Exploring the Wild with Mathematics

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The fusion of mathematics with biology, including in the realm of ecology, is not a novel concept (Seshaiyer & Lenhart, 2020; Cohen, 2004). In fact, for years, scholars have championed the value of an interdisciplinary approach, arguing that it opens the door to a richer, more nuanced understanding of the subjects. Amalgamation of these disparate fields not only challenges the traditionally qualitative nature of biological study but also seeks to dissolve the long-standing divide between biology and mathematics (Gross, 2000). This study aimed to develop a learning module for school-level education that integrates ecological concepts with mathematical principles, thereby attempting to foster a connection between the two disciplines within a coherent and meaningful framework. The module also sought to cultivate a deeper appreciation for the natural world. The current work presents some episodes from our pilot testing to highlight the module's potential in addressing students' misconceptions in mathematics and ecology.

Development of the module 'Jungle Safari'

The 'Jungle Safari' module is an interdisciplinary STEM module that aims to merge the worlds of wildlife, mathematics, geography, and ecology, providing students a holistic and engaging learning experience. By using the context of wildlife ecology, the module aims to provide students with an opportunity to deepen their understanding of key concepts in both academic subjects, ecology and mathematics. The module's main objective is to offer students an exciting and interactive way to apply their knowledge of mathematics and geographical concepts through real-life scenarios related to wildlife. It integrates math skills like coordinate plotting and scaling, geography concepts such as cardinal directions, mapping, and ecological concepts like territorial distribution of wild animals in their natural ecosystems. Through this module, the envisioned learning objectives are: students are able to recognise cardinal directions for navigation, explore map scales and coordinate plotting, understand wildlife behavior, calculate their territories, locate their approximate positions, and gain a preliminary understanding of proportional relationships on maps.

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Observations from student engagements

We pilot-tested the module with around 80 students from class 8, 9 and 11, who demonstrated an intuitive understanding of coordinate plotting, using an A-to-Z labelling and numerical values on axes. However, they faced challenges in some conceptual areas, prompting valuable discussions. For example, in one case, students initially represented a tiger's 8 km (territory) range as area of a square, assuming that is how they would convert distance to area in that context. Through discussion, they discovered that an animal (potentially) moving 8 km in any (and therefore all possible directions from a given point) forms a circular region rather than a square. Another interesting observation was while finding the midpoint between two animals, several student groups only considered gridlines, missing transversal lines, highlighting the need for a stronger understanding of geometry.

In one of the tasks, students were asked to mark a herd of animals near a river in the northwest direction near the river. While they understood the direction, they were determined to find the exact answer rather than focusing on approximate answer, the latter being the goal of the task. There was another task, where students had to find the shortest distance between an animal and a river. In this, many students initially used parallel gridlines, failing to consider diagonal movement of the animal. However, we also observed some students overcame this by applying the Pythagorean theorem for more accurate results. We also encountered situations where some students mismeasured distances when they started calculating length from a non-zero point on the ruler. The module also encouraged students to engage with scaling concepts through hands-on practice with maps, where they proportionally reduced or increased territories instead of solely relying on memorised formulas, thereby offering a visual understanding of the concept.

From an ecological perspective, an interesting observation arose when a student was marking the territory of a sloth bear and believed she had gotten the answer wrong. She asked, "*Par yeh bahar ja raha hai*," pointing to us that the territory of the sloth bear was going "outside" the national park, and therefore, her marking was incorrect. This prompted a discussion on the fact that protected areas are human-made, and wild animals do not recognise these boundaries. The discussion then emphasised how wildlife territories often overlap with human habitats, which may increase encounters (and possibly conflicts) with wild animals. It also highlighted anecdotes of how densely populated communities near forest fringes have harmoniously co-existed with wildlife in their vicinity, as seen in many parts of our country.

The findings from this pilot implementation underscore the module's efficacy in fostering conceptual understanding and engagement in both mathematics and ecology. Moving forward, we intend to refine the module further by systematically collecting feedback from peers and conducting additional trials with students, thereby enhancing its instructional design and pedagogical effectiveness.

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