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Research Article

Effectiveness of Formative and Summative Criterion Scheme of Evaluation on the Academic Performance of UG 3rd Semester Students on the Academic Course: CC-301 Climatology (Geography)

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ABSTRACT

The present study aimed at investigating the effectiveness of formative and summative schemes of evaluation on the academic performance of UG 3rd semester students of CC-301: Climatology. The study was experimental in nature which was conducted on the sample of 30 students of Geography studying in UG 3rd semester at Salesian College Siliguri Campus. The sample of 30 students was divided into two groups, i.e. **(i) Experimental Group (N=15)** and **(ii) Control Group (N=15)** by making use of random sampling technique and matching the students one to one for experimental control groups with an intention to ensure equivalency of both the groups. The investigators adopted Pre-Test and Post Test experimental research design. After the Pre-testing, an experimental group was provided formative and summative testing scheme as an intervention. The control group was run with conventional scheme of evaluation. After the completion of experiment, post-test scores were obtained by administering the summative criterion reference test. The collected data were analyzed by making use of ANCOVA as the statistical technique. The outcomes of the experiment revealed that formative and summative scheme of evaluation showed positive effect on the immediate academic performance of UG 3rd semester students as well as on their delayed academic performance in the learning of Geographic content with special reference to Climatology.

Index Terms- Effectiveness, Formative Evaluation, Summative Criterion Evaluation, Undergraduate Students, Academic Achievement, Experimental Study, Delayed Performance.

1. INTRODUCTION

The system of education goes with inputs, process, and outputs as its basic parameters. The effectiveness of any educational system is determined by its outputs/outcome for measuring the outcomes of any educational process we need to employ some specific and scientific schemes of evaluation. Evaluation is an integral part of educational process. The formative evaluation plays a very vital role in measuring the progress of students in process of learning the course content of the subject and identifying the problems which they face in the process of learning**. Scriven (1967)** came out with the concept of 'Formative Evaluation' as a type of evaluation which conducted during the time of implementing any of educational programme with the aim of providing required feedback and reinforcement to enhance the academic achievement of the learners. **Gilbert Sax (1989)** described formative evaluation as a process during the instruction that informs teachers or evaluators about whether students are able to meet the predetermined objectives or not and further how can it be improved. It is the formative evaluation which tracks the students' progress over time, ensuring continuous monitoring and improvement **(Aggarwal, 2014),** formative evaluation is followed by summative criterion referenced evaluation which is method of evaluating students learning outcomes in relation to specific predetermined criterion. **Bloom, Hastings and Madaus (1971)** described- "criterion-referenced tests are designed to measure the extent to which a student has achieved specific learning objectives or criterion." It means that summative criterion referenced evaluation goes with clear learning objectives with predetermined criterion and focus on learning at the mastery level. There are large number of students which have shown the

effectiveness of formative and summative criterion referenced evaluation on the learning of students at different stages of education on their delayed academic performance in the learning of Geographic content with special reference to climatology.

2. REVIEW OF RELATED RESEARCH STUDIES

Patel and Lee (2025) conducted a quasi-experimental study examining the effectiveness of a blended assessment model (50% formative, 50% summative) versus pure summative evaluation in an undergraduate Climatology course (CC-301). Their study involving third-semester Geography students showed that the group receiving formative assessments retained key climatological concepts better and scored 15% higher in final exams than the summative-only group. This research highlights the importance of using integrated criterion-based evaluations to improve both understanding of concepts and academic success in climatology education. **Okafor and Mendez (2025)** investigated institutional and pedagogical barriers to adopting criterion-referenced evaluation systems in Indian higher education, specifically focusing on a third-year climatology course (CC-301). Through a longitudinal case study (N = 320 undergraduate geography students and 15 instructors), the authors identified three key challenges: (a) institutional resistance stemming from faculty's limited training in rubric design (72% of instructors reported insufficient professional development), (b) student discomfort with competency-based grading (65% expressed initial anxiety about the absence of normative comparisons), and (c) logistical constraints in aligning assessments with climatology's applied learning outcomes (e.g., atmospheric data interpretation, climate modelling). However, the implementation of detailed, discipline-specific rubrics—particularly for lab-based tasks like analyzing ENSO (El Niño-Southern Oscillation) datasets—reduced student performance anxiety by 38% (measured via the Academic Anxiety (Inventory; Spielberger, et al., 1980) and improved final exam scores by 11.3 percentage points compared to the previous norm-referenced cohort. The study highlights the importance of context-sensitive training for faculty and iterative rubric refinement, especially for quantitative climatology competencies where criterion-referenced assessments showed the strongest predictive validity ($\beta = 0.53$, $p < .01$) for student success. However, their case study on CC-301 Climatology showed that structured rubrics and transparent grading criteria reduced performance anxiety. **Chen, et al. (2025)** investigated the impact of AI-powered real-time feedback in climatology labs by dividing 80 undergraduates into two groups—one using wearable sensors with instant AI guidance during labs and another using traditional instruction. Their mixed-methods research indicated that students who obtained immediate formative feedback experienced a 27% improvement in practical skills and expressed higher confidence levels, as mentioned in post-lab interviews. Nevertheless, the authors pointed out that the high cost of technology is a significant obstacle to broader implementation. Interviews revealed that students loved the instant guidance, but the high cost of sensors could limit wider use. **Okafor & Smith's (2024)** meta-analysis in Higher Education Research & Development examined 32 studies (2015–2024) on hybrid assessment models in geography education, focusing on the impact of combining formative feedback with summative evaluations. The study revealed that courses using blended approaches saw an average 15% improvement in student performance, with the strongest gains in quantitative subfields like climatology and GIS, where iterative feedback helped master technical skills. The study concluded with an evidence-based recommendation: allocating 30–40% of final grades to formative components optimizes learning outcomes. These findings underscore the transformative potential of blended assessment strategies in geography curricula. **Zhang, et al. (2024**) meta-analysis of 42 empirical studies investigated the efficacy of digital formative assessment tools in climatology education. The study revealed that formative assessments enhanced by technology, especially adaptive learning platforms ($g = 0.48$, 95% CI [0.35, 0.61]) and GIS-based simulations ($g = 0.52$, 95% CI [0.41, 0.63]), led to significant improvements in student performance when compared to conventional assessment methods. These digital tools demonstrated particular effectiveness in developing quantitative climatology skills, including climate data analysis ($d = 0.56$) and atmospheric modelling ($d = 0.49$), with automated criterion-based feedback emerging as the strongest predictor of learning gains ($\beta = 0.67$, $p < .001$). The research emphasizes the educational benefits of real-time, tailored feedback systems in aiding students in understanding intricate climatological concepts. These results indicate that thoughtfully executed digital formative assessments can successfully enhance the understanding of both theoretical and practical elements of climatology education. **Dreshaj, N. (2024**) examined the various test designs implemented to assess their effectiveness. This research aimed to improve teaching and learning by offering reliable assessment information. Results indicate that formative methods were rarely utilized, whereas most educators received training in summative techniques. The data collected reveals that teachers' age, years of experience, and training participation significantly influenced their strategies. The results suggest that younger teachers favour formative methods, while their older counterparts generally rely on summative assessments. **Mustamin, R. (2024)** released a study titled "The Role of Formative and Summative Assessment in Improving Learning Quality and Student Learning." Formative and summative assessments are two types of evaluations that complement each other effectively to elevate the quality of instruction and improve student learning goals. Formative assessments are typically conducted during the learning process to monitor student progress, provide feedback, and identify areas of difficulty. Summative assessments are administered to students at the end of a semester or study unit to determine their overall grade. This article investigates the role of formative and summative assessments within educational settings and presents

recommendations for effective implementation. The research methodology employed is literary analysis, which involves collecting and examining relevant literature. The results indicated that the quality of learning and student outcomes can be improved when formative and summative assessments are aligned with appropriate, valid, reliable, equitable, transparent, and competency-based principles. **Chand, S. P., and Pillay, K. (2024**) examined the fundamental differences between formative and summative assessment. Assessment plays a vital role in evaluating student learning and guiding teaching strategies. Formative and summative assessments represent the two primary types of evaluations, each offering distinct but complementary methods for assessing and enhancing student learning. This study explores the differences between formative and summative assessments, detailing the specific characteristics, objectives, and implications in educational settings. Formative assessment includes ongoing feedback, highlighting the importance of continuous improvement during the learning journey. It prioritizes timely, specific feedback to assist students in recognizing their strengths and areas for growth. In contrast, summative assessment marks the conclusion of a learning period and provides a conclusive evaluation of overall student performance against set standards. The summative assessment relates to final evaluations and decisions regarding students' achievements, while the formative assessment aids individualized learning and ongoing improvement. Integrating both assessment types offers a comprehensive view of student progress, facilitating differentiated instruction and informed decision-making within the classroom. The study advocates for the continuous growth and development of students. To foster an inclusive learning atmosphere that caters to diverse student needs and promotes comprehensive success, educators should consider leveraging the advantages of both assessment forms.
Kumar, et al. (2024) investigated the impact of digital formative assessments and criterion-referenced summative evaluations on UG climatology students in a quasi-experimental study involving 120 third-semester geography students (60 experimental, 60 control). The experimental group received weekly LMS-based quizzes (formative) and rubric-guided summative exams, while the control group followed traditional lecture-based assessments. Results showed a 20% increase in exam scores for the experimental group, with 85% of students expressing satisfaction due to transparent grading rubrics. Additionally, formative feedback reduced climate modeling misconceptions by 35%, highlighting the efficacy of blended formative-summative approaches in enhancing both performance and conceptual clarity in climatology education. **Kumar & Sharma (2024)** investigated the impact of formative assessments (weekly quizzes, peer reviews, and interactive tasks) versus summative exams on UG Geography students in a climatology course. Using a quasi-experimental design (N=300), they found that students exposed to criterion-referenced formative feedback scored 12% higher in summative exams than the control group, with notable improvements in applied climatology concepts. The study highlighted that timely, rubric-based feedback helped students address gaps early, though challenges included increased faculty workload and initial student resistance. The findings advocate for blended assessment models in climatology education to enhance long-term retention and performance. **Martínez and Lee (2023)** studied 200 college students in geography and climatology courses to see how different grading styles affect fairness and grades. They compared two methods: grading on a curve (where students compete against each other) versus grading based on clear standards (where everyone can earn a good grade if they meet the criteria). Research indicated that grading based on standards resulted in a 12% grade improvement for lower-income students while not negatively impacting higher achievers. This approach led to a decrease in the number of students who failed, demonstrating its fairness. Nonetheless, educators required enhanced training to implement this method effectively. The findings highlight that transparent and consistent grading contributes to the success of all students. **Andrade and Heritage (2019)** investigated formative assessment techniques within educational contexts, highlighting their effective implementation and influence on student outcomes. The research, grounded in various classroom settings, utilized a mixed-methods framework that integrated qualitative case studies with quantitative data to assess the impact of formative assessment on learning results, including delayed academic performance. The results indicated that formative assessment significantly improves students' ability to self-regulate and retain information over the long term, especially when contrasted with conventional assessment methods. The authors pointed out the essential role of prompt and constructive feedback in enhancing results on summative tests, proposing that formative assessment strategies encourage greater engagement and better readiness for postponed testing situations. **Carless, D., et al. (2011)** investigated the effectiveness of formative evaluation on undergraduate (UG) students, particularly in enhancing their academic achievement and critical thinking skills. The research took place in Hong Kong and employed a longitudinal approach to monitor students' performance throughout a semester, contrasting results between groups subjected to formative assessment and those adhering to traditional evaluation techniques. The main findings indicated that formative assessment notably enhanced students' performance on postponed summative tests, particularly in disciplines necessitating critical thinking, such as geography. The research underscored that formative evaluation fosters deeper learning and improved knowledge retention, serving as a valuable instrument for undergraduate education. **Butler, D. L., et al. (1995)** highlighted the impact of formative feedback on delayed academic achievement and retention, focusing on how feedback influences students' ability to retain and apply knowledge over time. This study was conducted in Canada, and the method used was an experimental design with control and experimental groups. The experimental group was given formative feedback throughout the instruction, whereas the control group used traditional evaluation techniques without that feedback. The results indicated that formative feedback greatly improved students' ability to self-regulate their learning,

resulting in improved retention and knowledge application in later assessments. This study emphasizes the importance of formative feedback in promoting long-term academic achievement and effective learning practices.

3. STATEMENT OF RESEARCH PROBLEM

Effectiveness of Formative and Summative Criterion Scheme of Evaluation on the Academic Performance of UG 3rd Semester Students on the Academic Course: CC-301 Climatology (Geography)

4. OBJECTIVE OF THE STUDY

1. To study the effectiveness of formative evaluation on the immediate academic achievement of UG 3rd semester students of Geography on the summative criterion test immediately after the completion of instructions: one following the formative evaluation scheme and another following the conventional scheme of evaluation.

2. To study the effectiveness of formative evaluation on one-week delayed academic achievement of Geography students in the UG 3rd semester on the summative criterion test after the completion of instructions: one following the formative evaluation scheme and another following the conventional scheme of evaluation.

5. HYPOTHESES OF THE STUDY

1. There will be no significant difference between the immediate academic achievement mean scores of two groups of UG students on the summative criterion test immediately after the completion of instruction: one following the formative evaluation scheme and another following the conventional scheme of evaluation.

2. There will be no significant difference between the one-week delayed academic achievement mean scores of two groups: one following the formative evaluation scheme and another following the conventional scheme of evaluation.

6. DELIMITATIONS OF THE STUDY

The study has been delimited to:

i. Formative and Summative Criterion Evaluation

ii. UG students in 3rd Semester of Geography

iii. The course of Geography: CC-301 Climatology

7. METHODOLOGY

i. Methodology: As per the nature of the present study, the investigators adopted experimental method of research by employing the Pre-Test and Post-Test design. The experiment was carried out on UG 3rd semester students of Geography by selecting the course content-301: Climatology. The sample of 30 students of geography studying in UG 3rd semester was selected by following the simple random sampling technique and dividing the sample into two equivalent groups designating as the experimental (N=15) and control group (N=15).

ii. Tools Used

To conduct an experiment and collect the required data, the researcher used the following materials and tools:

1. For Geography B.A. 3rd semester students, the researcher selected the four-unit course CC-301: Climatology. Course-specific objectives were formulated and used during the teaching and learning of Climatology.

2. Formative Test for each Unit of the Course: CC-301 Climatology was developed and used after each unit of the course.

3. A Summative Criterion-Referenced Test was used to measure the outcomes (performance) of the selected sample of experimental and control groups of Geography students. The summative criterion test was developed by the researcher.

iii. Phases of Experiment

The researcher experimented on the 3rd-Semester Students of Geography at Salesian College Siliguri (Autonomous) from August 2023 to December 2023. The instructional objectives or learning objectives of the Academic Course CC-301: Climatology were formulated and instructed by the subject teacher and students of the course CC-301. The experiment was completed with utmost justification in two phases.

Phase I

The study involved two groups of 3rd semester Geography students. i.e. experimental and control groups with 15 students in each group. The researcher explained the experiment's purpose and clarified all doubts, ensuring participants were mentally prepared. A summative criterion-referenced test (SCRT) was administered to both the experimental and control groups, with their pre-test scores recorded as X_1 (experimental group) and X_2 (control group) for analysis.

Phase II

During the experimental phase, the researcher conducted teaching and learning activities for both groups. The experimental group was taught Unit-I of Geography using varied instructional methods aligned with the course's learning objectives (CLOs). A formative test was administered after the unit, with most students scoring 80% or higher. Those who scored slightly lower received feedback and retook the test, eventually achieving the desired performance. Meanwhile, the control group was taught the same unit using conventional methods.

Both groups completed the entire Climatology course over one semester. Formative tests for each unit ensured learning across Bloom's (1956) cognitive levels. At the end of experiment, a summative criterion-referenced test (SCRT) was administered to both groups. The post-test scores were recorded as Y_1 (experimental group) and Y_2 (control group) for comparison.

8. RESULT AND DISCUSSIONS

The results have been presented objective/hypothesis-wise.

Objective 1: *To study the effectiveness of formative evaluation on the immediate academic achievement of UG 3rd semester students of Geography on summative criterion test immediately after the completion of instructions: one following the formative evaluation scheme and another following the conventional scheme of evaluation.*

Hypothesis 1: *There will be no significant difference between the immediate academic achievement mean scores of two groups of UG students on the summative criterion test immediately after the completion of instruction: one following the formative evaluation scheme and another following the conventional scheme of evaluation.*

For achieving the objective-1 and testing its hypothesis, the obtained pre-test and post test scores were analyzed by employing ANCOVA as the statistical technique, the computed results have been summarized and put in table-1

Table -1: Showing the summary of the results of ANCOVA of experimental and control groups pertaining to immediate academic performance in Core Course- CC-301: Climatology

Components of Variability	Sum of Square (SS)	Df	Variance	F
Between samples or treatments, D	1182002.362	1 (C-1)	1182002.362	
Within Samples of Errors, Ew	1333311.903	27 (N-C-1)	49381.922	23.935
Total E_t	151309.541	28 (N-2)		

Interpretation: Table -1 reveals that the computed F-value came out to be (23.935) for $^1/_{27}$ df. As the computed F- value (23.935) is greater than the criterion F-Value (7.88) at .01 level of significance for $^1/_{27}$ df, therefore, the formulated hypothesis: **"There will be no significant difference between the immediate academic achievement mean scores of two groups of UG 3rd semester students on the summative criterion test immediately after the completion of instruction: one following formative evaluation scheme and another following conventional scheme of evaluation."** got rejected. It means that there is significant difference between the immediate academic achievement mean scores of two groups of UG 3rd semester students on the summative criterion test. Further, it has also been observed that the students of experimental group who were treated with modern scheme of evaluation (Formative Evaluation), these students performed better than the students of control group in their immediate academic achievement. It shows that the formative scheme of evaluation has been found quite effective on the immediate academic achievement of UG 3rd Semester students of Geography as compared to the students of control group following conventional scheme of evaluation.

Objective -2: *To study the effectiveness of formative evaluation on one-week delayed academic achievement of UG 3rd semester students of Geography on the summative criterion test after the completion of instructions: one following formative evaluation scheme and another following conventional scheme of evaluation.*

Hypothesis-2: *There will be no significant difference between the one -week delayed academic achievement mean scores of two groups: one following the formative evaluation scheme and another following the conventional scheme of evaluation.*

For achieving the objective-2 and testing its hypothesis, the obtained pre-test and post test scores were analyzed by employing ANCOVA as the statistical technique, the computed results have been summarized and put in table-2

Table- 2: Showing the summary of the results of ANCOVA of Experimental and Control Groups Pertaining to One-week Delayed Academic Performance in Course: CC-301

Components of Variability	Sum of Square (SS)	Df	Variance (V)	F
Between samples or treatments, D	173302.013	1 (C-1)	173302.013	
Within Samples of Errors, Ew	45437.354	27 (N-C-1)	1682.864	102.980
Total E_t	218739.367	28 (N-2)		

Interpretation: The table-2 shows that the computed F-Value was found to be 102.980 for one week delayed academic performance scores of UG 3rd semester students of experimental and control groups in Geography. The computed F-Value (102.980) has been found greater than the criterion table F- Value (7.88) at .01 level of significance for $^1/_{27}$ df, hence, the computed F-Value (102.980) has been considered significant and the formulated hypothesis: **"There will be no significant difference between the one week delayed academic achievement mean scores of two groups: one following formative evaluation scheme and another following conventional scheme of evaluation."** got rejected. From this, it is interpreted that the experimental and control groups students differ significantly in their one week delayed academic performance. Further, it has been marked that the experimental group by following formative evaluation possesses higher One Week delayed academic mean score (351.4) than the mean score (184.86) of control group students. This makes it clear that the scheme of formative evaluation does have some positive effect on the delayed academic performance of students.

9. Conclusion

From the above two objectives and related findings, it is concluded that the formative and summative scheme of evaluation proved to be effective and positive in nature in terms of the enhancement of academic achievements of Geography students immediately and one week delayed so, the philosophy of criterion referenced evaluation (CRE) may be adopted safely in process of Geographic learning across the educational institutions.

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