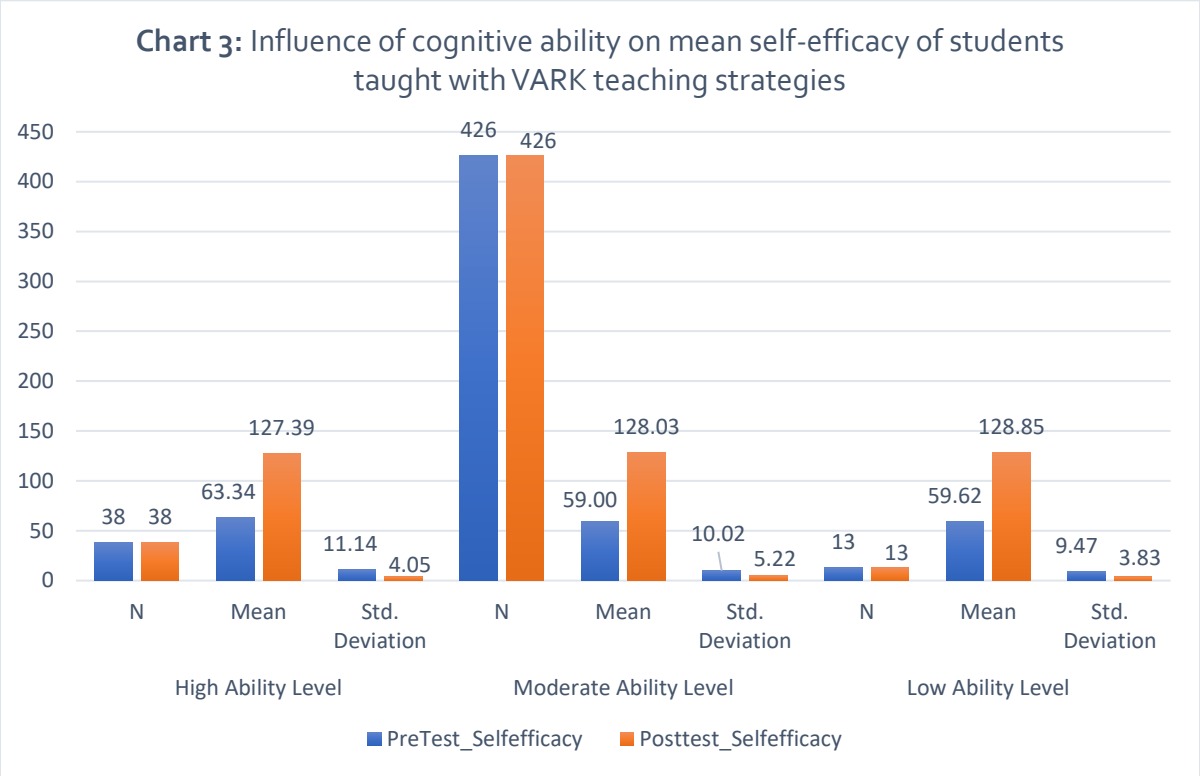
Research Question 2

Research question 2 was posed to determine the moderating influence of cognitive ability on the mean self-efficacy rating of students who received Dialogic treatment. Chart 2 shows the pre-test, post-test mean and standard deviation self-efficacy rating of students taught Biology content with Dialogic teaching strategies. The chart shows that 10, 254 and 213 indicated high, moderate and low cognitive ability levels. Students with high, moderate and low cognitive ability level showed a mean gain (the difference between pre-test and post-test) of 74.8, 76.2 and 76.37 respectively. This result shows that irrespective of cognitive ability level, dialogic teaching strategy proved efficacious in improving students' self-efficacy.



Research Question 3

Research question 3 was posed to determine the moderating influence of cognitive ability on the mean self-efficacy rating of students who received VARK treatment. Chart 3 shows the pre-test, post-test mean and standard deviation self-efficacy rating of students taught Biology content with VARK teaching strategy. The chart shows that 38, 426 and 13 indicated high, moderate and low cognitive ability levels. Students with high, moderate and low cognitive ability level showed a mean gain (the difference between pre-test and post-test) of 64.05, 69.03 and 69.23 respectively. This result shows that irrespective of cognitive ability level, VARK teaching strategy proved efficacious in improving students' self-efficacy, as all students had a better post-test mean self-efficacy.



Hypotheses 1 and 2

Hypothesis 1 was formulated and tested to determine how significant or not the effect of teaching strategies and cognitive ability levels was on students who took part in the experiment. The findings are presented on table 1.

Table 1: Analysis of Covariance (ANCOVA) for the effect of teaching strategies and cognitive ability level on Biology students' mean self-efficacy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	31841.797a	6	5306.966	406.904	.000
Intercept	577624.342	1	577624.342	44288.548	.000
PreTest_Selfefficacy	11952.080	1	11952.080	916.409	.000
Treatment	3239.190	1	3239.190	248.360	.000
Cognitive_Ability	10.593	2	5.296	.406	.666
Error	12351.054	947	13.042		
Total	16808494.000	954			
Corrected Total	44192.851	953			

Table 1 shows that the probability associated with the calculated value of F (248.360) for the effect teaching method on student's self-efficacy is 0.000. Since the probability value of 0.000

is less than 0.05 level of significance, the null hypothesis is rejected. Thus, the difference in the mean self-efficacy ratings of students taught with Dialogic and those taught with VARK teaching strategies is significant. The table also shows that the influence of cognitive ability level on students' self-efficacy is not significant, as shown by a probability value of 0.666, thus providing an answer for hypothesis 2.

Discussion

As shown on chat 1, dialogic and VARK teaching strategies proved efficacious for improving students' self-efficacy. A comparison of the pre- and post-test self-efficacy data collected from both dialogic and VARK classrooms indicated an increase in the mean self-efficacy of the students who received the treatments. Relatively, the dialogic teaching strategy proved to be more effective at improving students' self-efficacy than the VARK teaching strategy. The nature of activities and teacher-learner interaction that took place in the classrooms surely contributed to the difference in mean increase in self-efficacy.

The dialogic classroom was designed to put the learner in-charge of his own learning, fostering the learning to learn ideology. The learner thus grows in confidence as he searches for knowledge, shares information with colleagues and critiques, support other students' conceptual formation in the dialogic environment. This boost in confidence is undoubtedly responsible for the rise in self-efficacy witnessed in the dialogic classroom. Dialogic teaching strategy engaged students in conversations around the concept of study with the teacher allowing students to conceptualize science ideas and share their conception, and the process through which they arrived at this conception with their classmates. Students typically worked in groups to develop these conceptions and then shared with the class. By adopting this method, the teacher becomes passive, allowing students take 'control' of how their learning progresses. This process instils confidence in the students' ability to learn 'on their own' under little or no supervision. Because the dialogic classroom environment was designed to welcome contributions from every student, students who seemingly lacked the confidence to express themselves rose up to the challenges encountered during dialogue. The findings from the study which shows a significant increase in self-efficacy at post-test is an indication that a dialogic classroom is effective for improving students' confidence in their ability to do well in sciences (Biology).

The dialogic classroom was more experiential and students were more involved in the overall learning process than those in VARK classroom. The students from the dialogic classroom who took part in the interview at the end of the experimental phase indicated that they enjoyed the dialogic experience because it gave them opportunity to learn from their mates and have their views about the content heard. One student in expressing what stood out for her from the dialogic classroom posited that unlike in their conventional classroom, the teacher did not pose as the custodian of knowledge, but asked them what they thought about a concept, allowed them share their views first, before helping them see why they are correct or wrong.

The dialogic classroom proved slightly more efficacious in improving students' self-efficacy than VARK classrooms because learners obtained information to appraise their self-efficacy from their actual performances, their vicarious experiences, the persuasions they received from others, and their psychological reactions (Bandura, 1997; Schunk, 1995). VARK classrooms allow every student to learn via media that appealed to all four senses, with kinaesthetic aspects of the teaching strategy requiring students to take part in certain activities. A student in a dialogic classroom who shares an idea with his group or the rest of the classroom and receives affirmation/positive reinforcement from the classroom teacher moderating the dialogue, would develop a positive emotional state towards the task at hand, creating a mindset that if s/he can succeed at that given task, s/he can succeed at other task throughout the course. In like manner, anxiety and failure can erode this positive feeling, with significant negative impact on the student's self-efficacy.

By reducing negative remarks around the dialogic and VARK classrooms, keeping positive remarks at optimum levels (Margolis & McCabe, 2006), teachers can ensure that these instructional strategies would significantly improve students' self-efficacy. The level of an individual's self-efficacy is to a great extent influenced by how much the individual is seemingly in control of or actively involved in the classroom activities. In order to arouse students' self-confidence in their ability to study and grasp science concepts, the teacher must first show that s/he recognizes this ability in the learner. Although the VARK classroom did improve students' self-efficacy, a teacher adopting it as a method of teaching has to ensure that students are not made too passive, but are actively involved in the lesson. This will trigger a rise in their self-confidence, which will translate into higher self-efficacy.

To improve the efficacy of the VARK classroom, teachers must design it to ensure that students have the 'in charge' feeling, with more learning experiences that allow them exude confidence and tap into their innate abilities to excel. This would stimulate one or more of the four sources of self-efficacy (mastery experiences, vicarious experience, verbal persuasion and a positive emotional state), resulting in improved self-efficacy among students. Notwithstanding the difference in efficacy of teaching methods for improving science students' self-efficacy in favour of dialogic instructional strategy, it is important to highlight that both instructional strategies had significant effect on students' self-efficacy (table 1). This finding agrees with those of Ali, Fataneh, Samanm, Mahmoud and Anahita (2018), Ugwuadu (2013), Moayyeri (2015), and Nzesei (2015) who pointed out that dialogic teaching strategy is effective for improving psychological constructs like attention, interest and self-efficacy, all of which affect learning outcomes.

The findings of the study also reveal that cognitive ability levels have a moderating influence on self-efficacy of students placed in a dialogic or VARK classroom. This can be seen on charts 2 and 3, where students with moderate and low cognitive ability levels showed a slightly higher mean gain in self-efficacy than students with high cognitive ability level. Conventionally, students with high cognitive ability level tend to perceive certain activities conducted in class as a waste of

their time because they understand contents being taught with ease. As a result, they may not fully engage in class dialogue or activities in the VARK classroom. This would result in their self-confidence not stimulated by the teaching strategies as much as it does those with moderate and low self-efficacy. However, the ANCOVA results show that the moderating influence of cognitive ability levels on self-efficacy of students is not significant (results from hypothesis 2 presented on table 1), an indication that there is not much of difference in the post-test mean self-efficacy between high, moderate and low cognitive ability level students. This implies that irrespective of cognitive ability level of a student, his/her self-efficacy will be improved when placed in a dialogic or VARK classroom. Therefore, the efficacy of dialogic and VARK teaching strategies for improving students' self-efficacy is not hampered by their cognitive ability level.

In Nigerian school system, classrooms are generally composed of students with different cognitive ability levels. The cognitive ability level of a student is a construct of his academic achievement. Studies have shown that learners are qualitatively different in their ability levels and this reflects on the rate at which they assimilate science facts and principles taught by the teacher. Thus, students of varying cognitive ability levels are expected to perform differently depending on the method of instruction adopted (Ushie, Akpa, Okworo & Ema, 2014). A students' level of self-efficacy notwithstanding, the cognitive ability s/he possesses would exert a level of influence on his/her academic achievement. It is therefore imperative that teachers pay attention to students' self-efficacy as much as they do to their cognitive ability.

The findings of this study authenticate Bakhtin (1981) notion that human consciousness is by nature dialogic. That by interactional activities, the consciousness becomes internalized. Bakhtin defocus learning from the cognitive processing that takes place in an individual learner to the social interaction in which learners participate (Teo, 2019). The theoretical underpinning of findings of this study is also on Vygotsky (1978) sociocultural theory of learning which postulates that learning is a social act and not merely a cognitive process. That learning is achieved through active interaction in a social setting. Vygotsky emphasized that the social dimension of consciousness is primary while the individual dimension of consciousness is derivative and secondary. Both dialogic and VARK pedagogies explored in this study oppose the teacher-directed frontal teaching (conventional/lectures) that succeeds in transmitting factual knowledge. Both locate learning in and through interaction, where learners engage with one another to solve a common problem, debate an issue, or evaluate the merits and demerits of a suggestion, thereby moving away from construing learning as a solitary cognitive activity to one that is necessarily predicated on, and constructed through, human interaction.

Conclusion

Literature have shown that conventional methods of teaching adopted by teachers in schools have proven ineffective over the years. This study has proven that dialogic and VARK teaching strategies significantly improved students' confidence in performing well in Biology (self-

efficacy). The ideas unravelled by the study ought to 'put stars' in the eyes of science (Biology) teachers to choose, learn and use dialogic and VARK teaching strategies in curriculum implementation. This would improve students' performance in sciences, and by extension, foster development through science and technology. Beyond improving engagement and participation, dialogic teaching ultimately improved students' ability to think and decide for themselves, which led to its being more efficacious than VARK.

Recommendations

The study recommends that;

1. Science teachers should consider self-efficacy an important factor that influences learning outcomes, and design lessons such that they will stimulate students' confidence in their ability to understand a concept. Considering that dialogic and VARK pedagogies have proven efficacious in improving students' self-efficacy, science teachers should adopt them for use in their classrooms.
2. Considering the efficacy of dialogic teaching for improving students' self-efficacy, State and federal Ministries of education should organize practical workshops to educate teachers about how to design effective dialogic and VARK classrooms.
3. Science curriculum planners should consider including dialogic teaching strategy as a recommended strategy to be used by teachers in teaching science concepts.
4. The educational administrators should also ensure that necessary infrastructure required for science teachers to implement dialogue in the classroom are put in place in our secondary schools.
5. Researchers studying dialogic teaching strategy should test its efficacy in improving other psychological constructs that have been shown through empirical studies to exert influence on learning outcomes. Some of these constructs include interest, attitude, self-concept, conceptualization, among others.

Acknowledgment

The researchers appreciate all the study participants and **Dr. Ebere Ibe** for her special role as the corresponding author for this research.

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