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TRANSFORMING UNDERGRADUATE ZOOLOGY EDUCATION UNDER NEP 2020: CURRICULUM REFORM, EXPERIENTIAL LEARNING, RESEARCH SKILLS AND EMPLOYABILITY IN INDIA

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ABSTRACT

The National Education Policy (NEP) 2020 represents a major reorientation of Indian higher education from predominantly discipline-centred and examination-oriented models toward flexible, multidisciplinary, experiential and outcome-oriented learning. Zoology is particularly well placed to benefit from this transition because its knowledge base intersects with biodiversity, ecology, fisheries, wildlife management, biotechnology, environmental health, animal resources and community-based conservation. This paper examines the implications of NEP 2020 for undergraduate Zoology education in India through a qualitative policy and curriculum analysis. The analysis considers the National Education Policy 2020, University Grants Commission (UGC) frameworks on undergraduate curricula, learning outcomes, internships, research development, environmental education, Indian Knowledge Systems and multidisciplinary higher education, together with relevant literature on active learning and science education. The paper identifies six interconnected areas of transformation: flexible curriculum architecture, outcome-based learning, practical and field-based education, undergraduate research, digital and interdisciplinary competence, and employability-oriented skill development. It argues that curriculum revision alone is insufficient. Effective implementation requires alignment among learning outcomes, pedagogy, laboratory and field infrastructure, assessment, faculty development, research opportunities and institutional partnerships. A NEP-Zoology Integrated Education Framework is proposed to connect disciplinary knowledge with practical competence, field investigation, research capability, environmental responsibility and career readiness. The

paper concludes that NEP 2020 can strengthen undergraduate Zoology as an applied and research-oriented life science, provided institutions move beyond nominal syllabus restructuring and develop coherent systems for experiential learning, authentic assessment and locally relevant biological research.

KEYWORDS: NEP 2020; Zoology education; undergraduate education; multidisciplinary learning; experiential learning; research skills; biodiversity; employability; Indian higher education; outcome-based education.

1. INTRODUCTION

The National Education Policy 2020 places higher education at the centre of India's transition toward a knowledge-based, equitable and innovation-oriented society. It calls for multidisciplinary institutions, flexible undergraduate programmes, curricular renewal, improved pedagogy, research opportunities, internships, environmental education and stronger links between education and society (Ministry of Education, 2020). The University Grants Commission subsequently developed implementation frameworks intended to translate these principles into institutional practice, including the Curriculum and Credit Framework for Undergraduate Programmes (CCFUP), learning-outcomes approaches, internship guidance, research development cells and frameworks for multidisciplinary higher education (UGC, 2022, 2023a, 2023b).

For Zoology, these reforms are more than an administrative restructuring of course credits. Contemporary zoological science increasingly operates across disciplinary boundaries. Questions concerning biodiversity loss, climate change, emerging diseases, aquatic pollution, food security, animal resources, wildlife conservation and ecosystem degradation require knowledge that combines organismal biology with ecology, chemistry, statistics, molecular methods, geospatial tools and social engagement. Undergraduate education must therefore prepare students to observe biological systems, formulate questions, collect and analyse evidence, communicate findings and apply knowledge to real-world problems.

Traditional undergraduate Zoology programmes have often been organised around a sequence of theoretical units and specimen-based practical exercises. Such approaches remain valuable for establishing foundational knowledge, but they can be strengthened through field investigation, project work, digital resources, quantitative analysis, research internships and interdisciplinary electives. Active-learning research in science education has consistently shown that structured engagement, problem solving and feedback can improve

learning compared with passive lecture-only approaches (Freeman et al., 2014; Prince, 2004). These findings support the pedagogical direction of NEP 2020, although their implementation in Zoology must remain sensitive to local institutional capacity and disciplinary requirements.

2. Rationale and Scope of the Study

The present paper addresses a specific gap in policy discussion: the implications of NEP 2020 when translated into the practical requirements of undergraduate Zoology. General discussions of higher-education reform can overlook discipline-specific issues such as specimen identification, microscopy, field sampling, animal ethics, biodiversity documentation, ecological statistics and laboratory safety. A Zoology-focused analysis is therefore useful for departments designing curricula, practical courses, internships and undergraduate research pathways.

The paper is a qualitative policy and curriculum analysis rather than a student-survey study. It does not claim experimental effects of NEP implementation or introduce fabricated institutional data. Instead, it synthesises official policy documents and established educational literature and uses these sources to develop a discipline-specific framework for implementation.

3. Objectives

To examine the major NEP 2020 provisions that are directly relevant to undergraduate Zoology education.

To analyse how flexibility, multidisciplinary learning and outcome-based education can be translated into Zoology curricula.

To examine the roles of practical work, field studies, internships and undergraduate research in strengthening Zoology learning.

To assess opportunities for integrating environmental education, Indian Knowledge Systems and digital competencies into Zoology programmes.

To identify implementation challenges and propose an integrated framework for improving employability and research readiness.

4. METHODOLOGY

A qualitative document-analysis approach was used. Primary policy sources included the National Education Policy 2020 issued by the Ministry of Education and UGC documents relating to the Curriculum and Credit Framework for Undergraduate Programmes, learning outcomes, multidisciplinary institutions, internships and research development. UGC

guidance on Indian Knowledge Systems and undergraduate environmental education was also considered. Secondary literature was used to interpret educational principles relevant to active learning, experiential learning and science education.

Documents were examined thematically under six analytical categories: curriculum flexibility and multidisciplinarity; learning outcomes and assessment; practical and field-based learning; research and internships; environmental and Indian Knowledge System dimensions; and employability and digital competence. The resulting synthesis was used to construct a proposed NEP-Zoology Integrated Education Framework. Because the study is documentary, the proposed framework should be treated as an analytical model for curriculum development rather than as a tested causal model.

5. NEP 2020: Implications for Undergraduate Zoology

5.1 Multidisciplinary and flexible curriculum

NEP 2020 explicitly promotes multidisciplinary undergraduate education and greater curricular flexibility. It envisages a system in which students can combine disciplinary study with subjects and experiences beyond a narrow major, while the preferred four-year bachelor's pathway provides additional space for major-minor combinations, multidisciplinary learning and research (Ministry of Education, 2020). The UGC's CCFUP translates this orientation into a student-centric credit structure with flexible choices, multidisciplinary components and multiple entry and exit options (UGC, 2022).

For Zoology, flexibility should not mean simply adding unrelated courses. It should create coherent combinations that reinforce biological problem solving. Zoology can be linked with Botany and Environmental Science for ecosystem studies; Chemistry and Biochemistry for toxicology and physiology; Biotechnology and Microbiology for molecular and applied biology; Statistics and Data Science for ecological inference; Geography and GIS for habitat analysis; Agriculture and Fisheries for animal-resource management; and Computer Science for biodiversity databases and bioinformatics. Such combinations reflect the multidisciplinary character of contemporary biological research.

5.2 Outcome-based education

The learning-outcomes approach shifts attention from what teachers cover to what learners can demonstrate. The UGC's Learning Outcomes-Based Curriculum Framework places emphasis on graduate attributes, programme learning outcomes and course learning outcomes (UGC, 2019). For Zoology, outcomes should therefore include not only conceptual

understanding but also observation, identification, experimentation, data handling, scientific reasoning, communication and ethical practice.

A well-designed Zoology programme could specify outcomes at several levels. At the knowledge level, students should understand animal diversity, structure, function, evolution, ecology, genetics and applied zoology. At the practical level, they should demonstrate competence in microscopy, specimen handling, laboratory measurements, field sampling and biological documentation. At the analytical level, they should interpret data using appropriate descriptive and inferential methods. At the professional level, they should communicate results, work collaboratively, follow laboratory and field safety procedures and recognise ethical responsibilities toward animals and biodiversity.

5.3 Practical and experiential learning

Practical education is fundamental to Zoology because many concepts cannot be adequately understood through text alone. NEP 2020 emphasises experiential, discussion-based and research-oriented learning, while its higher-education provisions encourage internships and research internships as ways of connecting academic learning with practical experience (Ministry of Education, 2020).

A modern Zoology practical programme should move progressively from guided observation toward authentic investigation. Early practicals may establish microscopy, identification and measurement skills. Later activities can involve ecological sampling, biodiversity inventories, water-quality assessment, morphometric analysis, animal behaviour, histological interpretation, population estimation and data analysis. Field exercises can use accessible local habitats such as ponds, reservoirs, agricultural landscapes, wetlands and urban green spaces. This model makes the curriculum locally relevant while generating opportunities for student-led inquiry.

Active learning is especially appropriate for this transition. A meta-analysis of undergraduate STEM teaching found that active learning improves student performance and reduces failure compared with traditional lecture-centred approaches (Freeman et al., 2014). Prince (2004) similarly highlighted the value of active, collaborative and problem-based approaches. These findings do not imply that lectures should disappear; rather, lectures should be integrated with activities that require students to interpret, apply and produce knowledge.

5.4 Field-based Zoology education

Fieldwork provides a direct bridge between biological theory and natural systems. Biodiversity surveys, bird counts, butterfly inventories, fish sampling, plankton analysis, insect documentation and habitat assessments can develop observation and sampling skills

while encouraging environmental responsibility. Field-based learning also provides opportunities to introduce concepts such as sampling effort, replication, seasonal variation, habitat heterogeneity and species richness in an authentic context.

The field component should be designed with scientific rigour. Students should receive training in sampling design, field notes, georeferencing, specimen or photographic documentation, identification keys, data quality and ethical considerations. Where collection is inappropriate or prohibited, non-invasive observation and photographic documentation should be prioritised. This is particularly important in wildlife and conservation studies.

5.5 Undergraduate research and research internships

NEP 2020 identifies research and innovation as central to higher-education transformation and calls for stronger research opportunities for students. It also links undergraduate education with research internships and practical engagement (Ministry of Education, 2020). The UGC's establishment of Research Development Cells further reinforces the objective of building research cultures within higher-education institutions (UGC, 2023c).

Zoology departments can introduce a staged research pathway. Students may begin with literature searching and scientific observation, progress to guided field or laboratory projects, and ultimately undertake independent projects requiring research questions, methods, data analysis and scientific reporting. Potential undergraduate themes include local biodiversity, freshwater ecology, insect diversity, fish biology, animal behaviour, parasitology, environmental toxicology, histology and conservation biology. The emphasis should be on appropriate methodology and reproducible records rather than on producing artificially impressive results.

Research internships can connect departments with universities, research laboratories, fisheries institutions, wildlife organisations, environmental agencies, biotechnology laboratories and other relevant organisations. Such placements can strengthen professional awareness and help students understand how biological knowledge is generated and applied.

5.6 Environmental education and biodiversity

Environmental education has unusually strong disciplinary relevance to Zoology. NEP 2020 identifies climate change, pollution, waste management, biodiversity conservation, management of biological resources, forest and wildlife conservation and sustainable development among areas suitable for holistic higher education (Ministry of Education, 2020). UGC subsequently issued an undergraduate framework for environmental education (UGC, 2023d).

Zoology departments can operationalise these provisions through local environmental projects. Students may document biodiversity, assess freshwater ecosystems, monitor invasive species, study plastic pollution, evaluate habitat quality or conduct conservation-awareness activities. Such work should connect ecological observations with scientific interpretation and community needs. Importantly, environmental education should not be confined to a single generic course; ecological and sustainability perspectives can be embedded throughout organismal biology, ecology, fisheries, wildlife and applied Zoology.

5.7 Indian Knowledge Systems and Zoology

NEP 2020 encourages engagement with India's knowledge traditions while maintaining scientific inquiry and contemporary relevance. UGC guidelines on Indian Knowledge Systems provide a framework for incorporating relevant knowledge into higher-education curricula (UGC, 2023e). In Zoology, this can include historically documented practices related to animal husbandry, fisheries, ethnobiology, traditional ecological knowledge, veterinary traditions and community-based conservation.

The educational value of IKS in Zoology is greatest when students learn to document, contextualise and critically evaluate knowledge. Traditional observations can generate research questions, but claims concerning efficacy, mechanism or safety should be assessed using appropriate scientific evidence. This approach respects cultural knowledge while maintaining scientific temper and academic integrity.

5.8 Digital and quantitative competencies

Modern zoological research is increasingly data intensive. Undergraduate students therefore require basic competence in spreadsheets, statistical analysis, data visualisation, digital identification resources, geographic information systems and biological databases. Digital skills should support rather than replace laboratory and field experience. A balanced model may combine field observations with digital data entry, statistical analysis and scientific reporting.

Quantitative literacy is especially important. Students studying population ecology, biodiversity or environmental monitoring should understand sampling effort, descriptive statistics, variability, correlation, uncertainty and appropriate statistical inference. The objective is not to turn every Zoology graduate into a statistician, but to ensure that biological conclusions are supported by defensible evidence.

6. Curriculum Architecture for NEP-Based Zoology

A coherent NEP-based Zoology curriculum can be organised around a progression from foundational knowledge to independent application. The following structure is proposed as a conceptual model rather than a prescribed national syllabus.

Stage	Primary emphasis	Representative learning	Expected competency
Foundation	Core Zoology and scientific literacy	Animal diversity, cell biology, ecology, evolution, basic practicals	Conceptual foundation and observation
Development	Applied and interdisciplinary learning	Physiology, genetics, environmental biology, statistics, digital tools	Laboratory, quantitative and interdisciplinary skills
Integration	Fieldwork, internships and research	Biodiversity surveys, laboratory projects, field studies, internship	Problem formulation and evidence generation
Advanced	Specialisation and career readiness	Research project, advanced electives, entrepreneurship, scientific communication	Independent inquiry, communication and employability

7. Assessment Reform

Curricular innovation will have limited effect if assessment remains dominated by memory-based examinations. NEP 2020's emphasis on competency, experiential learning and holistic development supports assessment practices that capture both knowledge and application (Ministry of Education, 2020). In Zoology, assessment can therefore combine written examinations with laboratory records, field notebooks, identification exercises, data-analysis tasks, research proposals, presentations, project reports and oral examinations.

Authentic assessment should remain transparent and reliable. Rubrics can specify criteria such as scientific accuracy, methodological quality, data handling, interpretation, communication and ethical practice. Continuous assessment should not become a multiplication of low-value assignments; each task should have a clear learning outcome and provide useful feedback.

8. Employability and Entrepreneurship

A contemporary Zoology programme should help students recognise the range of careers that biological knowledge can support. Potential pathways include laboratory services, environmental monitoring, fisheries and aquaculture, wildlife and biodiversity work, ecological consultancy, education, research support, biotechnology-related activities, scientific communication and entrepreneurship. The exact emphasis should be adapted to regional opportunities.

Entrepreneurship can be introduced through applied modules involving apiculture, sericulture, ornamental fish culture, aquaculture, biodiversity documentation, environmental services and biological-resource management where scientifically and legally appropriate. Such courses should include business planning, quality control, regulatory awareness and ethical practice rather than treating entrepreneurship simply as a list of occupations.

9. Faculty Development and Institutional Capacity

NEP implementation depends on faculty capacity. UGC's teacher-development initiatives emphasise contemporary pedagogy, research, ICT integration, biodiversity and sustainability-related competencies (UGC, 2024). Zoology faculty may require continuing professional development in outcome-based curriculum design, field methods, quantitative analysis, digital tools, research supervision, inclusive teaching and interdisciplinary collaboration.

Infrastructure is equally important. Departments need functional laboratories, microscopes, basic field equipment, computing facilities, reliable internet access, specimen resources and safe spaces for project work. Institutions with limited resources can build partnerships and shared facilities rather than attempting to duplicate every specialised laboratory. Collaborative arrangements with nearby universities, research institutes, government departments and biodiversity organisations can expand student opportunities.

10. Challenges in NEP-Based Zoology Education

Implementation is likely to be uneven because institutions differ in staffing, infrastructure, financial resources and autonomy. A curriculum may formally contain fieldwork or research components while students receive little actual opportunity to undertake them. Similarly, multidisciplinary choice is meaningful only when institutions can offer a sufficiently broad range of courses or establish credit-sharing arrangements.

Another challenge is workload. Faculty members may be expected to teach new courses, supervise projects, manage field activities and complete administrative requirements without corresponding support. Departments therefore need realistic student–teacher ratios, laboratory schedules, field-safety protocols and institutional recognition of mentoring and research supervision.

Assessment and quality assurance also require attention. Rapid curriculum expansion can produce fragmented programmes in which students collect credits without developing a coherent biological identity. The solution is not to reduce flexibility but to create clear

programme outcomes and progression requirements. Flexibility should operate within an academically meaningful structure.

11. Proposed NEP-Zoology Integrated Education Framework

The present study proposes the NEP-Zoology Integrated Education Framework (NZIEF), consisting of six mutually reinforcing components: (1) disciplinary foundation, (2) practical competence, (3) field and community engagement, (4) research and quantitative skills, (5) multidisciplinary and digital application, and (6) employability, ethics and environmental responsibility.

The first component ensures strong foundational Zoology. The second converts knowledge into laboratory and observational competence. The third connects learning with local ecosystems and communities. The fourth develops evidence-based inquiry. The fifth enables students to combine biological knowledge with statistics, computing, environmental science and other disciplines. The sixth connects graduate capabilities with professional practice and responsible citizenship.

The framework should operate as a progression rather than as six isolated course categories. For example, a student studying freshwater biodiversity could begin with animal diversity and ecology, learn sampling and identification techniques, conduct a field survey, enter observations into a database, analyse diversity patterns statistically, interpret environmental variables and prepare a scientific report. The same project can therefore integrate several NEP objectives without artificially adding separate activities.

12. DISCUSSION

The analysis indicates substantial conceptual alignment between NEP 2020 and the needs of contemporary Zoology education. Multidisciplinary learning reflects the increasingly integrative nature of biological science. Outcome-based education can clarify what graduates should be able to do. Experiential learning can connect theoretical concepts with organisms and ecosystems. Research internships can provide exposure to professional scientific practice. Environmental education can use Zoology's natural connection with biodiversity and ecosystem processes, while IKS can be incorporated through evidence-based documentation and critical analysis.

The central issue, however, is implementation quality. Policy documents establish direction, but educational outcomes depend on institutional processes. The UGC's current policy architecture includes the CCFUP, multidisciplinary institutional guidance, research

development cells, environmental education, IKS, internships and other initiatives (UGC, 2023a, 2023c, 2023d, 2023e). These instruments create a substantial foundation, but departments must translate them into coherent student experiences.

A further implication is that Zoology departments should define their local identity. A college in a region rich in freshwater resources may develop strengths in aquatic biology and fisheries; another may emphasise biodiversity and wildlife; another may develop laboratory-oriented molecular or histological competencies. NEP's flexibility can therefore support regional specialisation without sacrificing national academic standards.

13. Recommendations

Map every Zoology course to clearly stated course and programme learning outcomes.

Increase authentic laboratory, field and project-based learning rather than merely increasing the number of practical exercises.

Develop structured undergraduate research pathways with training in literature review, research design, data management and scientific writing.

Use local ecosystems and biological resources as learning laboratories wherever ethically, legally and logistically appropriate.

Create multidisciplinary electives linking Zoology with environmental science, biotechnology, statistics, GIS, agriculture, fisheries and computer science.

Strengthen internships through formal partnerships with universities, research laboratories, wildlife and environmental organisations, fisheries institutions and relevant industries.

Integrate environmental sustainability, biodiversity conservation and scientific temper across the Zoology curriculum.

Introduce IKS components through documentation and critical scientific evaluation rather than unverified claims.

Adopt assessment methods that evaluate practical competence, data interpretation, research communication and problem solving in addition to conceptual knowledge.

Provide regular faculty development and institutional support for digital pedagogy, research supervision, quantitative methods and interdisciplinary teaching.

14. Limitations

This paper is a policy and curriculum analysis and therefore does not provide empirical estimates of student achievement, employability or institutional implementation quality. The proposed framework has not yet been evaluated through a controlled intervention or multi-

institutional survey. Future research should therefore examine NEP implementation across universities and colleges using student learning outcomes, faculty perceptions, infrastructure indicators, internship participation, research outputs and graduate progression. Comparative studies across regions would also help identify how local ecological resources and institutional capacity shape NEP-based Zoology education.

15. CONCLUSION

NEP 2020 offers an important opportunity to reposition undergraduate Zoology as a flexible, multidisciplinary, practical and research-oriented life-science programme. Its principles are compatible with the central requirements of modern Zoology: observation, experimentation, field investigation, quantitative reasoning, biodiversity understanding, environmental responsibility and scientific communication. The major challenge is to ensure that policy language is translated into authentic learning experiences.

The proposed NEP-Zoology Integrated Education Framework provides a practical way of connecting disciplinary knowledge with laboratory competence, field experience, research capability, digital and quantitative skills, community engagement and employability. Successful implementation will require coordinated action by universities, colleges, departments, faculty members and external partners. If curriculum, pedagogy, assessment, infrastructure and faculty development are aligned, NEP 2020 can contribute substantially to producing Zoology graduates who are not only knowledgeable but also capable of investigating biological problems and applying evidence-based solutions to environmental and societal challenges.

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