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EFFICACY OF CINDICAB-GAME IN ATTAINING THE THREE EDUCATION DOMAINS FOR TECHNOLOGICAL DEVELOPMENT AS PERCEIVED BY SCIENCE AND ARTS EDUCATORS IN NIGERIAN UNIVERSITIES

Eunice Nwakaego Onah, PhD
Department of Science Education, University of Nigeria Nsukka
eunice.onah@unn.edu.ng
&
Obe Pauline Ijeoma Obe, PhD
Department of Industrial &Technical Education, University of Nigeria Nsukka
pauline.obe@unn.edu.ng
&
Oluchi Enema
Department of English & Literal Studies, University of Nigeria Nsukka
cloudyenema@gmail.com
&
Maryrose Chibundo Enema
Department of Electronics Engineering, University of Nigeria Nsukka
maryrosenema@gmail.com
&
Fidelis E. Enema, MB, BS
College of Medicine Ibadan Nigeria
ekeneenema@gmail.com
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Abstract

This study examined the efficacy of CINDICAB-Game in attaining the three educational domains for technological development. The researchers found out that Cognitive, Affective and Psychomotor Domains are inevitable for 21ST century classrooms for technological development. CINDICAB-Game is effective in teaching and learning and the way Science/Arts Teachers in Nigerian universities perceive its efficacy in promoting the African culture of peace and unity can lead to technological development. The study also foundthat there was no significant difference in lecturers' view on Cognitive and Psychomotor domains' use of the Game. The following recommendations among others were made: Number and Numeration game such as CINDICAB-Game should be played by both Science and Arts Students to remove the Mathematical phobia associated with some abstract concepts in Education. Similar games can be produced in any other concepts to make teaching and learning more interesting for better understanding.

Keywords: CINDICAB-Game, Educational Domains, Educators &Technological Development

Introduction

Both Science and Arts Educators use mathematics daily which is a Science of numbers and shapes. Number and numeration, in particular Indices, are used in every aspect of life including Sciences, medicine and education. Science and Arts Educators use numbers often and when the number is expressed in index form, it is not readily understood by everyone.

No area of education courses can be completed without application of numbers in one way or the other. The arrangement of numbers in the number-line matters a lot: Example of number line:

$-\infty$ -10 -5 0 5 10 $+\infty$ One can see that if any two numbers are picked at random irrespective of their type,(positive or negative), the one on the right is always greater than the one on the left. Zero (0) is the reference point as the numbers (x_i)range from negative infinity ($-\infty$)through zero (0), to positive infinity($+\infty$) thus: $-\infty < y < +\infty$ represented diagrammatically as shown in number line below :

$-\infty$ -y 0 y $+\infty$ [from negative infinity through zero (0) to positive infinity]

Here. y can be integer, proper fraction, mixed number …It can be any type of number including indices, standard form, natural number, improper fraction or even mixed number.

Science Education experts, Vocational and Technical Education experts and Medical Experts make use of Numbers including Indices. When any non- zero number is written in the form x^a where x is called the base and x is not equal to zero(0) , a is called the power and a can be any integer, such number (x^a) is said to be in its index form. The plural form of index is indices. Examples: $5x5x5=5^3$, $2x2x2x2 = 2^4$, $10x10x10x10=10^4$,$8x8x8x8x8=8^5$ and

$2a^3 \times 2^2a^5 = 2^3a^8 = 8a^8$. Generally, if y is a non-zero integer, then, y x y x y x y x y x y = y^6.

In indices, the power/index indicates the number of times one is to multiply the base by itself. There are seven laws of indices which can be derived practically and they are useful in every aspect of life. In short, everyone uses indices in one way or the other since indices come from

numbers and numerations used by everyone. Even at home, in sharing of quantities, numbers are applied. Ratios are also used especially when the sharers of any item do not intend to share the items equally. In medical line, both liquid and solid drugs are quantified using numbers. This is because over-dosage or under-dosage of drugs may lead to death. Indices as part of number and numeration are used to reduce ambiguity of repeated numbers in any area when such a number is too lengthy when written ordinarily in every field of endeavour. Peace and harmony exist when things are done accordingly leading to prospects for development. Academic achievement of students is high when learners understand the teaching contents very well. From the WAEC chief examiners' report, it was observed that students perform poorly in number and numeration including indices (WAEC, 2020). One wonders if teaching methods may be a contributing factor.

According to Agwagah (2018), a teaching method that enables active participation of learners needs to be adopted to effectively figure out what is needed to be taught. Onah(2004) developed an effective game for teaching and learning indices. Currently, students are more interested in clicking and retrieving data from laptops and smartphones during teaching and learning. Teachers are to direct students aright as curriculum implementers. The researchers deem it worthy to modify the Indices card and board game to be found on Computer and to read 'Computer Indices Card and Board (CINDICAB) –Game'. The advantage of the use of game in teaching cannot be overemphasized. Explaining the importance of game, Agwagah (2018) indicated that game, when well arranged, generate interest and excitement and help students to understand difficult concepts in Mathematics and other subjects. Learning as game can create amusement and pleasure. This is in line with Ukeje and Obioma (2002) that amusement and pleasure gotten from teaching and learning using game as a strategy need to be combined with instruction for learners to be more active in teaching and learning processes. Bloom (2007) is of the view that in all subjects, learning contents are to be arranged in ascending order of difficulty so that knowledge gain may flow and increase. Teaching and learning using Computer game may flow equally when the contents are sequentially arranged. The authors bore this in mind while constructing the contents of Indices Achievement Test (INDAT) used for pre-test, post-test for both groups and also the game-contents played with hard copy by control group and equally played with similar contents found in computer system for experimental group.

CINDICAB-Game

CINDICAB-Game originated from Indices Card and Board (INDICAB) – Game developed by Onah(2004). The game was manually played initially to solve the problem of students' poor performance in Indices. Emphasis is on Equivalency of each Set of Questions. The game borrowed a leaf from Ukeje and Obioma (2002) that amusement and pleasure ought to be combined with pleasure while teaching abstract concepts so that effective learning will take place. The authors were of the view that when the game umpire in the classroom manage the class effectively, interest of the learners will be generated leading to better understanding of the concepts being taught.

The present researchers are of the view that a 21st century student is always with one's smart phone and modified the game to be played in computer as computer game CINDICAB-Game. This CINDICAB- game has been found to be effective (Onah, Obe, …(2022) and should then be promoted by all and sundry especially by Educators when the perceived Efficacy is high. The game can be included to Mathematics Palace- games (Ukeje and Obioma, 2002). Similar games can be developed in Arts and the like for technological development when modified in Industry for sale. Equivalency pattern found in each set of questions can be copied and transferred to other fields in Arts and Science Education in particular.

Card and Board game as the names suggest involve the inclusion of the three domains of educational objectives in teaching and learning processes namely: Cognitive, Affective and Psychomotor domains. Drawing and recording results of outcome on the board promote active participation of learners – both male and female students alike, (Onah, 2004). Drawing is mainly in psychomotor domain and when students learn with understanding and ability to transfer knowledge(Cognitive Domain) using this Computer game, achievement will likely be high leading to development in all domains of educational objectives found in education industry which is needed in this 21st century. Winners would occupy the palace called Mathematics Winners' Palace (MWP) and are expected to achieve higher from winners' gate (gate i, ii, iii, or iv) during and after Post-test. Technological development is the expected end product as various games developed by learners will be ready for sale thereby attracting funds. African culture of peace and unity promoted by game can lead to technological development . Education with its knowledge as the Power of every nation will be promoted.

Purpose of the Study

The main purpose of this study is to find out the efficacy of CINDICAB-Game In Attaining The Three Education Domains For Technological Development As Perceived By Science And Arts Educators In Nigerian Universities. Specifically, the study determined:

1.The perception of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game in attaining the three education domains for technological development.

2.The perception of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game or any other number equivalent Game on Cognitive and Psychomotor domains' skill acquisition for technological development.

Scope of the Study

This study focused on the efficacy of CINDICAB-Game in attaining the three education domains for technological development as perceived by Science and Arts Educators in Nigerian Universities. Number and numeration are applied in every field especially Sciences, Arts and Medical line. Indices, if not well understood by students who are future leaders in different areas constitute a problem, and the outcome may be alarming. Concepts under indices for SSI students were used for previous Experiment of 2022 because of the nature of the topic as indices fall under SSI Curriculum. Nigerian University Educators who are united by Social platform numbering 381were used as population while 120 respondents who reacted to questionnaire in the platform were used as a sample (70 Science and 50 Arts Educators).

Research Questions

1.What are the perception of Science and Arts Educators on the efficacy of the Computer Indices Card and Board (CINDICAB)- Game in attaining the three education domains for technological development?

2. What are the perception of Science and Arts Educators on the efficacy of the Computer Indices Card and Board (CINDICAB)- Game or any other number equivalent Game on Cognitive and Psychomotor domains?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

H01: There is no significant difference on the perception of Science and Arts Educators on the efficacy of the Computer Indices Card and Board (CINDICAB)- Game or any other Equivalent Game at the **Cognitive** Domain stage of understanding for technological development.

H02: There is no significant difference on the perception of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game or any other Equivalent Game at **psychomotor** domain's skill acquisition for technological development.

Methodology

This study employs descriptive research. According to Nwogu (2012), a descriptive researchdesign is employed when opinion of respondents are sort. A questionnaire of 10 items was used to collect data with reliability of 0.85 and Opinion of Science and Arts Lecturers were sort on a Four point Likert scale of : Strongly Agree 4points, Agree 3points, Disagree 2points and Strongly Disagree 1point.Data collected were analysed using MS Excel. Clustered Mean of 2.5 and above suggest High Agreement while below 2.5 indicate Low Agreement. For the null Hypotheses formulated at 5% Level of significant, T-test statistics was employed. If p value is less than 0.05, the null hypothesis of no significant difference is upheld as True. However, if the p value is greater than 0.05, we fail to accept the null hypothesis. In other words, we uphold that there is a significant difference. Brief description of Four sets of Equivalent Indices Games are given below after the Result-Tables, Discussion of Result, Recommendations and Conclusions. It is worthy to note that Sets of Equivalent Questions depend on number of Groups of Players. It can be three or even Five instead of Four as in the Example Below.

Results

Research Question 1: What are the perceptions of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game in attaining the three education domains for technological development?

Table1: Mean Perception of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game in attaining the three education domains for technological development.

Educators	**No N**	**Cognitive M1**	**Affective M2**	**Psychomotor M3**	**Remarks R1**	**R2**	**R3**
Science	70	3.89	3.77	3.80	High	High	High

Arts	50	3.60	3.51	3.55	High	High	High

Key for Table1: N: Number of respondents
M1, M2,M3 : Mean response in the Cognitive, Affective and Psychomotor respectively
R1, R2, R3 : Remark for each of the three respective Domains

Research Question 2: What are the perceptions of Science and Arts Educators on any other Computer equivalent number Game on Cognitive and Psychomotor domains for technological development?
Table2: Mean Perception of Science and Arts Educators on the efficacy of any other Computer equivalent number Game on Cognitive and Psychomotor domains fortechnological development

Group Educators	**No N**	**Cognitive Mean1**	**Psychomotor Mean3**	**Remarks R1**	**R3**
Science	70	3.17	3.01	**High**	**High**
Arts	50	3.09	2.17	**High**	**Low**

Key for Table2 N: Number of respondents
Mean1,Mean3 : Mean response in the Cognitive and Psychomotor respectively
R1,R3 : Remark for each of the respective two domains -Cognitive and Psychomotor

H01: There is no significant difference at 5% level of significance on the perception of Science and Arts Educators on the efficacy of any other Computer equivalent number Game on Cognitive domain's stage of understanding.

Table3: Analysis of T-Test for Independent Sample on the perception of Science and Arts Educators on the efficacy of any other Computer equivalent number Game at Cognitive domain's

Group Educators	**No N**	**Cognitive T Mean value**	**Remarks**
Science	70	3.17	
Arts	50	3.09	**NS**
		0.041	

Key for Table3: N: Number of respondents
NS: Not Significant 0.041< 0.05 . Null Hypothesis is, therefore, upheld
H02: : There is no significant difference at 5% level of significance on the perception of Science and Arts Educators on the efficacy of any other Computer equivalent number Game at Psychomotor domain's stage of skill acquisition for technological development. .
Computer Indices Card and Board (CINDICAB)- Game at psychomotor domain stage of understanding.

Table4: Analysis of T-Test for Independent Sample on significance of the perception of Science and Arts Educators on the efficacy of any other Computer equivalent number Game at Psychomotor Domain's skill acquisition for technological development.

Group Educators	**No N**	**Psychomotor T Mean value**	**Remarks**
Science	70	3.01	S
Arts	50	2.17	
		0.094	

Key to Table 4: N:Number of Respondents,
S : Significant, 0.094 > 0.05, Null Hypothesis is rejected

Discussion of Result
From the results presented in the **Tables** above, high perception of Educators on Efficacy of CINDICAB-Game In Attaining The Three Education Domains For Technological Development was observed. More also, the perception of Science and Arts Educators on the efficacy of Computer Indices Card and Board (CINDICAB)- Game or any other number equivalent Game on Cognitive and Psychomotor domains was high. The t-test for unpaired sample present no difference between the two groups of Educators on Cognitive domain. It was however observed that a significant difference exist between Science and Arts Educators on the perception at psychomotor domain. This constitute a problem that needs to be addressed as both Science and Arts Educators need to be carried along in any development especially Technological Development that need psychomotor activities for its growth. Use of Computer in teaching especially Computer game was found to be effective and should be encouraged by all especially Lecturers who are curriculum implementers and formators of future Teachers. Use of game in teaching and learning was supported by Ukeje and Obioma (2002) that amusement and pleasure gotten from teaching and learning

using game as a strategy need to be combined with instruction for learners to be more active in teaching and learning processes. Bloom (2007) is of the view that in all subjects, learning contents are to be arranged in ascending order of difficulty so that knowledge gain may flow and increase. The researchers bore this in mind while arranging the contents of the INDICAB and CINDICAB games.

The three domains of Education objectives which include: Cognitive, Affective and Psychomotor Domains when achieved can promote technological development especially Cognitive which is in the mind at knowledge growth and Psychomotor which emphasize skill acquisition. Onah, Obe, Enema (2022) emphasized technological development that: Mathematics implies Science and Science imply technological development and progress. When Arts and Science Educators develop equivalent Sets of Games in different difficult concepts in their respective areas, money can be generated as many will buy the products when enough awareness is created. Harbor (2002) lamented that the society lack enough Computer software for teaching difficult concepts in Mathematics and other Subjects.

Onah(2004) found game to be effective in teaching. Also, Onah, Obe, …(2022) found CINDICAB Game to be effective in teaching processes. The question now is: Would Science and Arts Educators perceive the use of Computer indices game to be effective? The researchers have answered the above question after observing the results in the above **Tables**. The research questions were answered using clustered mean while the null hypotheses were tested using t-test at 0.05 level of significance. Results revealed that use of Computer Game in teaching generally increased students' academic achievement in indices and Educators generally perceive it to be high.

However, the t-test result in Table 4 was found to be significant between the Science Educators' and Arts Educators' perception in favour of Science Educators. Perception in CINDICAB Game was higher.
Based on the results, the following recommendations were made:

Recommendations

1. CINDICAB- game was found to be effective in promoting high achievement in learners in all the three domains of Educational objectives and should then be promoted by all and sundry for development in education industry.

2. Arts Educators along with Science Educators need to understand better the need for equivalent sets of questions to be set and also to be played in other concepts ant not only in CINDICAB- game for technological development
3. Development of Computer-games in teaching difficult concepts in Mathematics should be adopted in every secondary school and also in institutions of higher learning for better understanding.
4. Arts room in schools, and Science laboratories should be equipped with relevant equivalent sets of game questions in all schools in the state for higher achievement signifying development in education sector. This will promote transfer of knowledge at both secondary schools and Universities.
5. Annual workshops should be organized for teachers and Lecturers on development and use of games in teaching especially use of Computer games. Also, training of teachers should include how to apply Bloom's taxonomy in teaching and learning for better understanding of difficult concepts in any subject area and every field of endeavour and also how to make use of **'x^2'** in the Computer Tool barfor keying in any type of non – zero number in its index form.

Conclusion

1. The high perception of Educators on CINDICAB Game generally is very encouraging. The use of Computer in teaching has been found to be effective. Computer Indices Card and Board (CINDICAB)-Game has advantage over ordinary game without computer and has to be adopted by all and sundry so that development in education industry is promoted.
2. Computer and Mathematics are highly related and they go hand in hand. Both can be used in computing and communicating. For instance, result gotten while calculating average of certain numbers manually, using mathematical formulae, is of the same quantity when MS Excel in Computer is used for processing the same set of numbers. The main difference is that the Computer performs its functions faster and neater. The two are needed by everyone and should be promoted.
3. Use of Computer in teaching promote a Chinese proverb: 'I hear and I forget, I do and understand, I see and I remember'. Viewing a computer screen while teaching is going on has increased students' achievement and should be adopted in teaching all subjects.

4. Reduction on Mean perception of Science and Arts' Educators when other Computer number Game was mentioned constitute worries to researchers and need to be addressed by all and sundry so that the seventeen (17) interlinked Sustainable Developmental Goals (SDGs) will be attained.

Description of CINDICAB-Game: Diagram of the Board game Bearing Mathematics Winners' Palace (MWP) is drawn and described thus: Circle centre 'O' is represented by 'MWP' at the centre and the circumference bearing gates i, ii, iii and iv with eight (8)steps each gate, 2 Marks per correct score. Highest (8) becomes the winner. Value card game is played for ties to determine the actual winner.

The Four Sets of Equivalent Indices Game Is Played After Teaching 7 Laws of Indices.

The seven(7) Laws of Indices: Let p be any number different from zero (0)and p is not infinity, also, let m and n be any integer ,the following hold:

(1) $p^m \times p^n = p^{m+n}$, (2) $p^m/p^n = p^{m-n}$, (3) $p^0=1$, (4) $p^{1/3} = \sqrt[3]{p}$,
(5) $P^{2//3} = (\sqrt[3]{p})^2$,(6) $p^{-n} = 1/p^n$,(7) $(p^m)^n = p^{mn}$

The Four Sets of Equivalent Indices Game Include Set: A, B, C, D thus:

SET A: SIMPLIFY :
i $2a \times 3a^2$
ii $(2a)^2 \times 3a(2a)^2 \times 3a$
iii $2a \times (3a)^2$
iv $(2a)^3 \times 32a$

SET B: SIMPLIFY :
i $0.125^{1/3} \times h^0$
ii $0.027^{2/3} \times q^0$
iii $r^0 \times 0.04^{3/2}$
iv $p^0 \times 0.008^{3/2}$

SET C: SIMPLIFY :
i $(9/16^{-3/2}$
ii $(1/27)^{-2/3}$
iii $4^{-3/2}$ iv $(4/25)^{-3/2}$

SET D: SOLVE :
i $4^{p-1} = 64$

ii $3^{2q+1}=27$
iii $5^{r+1}=125$
iv $7^{v-2}=49$

VALUE CARD GAME (in case of ties). **Correct and highest score is needed as winner.**
EVALUATE:
i 5^{3x-1} for x =1
ii 2^{2x-1} for x =2
iii $81^{x-2/3x}$ for x =3
iv $40^{x-1/2}$ for x = 4

NB: Value card game is only played when there is **Tie**. It helps to determine the actual winner of the game when two or more groups have equal scores.

African culture of peace and unity can lead to technological development when Educators who are curriculum implementers and game umpires in classrooms do the needful irrespective of treatment received from the employers.

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