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Developing And Assessing Affective Skills In Physics Through A Gagné-Informed ICT-Integrated Instructional Design Framework: A Study Of Secondary School Learners In Nairobi, Kenya

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Abstract: ***Physics performance at the secondary school level remains persistently low, partly due to ineffective instructional design and the neglect of affective learning outcomes — attitudes, motivation, and values — in evaluation frameworks. This study investigated the effect of Gagné's Nine Events of Instruction on affective skill development in Physics among Form Two students in Nairobi County, Kenya. A quasi-experimental Solomon Four-Group Design was used, with an experimental group (n = 65) taught using Gagné's model and a control group (n = 73) taught via conventional lecture methods. Non-parametric tests (Mann-Whitney U and Kruskal-Wallis H) were applied. Results showed significantly higher affective outcomes in the experimental group (U = 170.00, z = -9.403, p < .001, r = .801), confirming practical significance. Gagné's model more effectively cultivates positive Physics attitudes than conventional teaching. Recommendations include integrating affective assessment into national examinations and embedding affective-domain outcomes in teacher-training curricula.***

Keywords: ***Affective skills, Gagné's instructional design, Nine Events of Instruction, Physics learning outcomes, secondary education.***

I. INTRODUCTION

Across the globe, countries have prioritized STEM instructional design to strengthen learning outcomes and advance socio-economic sustainability. Emphasizing conceptual understanding and critical thinking, the U.S. Next Generation Science Standards promote inquiry-based and active learning in Physics (Bybee, 2014). Rather than relying on rote memorization, Finland's competency-based curriculum shifts the focus to problem-solving (Sahlberg, 2015). Gagné's (1985) model, which advocates structured, sequential learning experiences across all five domains, including affective skills, aligns with both approaches.

In Africa, South Africa's ICT4RED initiative introduced digital tools into STEM classrooms (Czerniewicz & Brown, 2014). Across East Africa, the SMASE initiative provided in-service training for science educators (SMASE, 2013). However, Physics performance in Kenyan secondary schools remains persistently below average, as indicated by KCSE mean scores (KNEC, 2019). Notably, Julius et al. (2012) identify instructional design, rather than teacher qualifications, as the more decisive factor in student achievement.

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A critical, underexplored factor in this underperformance is the neglect of affective learning outcomes—students' attitudes, motivation, and values—in both instruction and assessment. Gagné (1985) listed attitudes as one of five core learning outcomes, stating that affective states shape academic engagement. Yet effective outcomes are still absent from Physics instruction and KCSE evaluation frameworks. This study examines how Gagné's Nine Events of Instruction affect the development of affective skills in Form Two students in Nairobi County, Kenya, and compares them with conventional lecture-based methods.

II. BACKGROUND

Globally, education systems have adopted evidence-based instructional design models in STEM to improve outcomes and support holistic development (National Research Council, 2012). The U.S. NGSS, STEM Education Act, and Every Student Succeeds Act encouraged inquiry-based learning and teacher development (Bybee, 2014; U.S. Department of Education, 2018). Finland and Singapore also implemented student-centered, problem-solving approaches aligned with Gagné's framework (Sahlberg, 2015; Tan et al., 2017). In Africa, South Africa's ICT4RED initiative used digital tools in Physics classrooms consistent with Gagné's principles (Czerniewicz & Brown, 2014).

Regionally, SMASE offered in-service training for science educators. Still, Physics performance in Kenya is below average on all three KCSE papers (KNEC, 2019). Michel et al. (2007) blame weak pedagogy and limited resources. Kibaara (2014) cites understaffing and negative student attitudes as factors. Both highlight instructional quality as central to the problem.

Schools in Nairobi County reflect the national underperformance. Julius et al. (2012) argue that instructional design is more decisive than teacher qualifications. Angell et al. (2004) find that ineffective delivery worsens students' attitudes toward Physics. This suggests that a structured instructional framework could address these gaps.

This study examines affective skills—students' values, attitudes, and dispositions toward Physics—as the dependent variable. Gagné's Nine Events of Instruction serves as the independent variable, while learner autonomy and purposeful feedback, highlighted by Dresel and Hall (2013) as hallmarks of structured instructional models, are essential for affective growth. Systematic examination of Gagné's model as an intervention for affective outcomes in Physics remains limited. By positioning itself as a strategic framework to bridge policy aspirations and classroom realities, this research offers practical implications for educators, policymakers, and curriculum developers.

OBJECTIVE OF THE STUDY

This study aimed to examine differences in affective skill development, as a Physics learning outcome, between Form Two students in Nairobi County who were exposed to Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods.

NULL HYPOTHESIS (H_0)

There is no statistically significant difference in affective skill development, as a Physics learning outcome, between Form Two students in Nairobi County who were taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods.

THEORETICAL FRAMEWORK

This study uses Gagné's Conditions of Learning Theory (Gagné, 1985). This theory gives a clear plan for teaching different types of skills. Gagné said learning depends on both the student's mind and what teachers do, and that lessons should be designed to reach specific goals (Gagné et al., 2005).

TAXONOMY OF LEARNING OUTCOMES

Gagné (1985) classified learning outcomes into five domains: verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes (affective skills). Each requires distinct instructional conditions. This study focuses on affective skills, defined as internal states that predispose learners toward particular actions regarding Physics.

CONDITIONS OF LEARNING

Gagné (1985) distinguished between internal and external learning conditions. Internal conditions include prior knowledge, cognitive structures, and motivation. External conditions cover instructional stimuli and pedagogy. Effective instructional design needs deliberate alignment of both to achieve meaningful attitude change and skill acquisition.

HIERARCHY OF LEARNING

Gagné's (1985) learning hierarchy has eight levels, from basic signal learning to complex problem-solving. Each level builds on the one before. In Physics instruction, it's important to sequence affective skill development with cognitive and procedural learning.

THE NINE EVENTS OF INSTRUCTION

Gagné et al. (1992) operationalized the theory through nine sequential instructional events: gaining attention, informing learners of objectives, stimulating recall, presenting content, providing guidance, eliciting performance, giving feedback, assessing performance, and enhancing retention and transfer. These events are structured external stimuli that trigger internal processes, supporting the acquisition and retention of learning. In this study, the Nine Events serve as the independent variable for examining affective skill development in Physics compared with conventional lecture-based instruction.

The research's conceptual framework is shown in *Figure 1*.

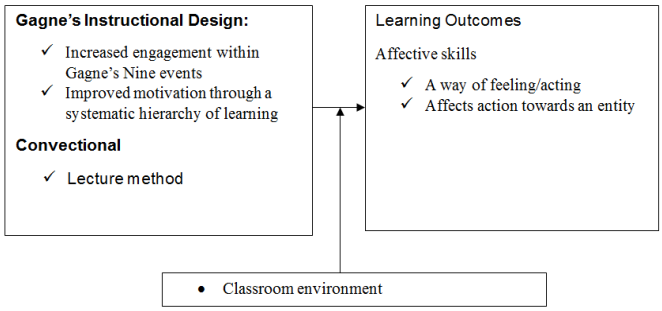

Figure 1: Conceptual framework

III. LITERATURE REVIEW

AFFECTIVE SKILLS AS A LEARNING OUTCOME IN GAGNÉ'S INSTRUCTIONAL DESIGN

Gagné (1985) named attitude as one of five main learning outcomes, noting that feelings shape what learners do and how well they perform. Unlike thinking skills, attitudes can change with careful teaching. Bloom (1956) and Krathwohl et al. (1964) also found that attitudes show real learning, not just early signs of it. Brogg (1979) called for broader measures of learning that include motivation and attitude, as well as thinking skills.

MEASURING AFFECTIVE SKILLS

Measuring affective skills is a persistent methodological challenge. Krathwohl (1964) attributed the erosion of affective outcomes to teachers' reluctance to assess attitudes and to the inadequacy of appraisal tools. Babbi (2021) proposed self-report instruments with four indicators: opinion strength, personal importance, level of concern, and frequency of expression. Laminack and Long (1985) recognized the affective domain's role in student achievement but found limited empirical evidence for its systematic use as a research variable.

AFFECTIVE SKILLS AND SELF-EFFICACY

Bandura (1977) established that behavioral change in learning is tied to self-efficacy — the learner's belief in their capacity to perform — making it a meaningful indicator of affective development. Mayer (1998) identified interest, self-efficacy, and attribution as the three core motivational skills for effective academic problem-solving. Afjar et al. (2019) argued that teachers must consider learners' intrinsic motivation when selecting instructional models, as affective factors are products of the learning process itself. Wen-H. et al. (2019) affirmed that effective instruction enables critical reflection on beliefs and values, fostering innovation in knowledge acquisition.

AFFECTIVE SKILLS IN PHYSICS EDUCATION

Empirical studies consistently demonstrate a significant relationship between students' attitudes and their performance in Physics. Martinko and Talalovic Vorkapic (2017) found that positive attitudes predict stronger academic outcomes, while Veloo et al. (2015) established that a positive mindset deepens conceptual understanding. Conversely, Olusola and Rotimi (2012) found that negative attitudes reduce cognitive engagement and lower performance. Rijal and Bachtiar (2015) assert that positive attitudinal dispositions are essential for achieving learning objectives, as they directly influence engagement with challenging content.

EFFECT OF INSTRUCTIONAL DESIGN ON AFFECTIVE SKILLS

Research on structured instructional approaches and affective outcomes in Physics is growing. Akpokinioro et al. (2022) found that Gagné's learning hierarchy produced positive attitudinal outcomes, while Okeke et al. (2023) reported significantly more positive Physics attitudes among students taught via cognitively guided instruction compared to those taught via traditional methods. Mamuda and Peni (2022) highlighted that poor Physics performance often accompanies low self-confidence, underscoring the need for instructional models that cultivate both affective and cognitive competencies. These findings collectively support the premise that Gagné's Nine Events of Instruction offers a more effective framework for developing affective skills in Physics than conventional lecture-based approaches.

IV. RESEARCH METHODOLOGY

RESEARCH APPROACH

This study employed a quantitative research approach, which is characterized by clearly defined objectives established prior to data collection, thereby minimizing researcher bias (Bryman, 2016). The quantitative paradigm was further selected for its capacity to facilitate systematic data analysis through tables, graphs, and statistical summaries (Muijs, 2020), as well as its ability to encompass a broad range of concepts within a comprehensive research framework (Neuman, 2014).

RESEARCH DESIGN

A quasi-experimental design was adopted, specifically Solomon's Four Non-Equivalent Control Group Design. This design incorporates both experimental and control groups without random assignment of participants, instead utilizing intact groups as they exist in their natural settings (Keppel, 1991). Solomon's four-group design was selected for its strength in controlling for threats to internal validity, particularly pre-test sensitization effects, making it well-suited for assessing the impact of Gagné's Nine Events of Instruction on affective skill development in Physics.

The four groups were constituted as follows: Experimental Group 1 (E1), Experimental Group 2 (E2), Control Group 1 (C1), and Control Group 2 (C2), with E1 and E2 receiving instruction guided by Gagné's model and C1 and C2 receiving conventional lecture-based instruction.

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SAMPLING PROCEDURE

A multi-stage sampling procedure was employed. First, schools were stratified by type — public and private — to ensure representativeness across the two strata (Fleetwood, 2023). Simple random sampling was then applied to select four schools, two from each stratum. The selected schools were subsequently assigned to experimental or control conditions using simple random allocation, yielding 2 experimental and 2 control schools. The total sample comprised 143 participants: 92 students from public schools, 49 from private schools, and two Physics teachers.

RESEARCH INSTRUMENTS

TECHNOLOGY - ENHANCED GAGNÉ'S INSTRUCTIONAL DESIGN IN TEACHING HOOKE'S LAW

To assess affective skill development aligned with Gagné's framework, the researcher developed a bespoke instrument integrating two complementary theoretical frameworks.

To assess affective skill development aligned with Gagné's framework, the researcher developed a custom instrument that combined two complementary theories. (Affective skill development is the growth of learners' attitudes, values, and motivations.) Lessons used Gagné's Nine Events of Instruction, leveraging instructional technologies such as videos, animations, graphs, and photographs. (Gagné's Nine Events of Instruction is a stepwise model, including gaining attention and providing feedback.) The use of varied stimuli reinforces Gagné's (1985) claim that diverse methods activate multiple sensory channels and engage learners' internal affective states. For example, in teaching Hooke's Law, videos and animations demonstrated elastic and plastic material behavior. (Elastic behavior is when materials return to their original shape after force is removed; plastic behavior is when they retain their new shape.) Graphs illustrated the force-extension relationship, describing how materials stretch in response to force. Photos showing real-world applications, like spring balances and suspension systems, made abstract concepts concrete. Strategically integrating these multimedia tools throughout the nine events attracted attention, presented content clearly, supported guided learning, and fostered positive attitudes, motivation, and values toward Physics.

Although Gagné (1985) identified attitudes as internal states that influence learners' choices, his framework lacks a hierarchical structure for measuring attitudinal depth, which refers to the degree to which attitudes are internalized by learners. In contrast, Bloom's Affective Taxonomy (Krathwohl et al., 1964) addresses this limitation by tracing the learner's progression from initial awareness to a value-driven behavioral disposition through five progressive levels—Receiving (willingness to attend), Responding (active participation), Valuing (assigning worth), Organization (integrating values), and Characterization (consistent value-driven behavior). By integrating these two frameworks, the instrument could assess not only whether affective outcomes were achieved but also the depth of their internalization, thereby supporting both formative and summative measurement.

Affective Skills Activities Framework

Based on this theoretical integration, the researcher constructed an Affective Skills Activities framework (Table 1) that maps each of Bloom's five affective levels to specific learning activities and corresponding assessment strategies. This framework served as the conceptual blueprint for the scoring instrument, enabling the researcher to assign each learner a score reflecting the highest level of affective skill demonstrated during and after instruction.

Affective Level	Learning Activities	Assessments
Receiving	Watch, listen, read, focus groups	Feedback forms, lists, surveys
Responding	Active participation, group discussion, written assignments, problem-solving	Questionnaire, feedback form
Valuing	Debates, reflection papers, opinionated pieces, self-report	Questionnaire, rating scale
Organization	Analysis/contrast, concept mapping	Questionnaire, problem-solving tasks
Characterization	Critical reflection, self-report goals, group projects	Self-evaluation, group project criteria

Note. Adapted from a researcher-developed instrument grounded in Krathwohl et al. (1964).

Table 1: Affective Skills Activities Framework

Affective Questionnaire

The primary data collection instrument was an Affective Questionnaire (Table 2), developed by the researcher to measure students' attitudinal responses toward Physics instruction on Hooke's Law. The instrument operationalized each of Bloom's five affective levels through two items per level, yielding ten items in total. Respondents rated each item on a four-point scale ranging from 1 (*Poor*) to 4 (*Excellent*), with a dash (—) indicating uncertainty. This format aligns with established self-report conventions for measuring affective states, which commonly employ surveys, questionnaires, and rating scales to capture individuals' emotional and attitudinal dispositions (Babbi, 2021).

Note. Rate each item: 4 = Excellent, 3 = Very Good, 2 = Good, 1 = Poor, — = Unsure.

Affective Level	Activities	Rate(Score)
Receiving	Rate the video(s) watched during lessons	
	Rate your keenness to listen in class	
Responding	Rate your active involvement in group/class work	

	Rate the adequacy of questions given by the teacher	
Valuing	Rate the quality of group discussions in class	
	Rate the importance of the topic in daily life	
Organization	Rate your ability to contrast plastic and elastic materials	
	Rate your ability to determine the spring constant	
Characterization	Rate how well you can construct a spring balance independently	
	Rate the project(s) assigned outside the classroom	

Note. Instrument developed by the researcher, grounded in Bloom's Affective Taxonomy (Krathwohl et al., 1964).

Table 2: Affective Questionnaire Form — Hooke's Law

ETHICAL CONSIDERATIONS

The researcher adhered to established ethical principles governing academic research involving human participants throughout all phases of the study. Before data collection, all participants were fully informed of the study's purpose, procedures, and expected activities, ensuring voluntary and professional participation. All personal information obtained from participants was handled with strict confidentiality and used exclusively for this study. Consistent with open educational resource principles, no data were used for personal financial gain, and all publications arising from this research were made available on a non-commercial basis.

RESEARCH AUTHORIZATION

Formal ethical and administrative clearance was obtained from multiple relevant authorities before data collection commenced. The researcher secured a letter of authority from the School of Postgraduate Studies at Machakos University, a research permit from the National Commission for Science, Technology and Innovation (NACOSTI), and authorization letters from both the District Commissioner of Nairobi and the Nairobi County Director of Education. These authorizations granted permission to collect data from sampled participants across both public and private secondary schools in Nairobi County, ensuring full compliance with national research governance frameworks.

V. DATA ANALYSIS, INTERPRETATION, AND DISCUSSION

OVERVIEW

IBM SPSS version 26 software was employed for data analysis. Data interpretation in this study was supported through tabular summaries, bar charts, and box plots to facilitate clear visualization of findings. The guiding objective was to examine differences in affective skill development, as a Physics learning outcome, between Form Two students in Nairobi County who were exposed to Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods. Analysis was conducted in direct alignment with the stated null hypothesis: *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods.* The hypothesis was tested using both descriptive and inferential statistics, including means, standard deviations, independent-samples *t*-tests, and *p*-values.

NORMALITY TEST FOR AFFECTIVE SCORES

Before conducting inferential statistical analyses, the distribution of affective scores was examined to determine whether parametric or nonparametric methods were appropriate. Parametric tests, including independent-samples t-tests and ANOVA, assume normally distributed data; violations of this assumption risk inflated Type I or Type II error rates, thereby compromising the validity of the conclusions drawn (Field, 2018). A formal normality assessment was therefore conducted on all affective score data before proceeding to hypothesis testing.

CONCLUSION ON NORMALITY ASSESSMENT

Convergent evidence from descriptive statistics, extreme value analysis, formal Kolmogorov-Smirnov and Shapiro-Wilk tests, and Q-Q and box plots collectively establishes that the distribution of affective scores deviates meaningfully from normality. The distribution is characterized by a platykurtic shape, bimodal clustering, and the presence of extremely low and high values, despite being approximately symmetrical. In light of these violations, non-parametric statistical procedures were deemed more appropriate than parametric methods for all subsequent inferential analyses, as non-parametric tests do not assume normality (Field, 2018; Pallant, 2020). This decision ensures the validity and integrity of the hypothesis testing reported in the sections that follow

AFFECTIVE LEARNING OUTCOMES: GAGNÉ'S INSTRUCTIONAL DESIGN VERSUS CONVENTIONAL TEACHING

This section presents an analysis of affective skill development as a learning outcome, comparing Form Two students in Nairobi County taught using Gagné's Nine Events of Instruction with those taught using conventional lecture-based methods, in line with the third objective of the study. Given that affective outcomes — encompassing attitudes, motivation, and values — are shaped by the instructional experience itself rather than pre-existing learner characteristics, a pre-test assessment of affective skills was not conducted. Data were therefore collected exclusively upon completion of the instructional period. The analysis examined whether the structured sequential learning, hierarchical content

design, deliberate attention to learning conditions, and explicit focus on learning outcomes inherent in Gagné's model produced more positive affective responses than conventional lecture-based instruction. Post-instructional affective scores were analyzed to assess students' engagement, attitudinal orientation toward Physics, and emotional responses to the learning experience.

AFFECTIVE SCORE COMPARISONS BY INSTRUCTIONAL METHOD

To test the null hypothesis — *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods* — a Mann-Whitney *U* test was conducted. The Mann-Whitney *U* test is a nonparametric alternative to the independent-samples *t*-test, selected here because the affective scores are nonnormal, as established in the preceding normality assessment (Field, 2018). The test was used to determine whether there was a statistically significant difference in the distribution of affective scores between the two instructional method groups: Gagné's Nine Events of Instruction (Method Type 1) and conventional lecture-based teaching (Method Type 2).

Table 3 presents the Mann-Whitney *U* test results, reporting sample sizes (*n*), mean ranks, and rank sums for each group.

Ranks	Method Type	N	Mean Rank	Sum of Ranks
AffectiveScore	1	65	103.58	6720.00
	2	73	39.33	2871.00
	Total	138		

Table 3: Mann-Whitney Test for Affective Score Performance

Mean ranks serve as the primary descriptive indicator in nonparametric comparisons, with higher mean ranks indicating a tendency toward higher affective scores within that group (Pallant, 2020).

AFFECTIVE LEARNING OUTCOMES ANALYSIS: GAGNÉ'S NINE EVENTS OF INSTRUCTION VERSUS CONVENTIONAL TEACHING

This section presents an analysis of affective skill development as a learning outcome, comparing Form Two students in Nairobi County taught using Gagné's Nine Events of Instruction with those taught using conventional lecture-based methods, in line with the objective of the study.

AFFECTIVE SCORE COMPARISONS BY INSTRUCTIONAL METHOD

To test the null hypothesis — *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods* — a Mann-Whitney *U* test was conducted. The Mann-Whitney *U* test is a nonparametric alternative to the independent-samples *t*-test, selected here because the affective scores are nonnormal, as established in the preceding normality assessment (Field, 2018). The test was used to determine whether there was a statistically significant difference in the distribution of affective scores between the two instructional method groups: Gagné's Nine Events of Instruction (Method Type 1) and conventional lecture-based teaching (Method Type 2).

Table 4 presents the inferential statistics from the Mann-Whitney *U* test.

AffectiveScore	AffectiveScore
Mann-WhitneyU	170.000
WilcoxonW	2871.000
Z	-9.403
Asymp.Sig.(2-tailed)	0.000

Table 4: Mann-Whitney Test Statistics for Affective Score

MANN-WHITNEY U TEST INFERENTIAL STATISTICS AND EFFECT SIZE

The test yielded $U = 170.00$ and a Wilcoxon $W = 2{,}871.00$, the latter consistent with the rank sum for Method Type 2 reported in Table 7. The standardized test statistic was $z = -9.403$, with a two-tailed asymptotic significance of $p < .001$, confirming a statistically significant difference in affective scores between the two instructional method groups. The negative *z*-value indicates that Method Type 2 (conventional lecture-based teaching) was associated with systematically lower affective scores than Method Type 1 (Gagné's Nine Events of Instruction), consistent with the mean rank disparity observed in Table 7. Based on these results, the null hypothesis — *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods* — was rejected.

To assess the practical significance of this finding, the effect size was calculated as $r = |z| / \sqrt{N}$, where $N = 138$. Substituting the obtained values: $r = 9.403 / \sqrt{138} = 9.403 / 11.747 \approx .801$. According to Cohen's (1988) conventions, an effect size of $r = .801$ is classified as very large, substantially exceeding the threshold of .50 designated for large effects. This magnitude indicates that the difference in affective skill development between the two instructional conditions is not only statistically significant but also of considerable practical importance, with the instructional method accounting for a large proportion of the variance in affective scores. In substantive terms, Gagné's Nine Events of Instruction produced markedly superior affective learning outcomes in Physics compared to conventional lecture-based teaching.

KRUSKAL-WALLIS TEST ON AFFECTIVE SCORES BY SCHOOL

To extend the hypothesis test beyond a two-group comparison, affective scores were further analyzed across individual schools using the Kruskal-Wallis test. This additional analysis examined whether students from different schools differed significantly in their affective skill development, providing a more granular assessment of the null

hypothesis: *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods.* The Kruskal-Wallis test was selected as the appropriate non-parametric alternative to one-way ANOVA for comparing distributions across three or more independent groups (Field, 2018).

Table 5 presents the descriptive statistics for affective scores across schools prior to conducting the Kruskal-Wallis test, reporting sample sizes (*n*), means (*M*), standard deviations (*SD*), and minimum and maximum values for each school. These summary statistics provide an overview of the central tendency, variability, and range of affective scores at the school level, establishing the descriptive context for the inferential comparison that follows.

	N	Mean	Std. Deviation	Minimum	Maximum
Affective Score	138	57.20	22.780	13	98
	141	2.23	1.046	1	4

Table 5: Descriptive Statistics for Kruskal-Wallis Test on Affective Scores

The overall mean affective score was 57.20 (*SD* = 22.78), consistent with the descriptive statistics reported in Table 4. The large standard deviation relative to the mean indicates considerable variability in affective skill attainment across participants, reflecting the heterogeneity of affective responses within the sample. The minimum observed score was 13, and the maximum was 98, yielding a range of 85 that spans the majority of the measurement scale and confirms the presence of both very low and very high affective responses identified in the extreme value analysis (Table 5). The mean of 57.20 falls near the midpoint of the observed range (approximately 55.50), indicating a roughly central tendency with no evidence of floor or ceiling effects.

The second variable reported in Table 9 (*n* = 141, *M* = 2.23, *SD* = 1.046, minimum = 1, maximum = 4) represents the school grouping variable, with four discrete values corresponding to the four schools participating in the study. This variable serves as the independent grouping factor in the Kruskal-Wallis test, enabling comparison of affective score distributions across individual schools. The distribution of affective scores across the combined sample — characterized by substantial variability, a wide range, and no extreme skew — confirms the suitability of the data for nonparametric group comparisons using the Kruskal-Wallis test (Field, 2018).

Table 6 shows the mean ranks for each school.

	School number	N	Mean Rank
Affective Score	1	40	107.59
Affective Score	2	49	47.94
Affective Score	3	25	96.66
Affective Score	4	24	21.75
Affective Score	Total	138	

Table 6: Kruskal-Wallis Test on Affective Scores

These results suggest that students from Schools 1 and 3 scored significantly higher in the affective domain, while those from School 4 had the lowest scores.

Table 7 presents the inferential test statistics from the Kruskal-Wallis *H* test comparing the distributions of affective scores across the four participating schools. As established in the normality assessment, the non-normal distribution of affective scores precluded the use of one-way ANOVA, making the Kruskal-Wallis *H* test the appropriate non-parametric alternative for comparing distributions across three or more independent groups (Field, 2018). The test evaluates whether at least one school group differs significantly from the others in its distribution of affective scores, rather than assuming equivalence across all four groups. Table 7 reports the Kruskal-Wallis *H* statistic, degrees of freedom (*df*), and asymptotic significance level (*p*), which together provide the inferential basis for determining whether school-level differences in affective skill development are statistically significant.

	Affective Score
Kruskal-Wallis H	96.502
Df	3
Asymp. Sig.	.000
a. Kruskal-Wallis Test	
b. Grouping Variable: school number	

Table 7: Test Statistics for Affective Scores

The Kruskal-Wallis H test revealed a statistically significant difference in affective scores across the four school groups, H(3) = 96.502, p < .001, indicating that at least one school group differed substantially from the others in affective skill development.

Consequently, the null hypothesis — that no statistically significant difference exists in affective skill development between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods — is rejected at p < .001. These results align with the Mann-Whitney U test findings: U = 170.00, z = -9.403, p < .001, r = .801, and both two-group and school-level comparisons collectively confirm a statistically significant and practically meaningful advantage in affective skill development associated with Gagné's Nine Events of Instruction. Both experimental groups outperformed both control groups.

VI. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

AFFECTIVE SKILL DEVELOPMENT: GAGNÉ'S INSTRUCTION VERSUS CONVENTIONAL TEACHING

The statistical analyses consistently demonstrated that students taught using Gagné's Nine Events of Instruction achieved significantly higher affective scores than those taught using conventional lecture-based methods. The Mann-Whitney *U* test revealed that the experimental group (*n* = 65) had a substantially higher mean rank (103.58) than the control group (*n* = 73; 39.33), *U* = 170.00, *z* = -9.403, *p* < .001, *r* = .801. The very large effect size (*r* = .801) confirms that this difference was not only statistically significant but also of substantial practical importance, indicating that instructional

method accounted for a large proportion of the variance in affective skill development.

The Kruskal-Wallis *H* test further corroborated these findings at the school level, revealing statistically significant differences in affective score distributions across the four participating schools ($H(3) = 96.502$, $p < .001$). Schools assigned to the experimental condition consistently outperformed those in the control condition. Specifically, School 1 ($n = 40$) attained a mean rank of 107.50 and School 3 ($n = 25$) recorded a mean rank of 96.66, while the control schools recorded comparatively lower mean ranks: School 2 ($n = 49$) at 47.94 and School 4 ($n = 24$) at 21.75. The consistency of these school-level findings with the overall two-group comparison strengthens the robustness and generalizability of the conclusions drawn.

Collectively, these findings confirm that Gagné's Nine Events of Instruction enhanced affective skill development more effectively than conventional lecture-based teaching. Students in the experimental group demonstrated measurable improvements in attitudes, motivation, and values toward Physics when instruction was structured around Gagné's (1985) conditions of learning and explicitly aligned with affective learning outcomes. These results underscore the critical importance of deliberate instructional sequencing — encompassing practice, feedback, reinforcement, and congruence with affective learning outcomes — in fostering positive learner dispositions toward Physics. On the basis of this convergent statistical evidence, the null hypothesis — *There is no statistically significant difference in affective skill development as a Physics learning outcome between students taught using Gagné's Nine Events of Instruction and those taught using conventional lecture-based methods* — is conclusively rejected. The evidence strongly supports Gagné's structured instructional framework as a more effective approach than conventional lecture-based methods for cultivating positive attitudes, motivation, and values in secondary school Physics education in Nairobi County.

VII. RECOMMENDATIONS

The findings demonstrate that Gagné's Nine Events of Instruction significantly improved affective skill development — attitudes, motivation, and values — in secondary school Physics compared to conventional lecture-based methods, carrying important implications for policy, practice, and future research.

RECOMMENDATION 1: KENYA NATIONAL EXAMINATIONS COUNCIL

KNEC should revise national examination frameworks to incorporate systematic assessment of affective learning outcomes in Physics. Current structures prioritize cognitive achievement while neglecting the affective domain, inconsistent with both Gagné's (1985) framework and the Kenyan national curriculum. Specifically, KNEC should develop standardized rubrics for assessing affective skills in Physics papers and practicals, pilot-test their integration in selected schools before national rollout, and train examiners to reliably score in the affective domain.

RECOMMENDATION 2: TEACHERS SERVICE COMMISSION

TSC should mandate and fund in-service professional development equipping Physics teachers to implement structured instructional design effectively. Programs should prioritize lesson design that incorporates practice, feedback, and reinforcement aligned with affective objectives, the application of Gagné's Nine Events as a pedagogical sequence, and the integration of affective alongside cognitive assessment. A cascade training model — from master trainers to school-based mentors to all Physics teachers — is recommended as a cost-effective and sustainable strategy.

RECOMMENDATION 3: TEACHER TRAINING COLLEGES

Pre-service teacher education programs should redesign Physics pedagogy courses to explicitly address the affective domain. Gagné's (1985) conditions of learning should be embedded in the curricula for the Bachelor of Education and the Diploma in Education. Student teachers should develop lesson plans targeting specific affective outcomes — curiosity, persistence, and collaborative values — and reflect on affective development during teaching practice. Continuous assessment tools, including observation rubrics and portfolio guidelines, should include explicit indicators of affective instructional competence.

RECOMMENDATION 4: FUTURE RESEARCH

Several important gaps remain for future investigation. Longitudinal studies should examine whether affective gains from Gagné's model persist beyond a single term. Replication across other science disciplines and educational levels would assess generalizability. Qualitative investigations incorporating classroom observations and teacher interviews would illuminate which specific elements of Gagné's sequence contribute most to affective change. Comparative studies examining Gagné's model alongside other evidence-based frameworks would further identify best practices for developing affective skills in STEM education.

REFERENCES

[1] Afjar, A. M., Musri, & Syukri, M. (2019). The implementation of the ARCS learning model to improve students' learning activities and outcomes in a vocational high school. Journal of Physics: Conference Series, 1460(1), 012119. https://doi.org/10.1088/1742-6596/1460/1/012119

[2] Akpokinioro, S. R., Igwe, K. O., Umejiaku, C. C., & Adeniyi, A. (2022). Effect of Gagné's learning hierarchy on students' achievement in physics. Journal of Science Education and Technology, 31(4), 512–524. https://doi.org/10.1007/s10956-022-09975-w

[3] Angell, C., Williams, A., Thompson, J., & Mitchell, P. (2004). The relevance of science education: Students' views and attitudes. Studies in Science Education, 40(1), 109–144. https://doi.org/10.1080/03057260408560206
[4] Babbie, E. (2021). The practice of social research (14th ed.). Cengage Learning.
[5] Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191
[6] Bloom, B. S. (1956). Taxonomy of educational objectives: Handbook I. Cognitive domain. McKay.
[7] Brogg, D. W. (1979). Applying the conditions of learning. Educational Technology, 19(5), 24–30.
[8] Bryman, A. (2016). Social research methods (5th ed.). Oxford University Press.
[9] Bybee, R. W. (2014). NGSS and the next generation of science teachers. Journal of Science Teacher Education, 25(2), 211–221. https://doi.org/10.1007/s10972-014-9381-4
[10] Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.
[11] Czerniewicz, L., & Brown, C. (2014). The habitus of digital strangers in higher education. British Journal of Educational Technology, 45(1), 44–53. https://doi.org/10.1111/bjet.12072
[12] Dresel, M., & Hall, N. C. (2013). Motivation. In N. C. Hall & T. Götz (Eds.), Emotion, motivation, and self-regulation: A handbook for teachers (pp. 57–122). Emerald Group Publishing.
[13] Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). SAGE Publications.
[14] Fleetwood, D. (2023). Stratified sampling: Definition, method, and examples. QuestionPro. https://www.questionpro.com/blog/stratified-sampling/
[15] Gagné, R. M. (1985). The conditions of learning and theory of instruction (4th ed.). Holt, Rinehart & Winston.
[16] Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design (4th ed.). Harcourt Brace Jovanovich.
[17] Gagné, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). Principles of instructional design (5th ed.). Thomson Wadsworth.
[18] Julius, O., Ogenna, U., & Chukwuemeka, A. (2012). Relationship between teachers' qualifications and students' academic performance in physics in Nigerian secondary schools. African Research Review, 6(4), 67–78. https://doi.org/10.4314/afrrev.v6i4.6
[19] Keppel, G. (1991). Design and analysis: A researcher's handbook (3rd ed.). Prentice-Hall.
[20] Kenya National Examinations Council. (2019). KCSE 2019 examination report. KNEC.
[21] Kibaara, T. M. (2014). Challenges facing physics teaching and learning in secondary schools: A case study of Kirinyaga County, Kenya [Unpublished master's thesis]. Kenyatta University.
[22] Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). Taxonomy of educational objectives: The classification of educational goals. Handbook II: Affective domain. David McKay.
[23] Laminack, L. L., & Long, T. A. (1985). Instructional design and the teaching of physics. Journal of Physics Teacher Education, 3(2), 33–38.
[24] Mamuda, M., & Peni, S. A. (2022). Relationship between self-confidence and academic achievement in physics. Journal of Educational Research and Practice, 12(4), 123–135. https://doi.org/10.5590/JERAP.2022.12.4.09
[25] Martinko, S., & Talalovic Vorkapic, S. (2017). Attitudes developed by learners in physics class as predictors of success in other learning outcomes. International Journal of Science Education, 39(12), 1625–1643. https://doi.org/10.1080/09500693.2017.1340945
[26] Mayer, R. E. (1998). Cognitive, metacognitive, and motivational aspects of problem solving. Instructional Science, 26(1–2), 49–63. https://doi.org/10.1023/A:1003088013286
[27] Michel, O., Igwe, L., Kupoluyi, A., & Ondari, P. (2007). Factors affecting students' academic performance in secondary schools in Africa. Journal of Education and Practice, 3(12), 1–10.
[28] Muijs, D. (2020). Doing quantitative research in education with SPSS (2nd ed.). SAGE Publications.
[29] National Research Council. (2012). A framework for K–12 science education: Practices, crosscutting concepts, and core ideas. The National Academies Press. https://doi.org/10.17226/13165
[30] Neuman, W. L. (2014). Social research methods: Qualitative and quantitative approaches (7th ed.). Pearson Education.
[31] Okeke, U. K., Ramaila, S., & Ukoh, E. E. (2023). Students' attitudes toward learning in physics education: The role of cognitively guided instructional strategies. Journal of Physics Education, 58(6), 1102–1118. https://doi.org/10.1088/1361-6552/acf321
[32] Olusola, O. O., & Rotimi, C. O. (2012). Attitudes of students towards the study of physics in the College of Education, Ikere, Ekiti State, Nigeria. American International Journal of Contemporary Research, 2(12), 86–89.
[33] Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (7th ed.). McGraw-Hill Education.
[34] Rijal, S., & Bachtiar, R. (2015). The effect of Gagné's instructional design model on students' learning outcomes in physics. Journal of Science and Mathematics Education, 1(1), 1–8.
[35] Sahlberg, P. (2015). Finnish lessons 2.0: What can the world learn from educational change in Finland? (2nd ed.). Teachers College Press.
[36] SMASE. (2013). Strengthening mathematics and science education in East and Central Africa: Final evaluation report. SMASE–WECSA.
[37] Tan, O. S., Chye, S., & Lim, C. (2017). Problem-based learning and creativity: A review of the literature. In O. S. Tan (Ed.), Problem-based learning innovation: Using problems to power learning in the 21st century (pp. 22–38). Cengage Learning Asia.

ISSN: 2394-4404

[38] U.S. Department of Education. (2018). STEM 2026: A vision for innovation in STEM education. Office of Innovation and Improvement.
[39] Veloo, R., Nor, M. R. M., & Khalid, F. (2015). Positive attitude towards physics learning and its impact on learning effectiveness. Journal of Educational Research and Practice, 22(2), 145–160.
[40] Wen, H., Yang, P., & Zhou, J. (2019). Effective instruction in the affective domain: Fostering learner reflection and creativity. Journal of Educational Psychology and Instructional Design, 14(2), 88–101. https://doi.org/10.1080/00220671.2019.1582704