

Impact of Socio-Cultural Factors on Senior Secondary School Students' Academic Achievement in Physics

Hakeem Akintoye¹, Jimoh Saliu²

¹Department of Science and Technology Education, Lagos State University, Ojo, Lagos State, Nigeria

²Department of Language, Art and Social Science Department, Lagos State University, Ojo, Lagos State, Nigeria

Abstract: This study examined the impact of socio-cultural factors on the achievement in physics. Descriptive survey research designs were adopted. The sample for the study consisted of one hundred and seventy-one students who were selected from three intact co-educational senior secondary school physics classes. Two research questions raised for investigation alongside one corresponding null hypothesis were answered and tested respectively. Two Instruments: Physics Achievement Test (PAT) and Student Socio-cultural factors on Achievement Questionnaire (SSAQ) were used to collect data for the study. The Physics Achievement Test had a reliability coefficient of the achievement test was 0.87 using split-half method while that of the questionnaire was 0.91 using the Cronbach alpha method. using the Mean, Standard deviation, bar graph and Analysis of variance (ANOVA) statistical tools. The data collected were analysed using the Mean, Standard deviation, bar graph and Analysis of variance (ANOVA) statistical tools. Findings in this study revealed that of all the socio-cultural factors considered in this study which include sex, student attitude, parental educational background and peer group, parental educational background had the highest impact on students achievement. Also, the study revealed that there was significant impact between socio-cultural factors and students' achievement in physics; $F(5,123) = 2.676, p < 0.05$. The study concluded that socio-cultural factors such as sex, student attitude, parental educational background and peer group impact on student achievement in physics. should be considered by physics teachers when teaching the subject. It was recommended that physics teachers endeavour to address students socio-cultural challenges in order to enhance students achievement and interest in physics.

Keywords – Peer group, Achievement, Culture, Socio-cultural factors, Student attitude

I. INTRODUCTION

Scientific and technological breakthrough is usually the goal of any developing nations like Nigeria. Physics, one of the science subjects remains fundamental in the significantly technological development of the world at large. In spite of the importance of physics, there are many observable problems plaguing the teaching and learning of the subject, especially at the secondary school level. Students' views about the subject influence their understanding and learning of the subject (Redish, 1994). Many students think and believe that "Physics is difficult" (Carter & Brickhouse, 1989). Literature revealed that students generally regard physics as conceptually difficult, abstract, uninteresting;

describing the subject as elite in nature which is only suitable for exceptionally talented and gifted students (Dong-Hai & Sanjay, 2009; Angell, Guttersrud, Henriksen & Isnes, 2004).

In Nigeria, evidence of low enrolment and massive failure in external examinations are indicative that many students have difficulty learning the subject (Erinosho, 2013). In fact, it was observed that students enter secondary schools with an equal liking for biology and physics, however, over the period of secondary schooling, their liking for biology remains reasonably stable while that of physics declined (Angell, Guttersrud, Henriksen & Isnes, 2004). They perceived biology as interesting and physics as boring.

These problems in addition to poor methods of delivery of instruction (Kalijah, 2002) may be some of the reasons for students' poor performance in the subject both at the secondary and tertiary school levels. In a related study, Owolabi (2004) revealed that the performance of Nigerian students in ordinary level Physics was generally poor. Therefore, apart from the deployment of effective and meaningful teaching methods for the realization of high-level performance of students in physics, other factors which influence the academic achievement of students in physics must be considered. Socio-cultural factors that affect students' academic achievement are however, multifaceted. Adeyemo & Babajide (2012) found that tribal affiliates, traditional beliefs, cultures and occupation, peer related factors, including parental, social and economic status have influence on students achievement. However, Akinade (1996) opined that generally, these factors ranged from social factors (also termed environmental, acquired, external or phenotypic factors) such as home background, school related factors, teachers' factors and societal factors to peer influence. Cultural factors on the other hand, include set of tribal believes, moral values, traditions, language and laws.

The dearth in literature about how these factors affect students' academic achievement in physics in the Nigerian environment motivated this study to make an attempt in not only to identify these factors, but also find out the level at which each factor influences the academic achievement of senior secondary school physics students. The socio-cultural factors considered in this study include sex, peer group,

student attitude and parental educational background. In order to examine the level to which socio-cultural factors influence students achievement, there is the need to find out the extent to which each component of socio-cultural factors affect students achievement especially in science. Okebukola (2002) and Yip (2003) revealed that students understanding and ability to explain scientific phenomena are controlled by what they perceived from their cultural beliefs. In fact, Funda's investigation in 2015 showed that cultural influence has significant effect on students' attitude towards science and science-related careers such as medicine, forensic science, agriculture and so forth among different countries. In addition, cultural context has several components that determine and shape young people's attitude towards science and even their achievement in science. Moreover, in African culture, socio-cultural background of students impacts negatively on students' attitudes towards science (Kesemang & Taiwo, 2002) because they possess unscientific knowledge that are opposite to their cultural beliefs such as taboos and witchcrafts. Consequently, different cultures impact differently upon science and science-related selections. In fact, Okoye and Okeke (2007) noted that, it has been difficult to explain most natural occurrences and issues in African life using scientific knowledge and this is due to the fact that most people's beliefs have been crowned with mythology and superstition. This has resulted in divergence between students' daily experience in describing, understanding, interpreting and predicting natural phenomena. It is therefore imperative to further investigate how these socio-cultural factors such as sex, parental educational background and peer group impact on physics students' academic achievement in Nigeria.

Home factors that could affect learners' achievement include home environment with particular reference to home location, socio-economic status of parents, parental educational background, attitude of parents to child's education generally and the subject area specifically, parent-child relationship and the quality and quantity of feeding. In a related study to find out the relationship between home based environmental factors and academic performance of students, Apsalone and Sumilo (2015) observed a significant difference in the performance of students in relation to such factors as parental educational qualifications and health statuses of the students. Undoubtedly, level of qualification acquired by the parents can be an apparatus for assessing their children academic performance in schools. Okeke, Nzewi and Njoku (2015) found out that low income, lack of high qualification, low occupational status and parental involvement have notable effects on children's academic accomplishments. Otieno (2012); Chinyoka and Naidu (2013) revealed that low income and little education are strong predictors of physical, mental health and low academic achievement. This means that when parents with high educational background encourage and guide their children toward their educational attainment, the outcome will be quite encouraging. Some essential natures of physics are the fact that it requires high concentration, it is practical oriented and requires appreciable time. Hence, all

home related factors must be permissive to these special natures of the subject otherwise; learners' success in it may be jeopardized.

Peer group is described by Health Research Funding (2015) as a social group consisting of people who are equal in such respects as age, education or social class. They usually share a common interest and background and can be diverse in some different characteristics such as background, race, culture etc. Peer influence encourages others to change their attitude, values or behavior to conform to group's. Allen, Porter and McElhaney (2007) reported that adolescents who were well-liked by many peers displayed high level of ego development and secure attainment, as well as better interactions with their best friends. Furthermore, associating with friends who have a positive attitude towards school enhances students' own satisfaction with school whereas associating with friends who have a negative attitude toward school decreases it (Mark, 2014). Lavy and Schlosser (2007) revealed that friendship among students are critical interpersonal vehicle that move them towards physiological growth and maturity, allowing social compassion which influences the development of self-evaluation. Lashbrook (2000) noted that peer influence can inspire students' academic vigor and motivation for achievement. In the study conducted by Olalekan (2016), it was revealed that peer group generally has a lot of influence on students. In addition, observation and imitating the behavior of others, learners can avoid much wasteful random behavior and come close to reproducing the behaviours of which members are recognized.

Gender as one of the socio-cultural factors could play a significant role in influencing the academic achievement of students. Joseph, Onihunwa, Irunokhai, Yusuf and Adesina (2015) noted that gender is one of socio-cultural factors mentioned in literature to have considerable effects on students academic achievement especially in science subjects. In examining students achievement in respect of gender, Joseph, Onihunwa, Irunokhai, Yusuf and Adesina (2015) noted that gender is based primarily on the socio-cultural differences between girls and boys. Some researchers such as Awofala, Adeneye and Nneji (2011); Amosun (2011); Apata (2011); Dania (2014); Agbaje and Alaka (2014) Atovigba et al (2012) revealed that there exist a significant gender differences in students academic achievement and retention in various subjects. However, a significant difference with either the boys or the girls performing better was found also found.

The teachers students first come in contact with are their parents, therefore, parental educational background plays a major role in the academic performance of their students. Ahmad (2013) revealed that children from families where parents have less education tends to perform systematically worse in school than students whose parents are more educated. Furthermore, Musgrave (2000) stated that students from educated parents always like to follow the footsteps of their parents and this make them work actively in their studies. High educated parents deducted a lot of time, energy and

money to help their children to perform well in academic activities.

II. PURPOSE OF THE STUDY

The purpose of this study was to examine the impact socio-cultural factors on students' achievement in physics. However, since there are many socio-cultural factors that exist, this study specifically examined the extent to which each of these socio-cultural factors such as sex, peer group, student attitude and parental educational background impacted on students achievement in physics.

III. THEORETICAL FRAMEWORK

This study is underpinned by the theory of Vygotsky (1979) which stated that mental functioning of individual is not simply derived from social interactions; rather, the specific structures and processes revealed by individuals can be traced to their interactions with others. Vygotsky's socio-cultural thinking was vividly different from the school of thought of the cognitivists who saw the individual cognitive development as the key to understanding learning and as a prerequisite for the interacting with the world. Wertsch (1991) while discussing Vygotsky's work noted that as learners participate in a broad range of joint activities and internalize the effects of working together. This makes them acquire new strategies and knowledge of the world and culture. However, Tudge and Scrimsher (2003) was of the view that Vygotsky was not only interested in what was more knowledgeable others brought to the interaction, as well as how the broader culture and historical setting shaped the interaction. Vygotsky's sociocultural theory explained that mental functioning of individuals is associated with their culture, history and institution. Thus, mental functioning depends on social interaction of individuals with their surroundings, which are influenced by culture such that social participation enriching the psychological development of the individual.

The implication of Vygotsky's theory on teaching and learning physics is that teachers must endeavor to acquire philosophical understanding of humanity and cultures and knowledge on different learning theories, pedagogical models and teaching methods, students ability to learn relies heavily on pre-existing knowledge and understanding and the ways in which humans build on knowledge which accumulate on top of previous knowledge and goes even further by drawing attention to the cultural historical of this.

IV. RESEARCH QUESTIONS

1. To what extent does each socio-cultural factor of sex, peer group, student attitude and parental educational background influence students' achievement in physics?
2. What level contribution does each of the socio-cultural factors have on student achievement in physics:

V. HYPOTHESIS

Socio-cultural factors does not have any significant impact on students achievement in physics

VI. METHODOLOGY

This study adopted a descriptive survey research design in examining the effect of the socio-cultural factors on the achievement of senior secondary school physics students. The sample for the study consisted of one hundred and seventy-one students who were selected from three intact co-educational senior secondary school physics classes. Two Instruments: Physics Achievement Test (PAT) and Student Socio-cultural factors on Achievement Questionnaire (SSAQ) were used to collect data for the study. The question items on the achievement test were based on kinematics topics which are in agreement with the senior secondary school physics curriculum content. The Physics Achievement Test had a reliability coefficient of the achievement test was 0.87 using spilt-half method while that of the questionnaire was 0.91 using the Cronbach alpha method. The face and construct validities of both achievement test and questionnaire were determined by three seasoned senior secondary physics teachers as well as two experienced university physics education experts. Two research questions raised for investigation alongside one corresponding null hypothesis were answered and tested respectively using the Mean, Standard deviation, bar graph and Analysis of variance (ANOVA) statistical tools.

VII. PROCEDURE FOR DATA COLLECTION

A. Procedure

Prior to the administration of instruments, the researcher obtained approval to interact with the students in order to collect information from them. Before the administration of the instruments, the instruments were validated by using ten students as sample for the validation. The purpose of the validation stage was to ensure that the students understood the content of the instruments. It is imperative to state that the students who took part in the validation of the instruments were students of the schools that participated in the study. After all the correction which arose from the validation of the instruments, the instruments were administered in one week. The Achievement test was marked and students scores recorded. The questionnaire were also scored and prepared for analysis.

VIII. RESULTS

A. Research Question One:

To what extent does each socio-cultural factor of sex, peer group, student attitude and parental educational background impact on students' achievement in physics?

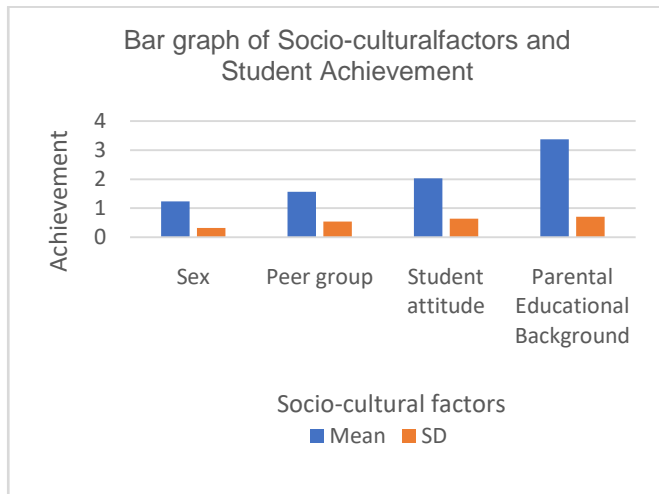


Figure 1: Bar graph showing the extent to which each socio-cultural factors components of sex, peer group, student attitude and parental educational background influence student achievement in physics. The result indicated that parental educational background had the highest influence.

B. Research Question Two:

What is the contribution level of each socio-cultural component to students’ achievement in physics?

Table 1: Strength of Prediction and Significant level of Identified Socio-cultural Factors on Students Physics Achievement Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	p.
	B	Std. Error	Beta		
(Constant)	61.343	1.083		56.640	.000
Sex	.056	.043	.024	.9843	.069
Parental education	.962	.068	.782	9.284	.001
Students attitude	.720	.082	.574	8.760	.000
Peer group	.210	.180	.077	1.171	.043

a. Dependent Variable: Physics achievement

Table 1 shows the relative strength of prediction and significant level of socio-cultural factors components such as sex, parental educational background, students’ attitude, and peer group on students’ achievement in physics. The result shows that the beta weight of parental educational background is the strongest impact on students’ achievement followed by students attitude, peer group and sex respectively. The result also revealed that each of the socio-cultural components has significant impact on senior secondary school students’ achievement in physics except sex.

C. Hypothesis

Socio-cultural factors do not have any significant impact on students achievement in physics

Table 2: One-way ANOVA Table for the significant impact of socio-cultural factors on students achievement in physics

Dependent Variable: Students achievement					
Source	SS	Df	MS	F	p
Corrected Model	2778.478 ^a	2	1389.239	2.676	.031
Intercept	56031.622	1	56031.622	107.929	.000
Socio-cultural factors	2778.478	2		2.676	.031
Error	62298.172	120	1389.239		
Total	370879.000	122	519.151		
Corrected Total	65076.650				

a. R Squared = .743 (Adjusted R Squared = .738)

Table 2 revealed that there is significant impact between socio-cultural factors and students’ achievement in physics; $F(5,123) = 2.676, p < 0.05$. Therefore, the hypothesis which states that socio-cultural factors do not have any significant impact on students achievement in physics is hereby rejected.

IX. DISCUSSION

The purpose of this study was to explore the impacts on some socio-cultural components on senior secondary school students’ achievement in physics. Results show that generally, there are some socio-cultural components that impact significantly on achievement especially in science. Examples of such socio-cultural components include socio-economic status, peer group, parental educational background, cultural beliefs, family size, parental occupation, traditional beliefs and so forth. Specifically, the socio-cultural components investigated in this study: sex, peer group, student attitude, parental educational background had significant impact on students’ achievement in physics. Also revealed in this study was parental educational background having the most significant impact on students’ achievement in physics while parental education background student attitude, peer group and sex followed respectively. Though, parental educational background had significant on students achievement in physics, it is necessary for physics teachers to complement the effort of parents especially those that are not educated by engaging in meaningful teaching of physics involving activity driven techniques in order to assist their students. In addition, their interactions with peers result to both positive and negative consequences. Where the relationship is negative with their peers, their reasoning ability and emotional development will be affected.

Socio-cultural factors are the larger scale forces within societies and culture that affects the thoughts, behaviors and feelings of individual members of those societies and cultures. Examples as aforementioned include language, law, aesthetics (appearance), religion, values, attitudes, social organizations, family, community a person’s role or status among others socio-cultural theory, an emerging theory in psychology that

looks at the important contributions that society makes to individual development by Vygotsky (1986), stresses the interaction between developing people and the culture in which they live. Vygotsky believed that parents, caregivers, peers and the culture at large were responsible for the development of higher order functions. According to him, “every function in the child’s cultural development appears twice; first, on the social level, and later on the individual level; first between people (inter-psychological), and then inside the child (intra-psychological). This theory emphasizes that adults and peers influence individual learning and also that cultural beliefs and attitudes affect instruction and learning (Njok & Sunday, 2014).

The home is the foundation from which learning activities of any child take off. Sociologist refers to the home as the bedrock of the socialization process, which implies learning. The type of home environment a child is born sets the limit for life’s adjustment (Isangedighi, 2011). Studies have shown that family characteristics can significantly affect children development and school achievement. The impoverish status of some parents makes it difficult for them to parent their children adequately. According to Denga and Akuto (2004), Poverty, a notorious social, economic and psychological factor, can be held accountable for poor parenting in developing countries. Illiterate parents’ poverty status makes them subject their children to indecent behaviours such as petty trading, malnutrition, childlabour, health risk, poor or no education among others. Educated parents are able to identify with the school learning experiences of their children, and therefore able to lend the necessary assistance to them. Uneducated parents lack the capacity to assist in the supervision of school assignments, or proper counseling of their school going children (Colclough, Al-Samarai, Rose and Tembon 2003). Also parental discipline is another factor; children who learn to accept parental authority will also accept teacher’s authority in school (Isangedighi 2011)

Beyond the immediate family, the community in which the child lives has a great influence to teaching and learning generally. High levels of poverty within the community can adversely affect children’s development regardless of the quality of individual family environment. This was confirmed by Broody et al, (2001) in a study of the influence of neighborhood characteristics on 10 and 11 years old Afro-American children in Iowa and Georgia. Their findings indicated that children who lived in disadvantaged communities, whether urban or rural were more likely to affiliate with antisocial peers than were children living in more affluence communities. Affiliating with antisocial peers had a negative effect on children’s academic progress even when those children came from nurturing supportive families (Njoku & Sunday, 2014). The effect of these socio-cultural forces to physics teaching and learning is that students become passive recipients of teachers’ knowledge. They neither ask questions in the class nor contribute or exchange ideas with their teachers and fellow students in the class. However, as noted

by Mezieobi and Domike (1996), physics cannot thrive in a learning environment where adventurism, exploration, curiosity, participation, inventiveness, independent thinking, investigation or inquiry and creativity are tabooed.

This study therefore, corroborates previous studies in science education which suggest that learners who have had themselves established in their cultural belief are likely to find the study of science mystifying because of the likely conflict between their anthropomorphic views of their world and the mechanistic views presented in science (Okebukola, 2002). Okoye and Okeke (2007) and Igbokwe (2010) also found that the cultural environment in which science is taught significantly affects its learning. This implies that misconceptions from cultural belief brought into Physics class by students significantly affect their learning of Physics (Bello, 2015). Also, Ahmad (2013) suggested that children from families where parents have less education tends to perform systematically worse in school than pupils whose parents have more education. Peer group influence which can be both negative and positive leads teens to engage in unhealthy and unsafe behaviours (De Guzman, 2007). Negative peer influences do exist and affect students negatively in their academic pursuit (David, 2018) while Landau (2002) noted that students who form positive peer group make more effort during learning, doing social activities, also fear to engage in delinquent activities.

X. CONCLUSIONS

The study attempted an exploration of the impacts of some socio-cultural components on senior secondary school students’ achievement in physics. From the findings by the study, it could be concluded that socio-cultural factors impact significantly on the academic achievement of students in physics and science generally.

Parental educational background calls for serious attention because it exerts the strongest impact on students’ academic achievement followed by student attitude, peer group and sex respectively. Physics teachers should take cognizance of learners’ environments for effective learning. They should Endeavour to related concepts in physics to learners’ needs, experiences, immediate and remote environments. Students should be helped to discover the relevance and the immediate and remote utility values of the subject.

REFERENCES

- [1] Ahmad, K. & Naeema, B. (2013). Influence of socioeconomic and educational background of parents on their children’ education in Nigeria. *International journal of scientific andresearch publications*, volume 3.
- [2] Akinade E, A., Adewuyibi, T.D.O & Sulaiman, A.A (2010) Socio-legal factors that influence the perpetuation of rape in Nigeria. *Procedia Social and Behavioral Sciences* 5 (1) 1760–1764.
- [3] Angell, C., Guttersrud, O., Henriksen, E. K., & Isnes, A. (2004). Physics: Frightful, but fun. Pupils’ and teachers’ views of Physics and Physics teaching. *Journal of Science Education*. 8 (8), 683–706.

- [4] Apsalone M, Šumilo E. (2015) Socio-cultural factors and international competitiveness. *Business, Management and Education*.13(2):276–291.
- [5] Brody, Ge X; Conger, R; Gibbons, F; Murry, V; Gerrard, M. and Simons, R (2001). The influence of neighborhood disadvantage, collective socialization and parenting on African American children's affiliation with deviant peers. *Child Development*. 72 (4) 1231-1246.
- [6] Carter, S.C. & Brickhouse, N.W. (1989). What makes chemistry difficult? *Alternate Perceptions*.
- [7] Colclough, C; Al-samaria, S; Rose P and Tembon, M. (2003). Achieving schooling for all in Africa: Cost, Commitment and Gender. England: Ashgate Publishing Ltd.
- [8] Denga, D.I & Akuto, G. W (2004). *Learning Difficulties and behaviour Disorders Among Nigerian Children*. Rapid Educational publishers Limited.
- [9] Dong-Hai., N & Sanjay, R. (2009). *Student difficulties in transfer of problem solving across Education (IJCDSE) Special Issue*, 3(3), 1510-1515 *Education*. 8 (8), 683-706.
- [10] Erinsho, S.Y. (2013). How do students perceive the difficulty of Physics in secondary school? *International Journal of Cross-disciplinary Subjects in Education (IJCDSE) Special Issue*, 3(3), 1510-1515.
- [11] Igbokwe, C. O. (2010). The effect of multicultural learning environment on cognitive achievement of pupils primary science. *Journal of Science Teachers' Association of Nigeria (STAN)*; 45 (1&2): 9-19.
- [12] Isangedighi, A. J (2011). *Essentials of Learning*. Calabar, Kendra: Cherry Free Psychology Newsletter. About .com Psychology. *Journal of Chemical Education*, 66, 223-225.
- [13] Kalijah, M. S. (2002). Education, training and careers in Physics for women in Malaysia. *IUPAP*
- [14] Kesemang, M. E. E., & Taiwo, A. A. (2002). The correlates of the socio-cultural background of Botswana junior secondary school students with their attitudes towards and achievements in science [Electronic version]. *International Journal of Science Education*, 24 (9), 919-940.
- [15] Lashbrook, J. T. (2000). Fitting in: Exploring the emotional dimension of adolescent pressure. *Adolescence*, 35(140): 747-757.
- [16] Lavy, V., and Shlosser, A. (2007). *Mechanisms and Impacts of Gender Peer Effects at School*. NBER Working Paper 13292. National Bureau of Economic Research. Cambridge, MA.
- [17] McElhaney, K.B., Immele, A., Smith, F.D., & Allen, J.P. (2006). Attachment organization as a moderator of the link between friendship quality and adolescent delinquency. *Attachment & Human Development*, 8(1), 33–46.
- [18] Mezieobi, K. A. and Domike, G. C. (1996). Social studies education in Nigeria, A Realistic Approach Enugu: Whyte and Whyte Publishers. *of Physics*, 62, 796-803.
- [19] Musgrave, C. B. (2000). Environmental factors affecting attitude towards science and mathematics. *Journal of Educational Psychology*, 91(1), 382–394.
- [20] Okebukola, P. (2002). Beyond the stereotype to new trajectories in science teaching. Ibadan: *Science Teachers Association of Nigeria*. 37: 28-31.
- [21] Okoye, B. E. & Okeke, O. C. (2007). Efficacy of eliminating superstitious beliefs strategy on achievement and knowledge retention in genetics among secondary school students. *Journal of Science Teachers Association of Nigeria (STAN)*.; 42 (1&2); 73-77.
- [22] Olalekan, A. B. (2016). Influence of peer group relationship on the academic performance of students in secondary schools: A case study of selected secondary schools in Atiba Local Government Area of Oyo State. *Global Journal of Human-Social Science*, 16, 4
- [23] Owolabi T. (2006). A Diagnosis of Students Difficulties in Physics. *Educational Perspectives* 7(2), 15-20. Pupils' and teachers' views of Physics and Physics teaching. *Journal of Science*
- [24] Redish, E. F. (1994). The implications of cognitive studies for teaching physics. *American Journal Representation*. Oxford. UK: Pergamon Press.
- [25] Tudge, J., & Scrimsher, S. (2003). Lev Vygotsky on education: A cultural-historical, interpersonal, and individual approach to development. In B. Zimmerman & D. Schunk (Eds.), *Educational psychology: A century of contributions* (pp. 207-228). Mahwah, NJ: Lawrence Erlbaum Associates
- [26] Vygotsky, L. S. (1978). *Mind in Society*. Cambridge, Massachusetts: Harvard University Press.
- [27] Vygotsky, Le (1986). Thought and language. Cambridge: The MIT press.
- [28] Wertsch, J. V. (1991). *A sociocultural approach to socially shared cognition*. In L. B. Resnick, J. M. Levine, & S. D.
- [29] Teasley (Eds.). Perspectives on socially shared cognition (p. 85–100). *American Psychological Association*. <https://doi.org/10.1037/10096-004>
- [30] Yip, D. Y. (2001). Promoting the development of a conceptual change model of science instruction in prospective secondary biology teachers. *International Journal of Science Education*; 23(7): 755-770.