Critical Thinking Skills: The Extent to which they are Taught in Physics Lessons in Secondary Schools of Transnzoia County, Kenya.

Dickson Kimeli Rutto, Simon Wanami, Peter Waswa

Centre For Teacher Education, University of Eldoret

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ABSTRACT

The study sought to establish the extent to which critical thinking skills were taught in physics lessons, in secondary schools of Transnzoia County, Kenya. It was occasioned by the inadequate critical thinking skills exhibited by candidates as observed by the Kenya National Examination Councill's (KNEC), Kenya Certificate of Secondary Education (KCSE) analysis reports in physics of the years 2018 and 2019. The research employed descriptive survey design, with both descriptive and inferential statistical tools used for data analysis. The target population was secondary school teachers of physics in the County. From the study, it was established that, the teaching of critical thinking skills in physics lessons did not adequately enhance learner's critical thinking skills, as such put them at a disadvantaged position in problem solving, including solving higher-order-level questions in examinations.

Key terms: critical thinking skills, extent, higher-order-level questions, instruction, physics lessons.

INTRODUCTION

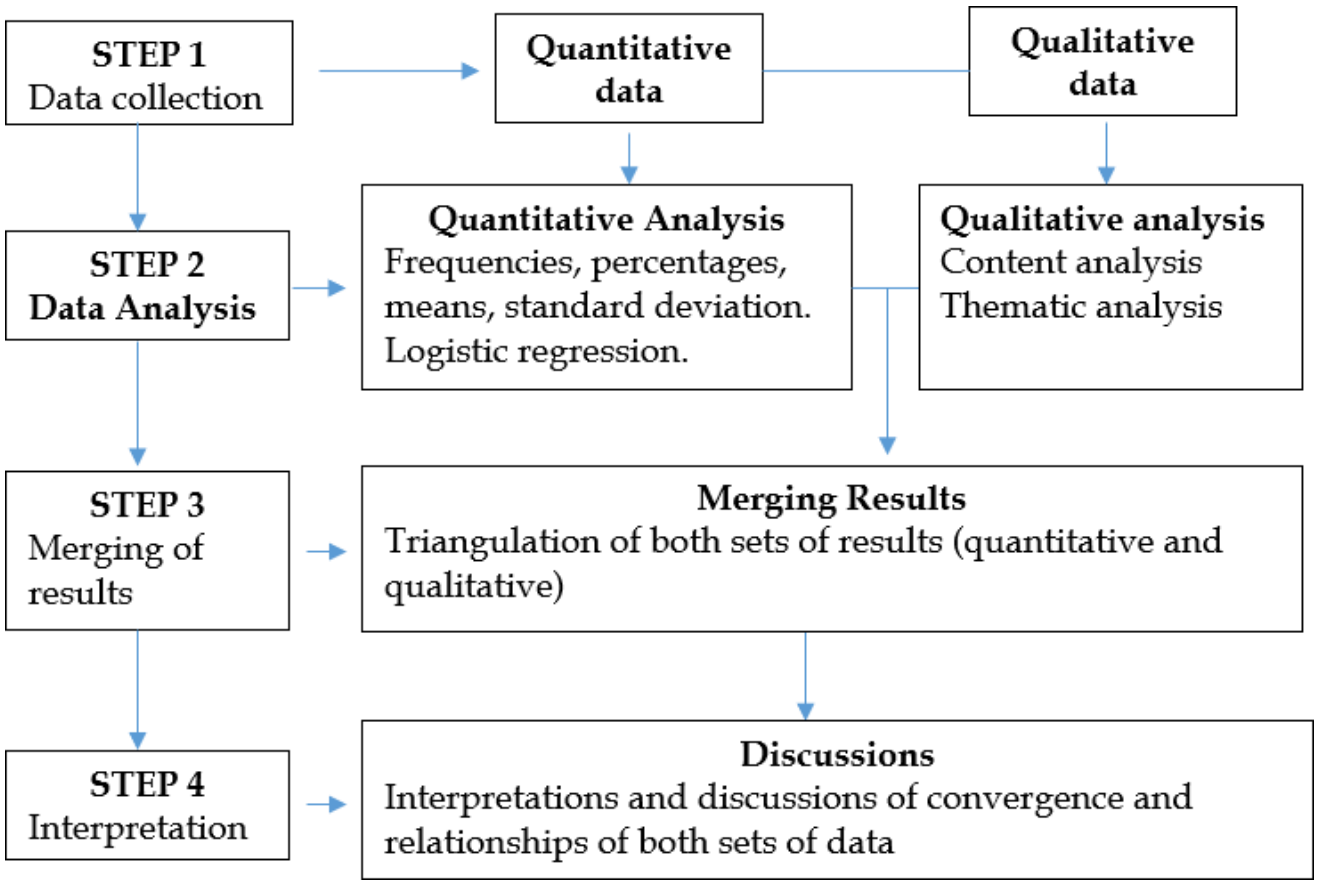
The Kenya Institute of Curriculum Development (KICD), outlines learner capacity for critical thinking as an objective of physics instruction in Kenyan secondary schools: KICD secondary school syllabus Vol. II (pp-37, objective No. 5). Similarly, it also outlines critical thinking as one of the core competencies in the Competency Based Curriculum (CBC): KICD Basic Education Curriculum Framework (2017: pp-21, competency No. 3). CBC is the curriculum currently under implementation in Kenyan schools. Furthermore, UNESCO (2013) in its technical consultation on Global Citizenship Education (GCE) outlined critical thinking as part of the competencies for GCE. As a result, teachers of physics are obligated to incorporate the teaching of critical thinking skills in physics lessons. In spite of this, the Kenya National Examination Council, a state corporation in the Kenyan Ministry of Education responsible for preparation, administration, processing and maintaining examination standards, has repeatedly pointed out that, candidates lack adequate critical thinking skills. For instance, KNEC (2018 & 2019) KCSE examination analysis reports in physics pointed out that, candidates were deficient of adequate critical thinking skills for effective problem solving. This observation was central to the study, as it sought to investigate the extent to which critical thinking skills were taught in physics lessons. It was geared towards establishing: the extent to which instructional strategies employed in physics lessons fostered the teaching of critical thinking skills; the efficacy of instructional resources in enhancing the teaching of critical thinking skills; the effectiveness of examinations administered to learners in assessing critical thinking skills and the challenges teachers of physics face in teaching critical thinking skills in physics lessons. The study was anchored on Merrill's First Principles of Instruction, an instructional theory put forward by David Merrill (2002). The theory identifies five Instructional Design Principles necessary for an effective learning process, an environment that facilitates acquisition of critical thinking skills in relation to this study. The instruction design principles are, problem solving principle, activation principle, demonstration principle, application principle and

integration of knowledge.

RESEARCH DESIGN AND METHODOLOGY

The study employed descriptive survey design, the convergent parallel model. Apuke (2017) noted that, descriptive survey is useful when accurate and extensive description of an educational practice is to be made. Consequently, the design was employed as the researcher aimed at obtaining extensive and elaborate information with regard to the teaching of critical thinking skills in physics lessons. It targeted secondary school teachers of physics in Transnzoia county, Kenya. As per the Teachers Service Commission (TSC) records, there were two hundred and six (206) teachers of physics in the county at the time of the study. Form II and III theory and practical examination papers were also employed for the study. From the target population, a sample size of one hundred and fifty-nine (159) respondents was obtained using Yamane Taro method at 0.05 level of significance. O'Leary (2014) noted that, our inability to access every element of a population does little to suppress our desire to understand and speak for. She further explained that, rarely do we speak to everyone we wish to speak about, so we sample, investigate, conclude, and attempt to argue the broader applicability of our findings. In the study, geographical clustering and simple random sampling techniques were used to determine the study sample. Questionnaires and analysis of documents were employed in obtaining data. Documents analyzed were form II and III theory and practical examination papers, the analysis was specific to finding out the proportion of question items that tested each of the three critical thinking skills under study, that is application, analysis and synthesis. Data generated from research instruments and documents, were compiled, coded, analyzed and interpreted. Statistical Package for the Social Sciences (SPSS) Version 24 computer programme was used in analyzing quantitative data while content analysis was used for qualitative data.

The following illustration gives a summary of the research process.



RESEARCH FINDINGS, INTERPRETATION AND DISCUSSION

The response rate realized was 92.45%. Saunders et al (2007) explained that, a response rate of thirty to fifty percent is good enough for generalizations. As a result, the response rate achieved met the threshold for analysis and generalizations. From logistic regression analysis it was established that, instructional strategies that can be employed within a lesson, that is: group learning, scaffolding, simulations, Socratic questioning, brainstorming, use of analogies and laboratory experiments were not statically significant (p-value 0.237) in fostering the teaching of critical thinking skills and explained an extent of up to 30.3% only. On the other hand, instructional strategies that extend beyond a lesson, that is: project based learning, problem based learning and inquiry based learning, were also not statistically significant (p-value 0.387) in fostering the teaching of critical thinking skills and explained an extent of up to 8.9% only. Alrubai (2014) observed that, brainstorming technique can foster the acquisition of creative and critical thinking. Similarly, Ferty et al (2019) explained that, there is improvement of critical thinking through simulations assisted by Scaffolding approach. Foster and Lemus (2015) indicated that, inquiry-based activities helped in improving learners' science skills by promoting awareness regarding to the role of creativity and critical thinking in scientific inquiry. Ranggi et al (2021) revealed that there is a strong positive effect of problem based learning on critical thinking skills. Consequently, the researcher advocates for more usage of the aforementioned strategies in order to realize significant development of learner's critical thinking skills.

With regard to instructional resources, it was found out that at 0.05 level of significance physics course books were statistically significant in enhancing the teaching of critical thinking skills (p-value 0.049), while teacher's guide books were statistically significant in fostering the teaching of analysis skills only. The rest of the resources under study, that is, realia, models, audio-visual and the services of a resource person were not statistically significant, (p-value 0.389) in enhancing the teaching of critical thinking skills in physics lessons and explained an extent of up to 22.5% only. Haryani et al (2021) observed that, teachers ought to use multiple resources to help them adequately integrate the skills of creativity, critical thinking and problem solving in learners. Further, Sadidi et al. (2019) indicated that, there is a significant association between instructional materials and enhancement of learner's critical thinking skills in physics instruction. As a result, it is in the researcher's view that, teachers of physics ought to incorporate more usage of instructional resources, realia, models, audio-visual devices and resource person in physics lessons, in order to realize a positive outcome in the teaching and acquisition of critical thinking skills.

Analysis of form II and III theory examinations vis-a-vis the proportion of test items involving, application, analysis and synthesis critical thinking skills were as shown in the following tables.

Analysis of form two theory examination, with regard to the proportion of application, analysis and synthesis test-items.

		FREQUENCY OF TEST ITEMS SPECIFIC TO CRITICAL THINKING SKILL							
		Application		Analysis		Synthesis		Cumulative Frequency	Cumulative Percentage
		F	%	F	%	F	%		
Total Test Items Analyzed, Including Subsections Of Questions.	**3,223**	752	**23.34**	211	**6.56**	112	**3.48**	**1,075**	**33.35**

The number of test items analyzed in form II theory examination were three thousand two hundred and

twenty-three (3223). The frequency (f) and percentage (%) of each skill was as shown in the table. Similarly, the cumulative frequency and cumulative percentage were also as shown.

Analysis of form three theory examination, with regard to the proportion of application, analysis and synthesis test-items.

		FREQUENCY OF TEST ITEMS SPECIFIC TO CRITICAL THINKING SKILL							
		Application		Analysis		Synthesis		Cumulative Frequency	Cumulative Percentage
		f	%	F	%	f	%		
Total Test Items Analyzed, Including Subsections of Questions.	**3,193**	807	**25.28**	228	**7.15**	125	**3.92**	**1,160**	**36.33**

The number of test items analyzed in form III theory exams were three thousand one hundred and ninety-seven (3197). The frequency (f) and percentage (%) of each skill were as shown in the table. Similarly, the cumulative frequency and cumulative percentage, were also as shown.

In both form II and III the practical examination question papers obtained was less than 20% of the expected. As such did not meet the threshold for analysis. Saunders et al (2012) observes that, a response rate of thirty to fifty percent is good enough for analysis and generalizations.

An analysis of KCSE physics examination papers spanning the years 2015 to 2019 was also carried out to establish the proportion of test items involving critical thinking skills: application, analysis and synthesis. It was found out that:

i. Out of all the questions in paper 1, the proportion of questions that involved critical thinking were: 47.22%, 48.78%, 51.43%, 54.35% and 43.58% respectively. Culminating to a mean of 49.07%.
ii. Out of all the questions in paper 2, the proportion of questions that involved critical thinking were: 48.72%, 62.79%, 48.57%, 52.26% and 48.94% respectively. Culminating to a mean of 52.26%.
iii. Out of all the questions in paper 3, the proportion of questions that involved critical thinking were: 89.29%, 82.35%, 80.00%, 88.46% and 92.85% respectively. Culminating to a mean of 86.59%.

It is shown that, question-items that required critical thinking skills constituted a significant proportion of the examinations in all the three papers. Practical papers (P3) being the most demanding in terms of critical thinking. As a result, teachers of physics need to include more critical thinking items in examinations they administer to learners in order to adequately prepare them for the national (KCSE) examination. Similarly, they ought to administer practical examination regularly. Teachers of physics are also encouraged to employ standard methods of assessing critical thinking skills. According to the American Educational Research Association (2014), the following are the standardized techniques for assessing critical thinking:

i. The Watson-Glaser Critical Thinking Appraisal.
ii. The Cornell Critical Thinking Tests Level X and Level Z.
iii. The Ennis-Weir Critical Thinking Essay Test.
iv. The California Critical Thinking Skills Test.
v. The Halpern Critical Thinking Assessment.
vi. The Collegiate Learning Assessment.
vii. The Critical Thinking Assessment Test (CAT).

The above techniques can be customized to assess critical thinking in physics lessons. Assessment of critical

thinking measures learner's competence in critical thinking, hence provide a way forward for intervention measures where necessary.

From the study, it was also established that, teachers of physics face an array of challenges in teaching critical thinking skills in physics lessons. The major challenges were:

i. Inadequate instructional resources
ii. Large number of learners per classes
iii. Time constraints, including inadequate laboratory time
iv. Non homogeneity in learners' abilities
v. Negative attitude of learners towards physics subject
vi. Lack of immediate real-life experiences of what is taught.
vii. Lack of initiative by learners with regard to physics learning
viii. Ill equipped laboratories

CONCLUSION

From the findings, it was concluded that, the teaching of critical skills in physics lessons did not adequately enhance learner's critical thinking, as such put them at a disadvantaged position in problem solving, including solving higher-order-level test-items in examinations.

RECOMMENDATIONS

From the study, the following recommendations were made:

1. Teachers of physics should make deliberate efforts to include the teaching of critical thinking skills in their lessons.
2. Teachers of physics should fully incorporate practical examination in all classes (form one to form four). Similarly, more question items involving critical thinking skills should be in included in theory examinations. The use of standardized techniques in assessment of critical thinking skills is also encouraged.
3. There is need to include more instructional content for teaching critical thinking skills in physics course books and other related instructional resources.
4. More training content for teaching critical thinking skills ought to be included in teacher training programmes.
5. Periodically teachers of physics need to be engaged in refresher courses aimed at boosting their pedagogical knowledge towards the teaching of critical thinking skills.

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