FY16 Innovations in Teaching with Technology Awards: In-course development and utilization of the NMITA Identification Tool (NIT): An on-line tool for learning about taxonomy, biodiversity informatics and species identification, blending technology and re

FY16 Innovations in Teaching with Technology Awards

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<th>In-course development and utilization of the NMITA Identification Tool (NIT): An on-line tool for learning about taxonomy, biodiversity informatics and species identification, blending technology and real fossils</th>
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Teaching paleontology and organismal biology provides opportunities and challenges for practical activities involving real specimens. An additional challenge is teaching students how to identify species when taxonomy (identifying and naming species) is underemphasized in science in general, let alone the classroom, even though it is one of the foundations of modern biodiversity informatics (the computerized handling of information about the different types of life found on Earth and variations with species). Traditionally, students learnt to identify diagnostic characters of species by drawing specimens, but this is a very unpopular activity today, as few students have received any formal instruction in drawing techniques. Currently, students look at suites of specimens in labs but receive no structured training in how to examine and describe the specimens they are studying.

We propose to involve students in class labs with the development, testing and use of an on-line identification tool as an innovative means of using technology to learn about taxonomy, practical techniques in identification, and biodiversity informatics. We propose to develop further an existing resource on the Neogene Marine Biota of Tropical America (NMITA) website - the NMITA Identification Tool (NIT) (see Supporting Document). NIT assists identification of taxa by selection of specific combinations of
multiple character states (diagnostic features), rather than through the traditional dichotomous keys where one of two contradictory character states must be selected before moving to the next choice. Images and descriptions illustrate every character and its state(s). Through the NMITA project, a variety of NIT modules currently are available for Caribbean corals, and bivalves and gastropods from south Florida.

We propose to add a new module for identifying fossil leaves – NIT: Cretaceous Leaves. The UI Paleontology Repository (UIPR) holds a large collection (c. 1,000 specimens) of fossil leaves from the Cretaceous Dakota Formation of the Midwest USA. The collection was purchased by UI President T. H. Macbride in 1898 from renowned fossil hunter, Charles H. Sternberg, but the specimen identifications are woefully out of date and many of the species names are no longer valid.

Undergraduate students in the courses listed below will use modern descriptions to populate the data tables, and then test their work by identifying actual and/or digitized fossils in the UIPR collections, effectively assisting in building, using and testing the NIT: Cretaceous Leaves module. Two undergraduate assistants (funded by ITTA) will help build the underlying resources. ITS staff (funded separately by a UIPR NSF grant) will modify existing queries to create the web interface on the UIPR website.

EES:1040 Evolution and the History of Life 3 s.h. (<184 students)

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EES:1030 Introduction to Earth Science 3-4 s.h. (<460 students)

EES:1050 Introduction to Geology 4 s.h. (<80 students)

EES:3210 Principles of Paleontology 3 s.h. (<25 students)

EES:4440 Phylogenetics and Biodiversity 3 s.h (<25 students)

EES:4700 Evolution of Ecosystems 3 s.h. (<50 students)

EES:4710 Evolution of Plants 3 s.h. (<25 students)

Timeline: January - February 2016. Build MORPHGLOSSARY table, create blank GENMORPH and SPMORPHOL tables, create webpage interface and character illustrations.

March 2016. EES:1040 students populate GENMORPH AND SPMORPHOL tables in lab activities focused on biodiversity informatics and history of plant evolution. Assistants check class data for errors. T. Adrain will upload data to Oracle database.
April 2016. EES:1040 students use the identification tool to identify Sternberg collection specimens, determining and resolving any errors.

Assistants will take digital photos of specimens throughout the Spring 2016 semester for use in class and online.

May 2016: NIT: Cretaceous Leaves will be available for use by future classes (including those listed above) and other institutions.

Specific learning objectives: undergraduate students learn about taxonomy and the foundations of biodiversity informatics by developing and using the NIT: Cretaceous Leaves module to identify real fossils. Through populating character states tables and identifying real specimens, students will learn the fundamentals of taxonomy, learn techniques in examining specimens, including looking for, and recognizing on the actual specimen, diagnostic features for identifying species. NIT: Cretaceous Leaves will teach students HOW to identify organisms in general and leaves in particular for this project. Students test their skills by using their own communal database to identify real individual specimens. They will comprehend the difficulties in identifying fossil specimens that may be partially preserved. They will experience variation within species, and similarity between species and will have to refine their data accordingly. They will learn that biodiversity informatics relies on accurate identification of species while making the detection of anomalous data easier. Students will experience data gathering and entry from published scientific resources. Species descriptions in scientific literature can be incomprehensible to the layperson at first. Parsing out the required information for the GENMORPH AND SPMORPHOL tables will allow students to become familiar with taxonomic terminology, the designation of diagnostic characters, and variation of character states, as well as variation within a character state. They will experience using their own data to determine identifications of actual fossils, and will receive feedback on errors detected by the undergraduate assistants, or will experience errors in the NIT that they will have to correct (e.g. if a character state selection does not resolve to a single species or viable array of species).

Engaged participatory learning: students will experience the satisfaction and/or frustration of collecting and using data to identify specimens and will appreciate the importance of accurate, organized data in biodiversity informatics. The activity will help them be more critical of other databases they visit or hear about in class. We anticipate that the development of this NIT module will act as a pilot for future modules involving other fossil groups and modern groups. The activity can be used in the other courses listed above as students either continue to identify Cretaceous leaves, or select other groups to work with (e.g., marine invertebrate groups in EES:3070 Marine Ecosystems and Conservation 3 s.h. (<72 students)). If possible, the queries will be easily adaptable to other taxonomic groups to allow for continued growth of the NIT modules.
with minimal IT development time and cost. After testing by the EES:1040 students, NIT: Cretaceous Leaves will be made available to the international paleontology community. T. Adrain has already communicated with institutions interested in having someone identify their Cretaceous leaf collections (Sternberg Museum at Fort Hays University, Natural History Museum (London, UK)) and anticipates that the tool can be used to identify digitized collections on-line as a crowd-sourcing project or high-school classroom project.

Impact on student learning in EES:1040 Spring 2016 will be assessed by:

- accuracy of data collection illustrating recognition of species characters and character states and fundamental understanding of taxonomic process;
- success of students in identifying specimens with the tool they’ve helped developed, and successful detection and correction of errors;
- successful identification of an undisclosed set of pre-identified specimens;
- lab questions for feedback about the exercise.

Future classes will follow the same outline if module-building is included. Otherwise, students will be given the table-building as an introductory exercise and then continue to identify specimens with the NIT: Cretaceous Leaves module.

The project will require funding for two undergraduate students to assist with building the necessary tables, creating illustrated glossaries of character states, checking data entries, photographing specimens, and organizing hands-on lab specimens for identification.

We already have access to underlying resources (Oracle database, NMITA applications and UIPR website) required to create the NIT: Cretaceous Leaves module. Three tables will be added to the Oracle database (though we may investigate the practicality of modifying existing tables to accommodate multiple taxa). Existing queries can be used as a template to create NIT: Cretaceous Leaves. ITS staff who currently work with NMITA (A. Rinner, L. Avila, R. Remesh Ranjini) have agreed to develop the necessary queries. Their involvement is already funded by an existing National Science Foundation grant (see Supplementary Document p. 4). They will NOT require ITT Award funds.

T. Adrain will provide fossils and lead the project. The UIPR has all the equipment needed to digitize specimens.

J. Adrain is the Instructor for EES:1040 and will assist with lab activity development and assessment.

The procedure for the project is as follows:

1) Create and populate character glossary table (two undergraduate assistants)
What resources will you need?

MORPHGLOSSARY will be populated by two undergraduate assistants who will work together to enter all available characters and character states of the Cretaceous leaves described by Wang 2002 (Diversity of angiosperm leaf megafossils from the Dakota Formation (Cenomanian, Cretaceous), North Western Interior, USA. University of Florida, Ph.D. Thesis) which updates or describes for the first time, more than 90 species of plants from the same geological formation as the UIPR Sternberg Collection.

2) Create webpages illustrating each character state (two undergraduate assistants)

The two undergraduate assistants will also develop webpages with illustrations for each character state either by photographing specimens in the UIPR, creating new diagrams, or referring to the Manual of Leaf Architecture (Smithsonian Institution 1999, http://www3.geosc.psu.edu/~pdw3/1999_MLA.pdf).

3) Create NIT queries (ITS staff funded by UIPR NSF grant)

Using the existing NIT queries as a template, ITS staff who maintain and develop the NMITA database, website, and queries, will develop the relevant new queries and web interface for NIT: Cretaceous Leaves.

4) Populate the genus morphology and species morphology tables (undergraduates in class)

The Oracle database tables GENMORPH and SPMORPHOL list all the character states of each genus and species to be identified. These tables will be populated by undergraduate students in the above classes who will be given a subset of species to enter into the database, taking information from Wang 2002 and other relevant publications. Students will prepare a spreadsheet in Microsoft Excel that will be imported, after checking for errors, into the Oracle database by the undergraduate assistants under the supervision of T. Adrain.

5) Use NIT: Cretaceous Leaves to identify fossil specimens (undergraduates in class)

Undergraduate students will test their taxonomy skills by identifying a suite of specimens using NIT: Cretaceous Leaves. They will test their own database in the process and appreciate how data accuracy improves database functionality and the importance of data accuracy in biodiversity informatics.

We estimate the total ITT funding required by the project to be $10,484. Funding is requested for salary for two undergraduate students @ $15/hour for 20 hours/week for 16 weeks + fringe @ 9.20% ($9,600 salary + $884 fringe = $10,484).
The project provides an ideal training opportunity for students interested in digitizing museum research collections and their inclusion in biodiversity informatics. Anyone working with biological collections such as the UIPR collections needs to have experience with databases and applications such as those involved here. In T. Adrain’s experience of supervising undergraduates working in the UIPR collections, undergraduate students benefit from working in a team, so that task problems can more easily be resolved and students can support each other’s work. The initial set up of determining characters will be labor intense, as will checking class data entries and digitizing specimens and preparing hands-on specimens for labs.

ITS staff will NOT require ITTA funds. They will be funded separately through the UI Paleontology Repository National Science Foundation grant DBI-1348322 (2 yrs., 5/01/14-4/30/16, $196,751); “CSBR: Natural History Collections: Critical renovation and revitalization of the University of Iowa Fossil Plant Collection” (PI = A. F. Budd, Co-PIs = T. S. Adrain, H. J. Sims, J. M. Adrain). See Supplementary Document (p.4) for NSF grant budget information. Development of the NIT: Cretaceous Leaves fits perfectly with the grant project’s focus on curating the UIPR fossil plant collection, including identification of specimens. Although the grant provides funds for undergraduates, their role is to rehouse the collection, and student involvement in the development of the NIT: Cretaceous Leaves is beyond the scope of that project.


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