Integration and Pedagogical Efficacy of Digital Field Methodologies in a Full-Year Sed/Strat and Structure Course

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Geology 317, Wyoming, 2011
What and Why

• How many of you drove part... or all of the way here?
• How many used your vehicle’s onboard or phone navigation App?
• When was the last time (if ever) that you use paper maps to navigate while driving?
Here We Go…

- Our Geology Educational Setting (somewhat unique)
- Curricular Initiative
- Issues
- Digital Solutions
- Preliminary Assessment
- Field Issues
Lafayette College

- Undergraduate
- Highly selective
- 2500 students
- 8 to 15 geology graduates/year
- No field camp requirement
- Substitute: field/laboratory projects in all courses
Holistic Approach

Depositional & Deformational Analysis

- Combined Sed/Strat & Structural Geology into full-year sequence
  - 8 to 20 students per year
- Why?
  - Nothing happens in isolation (think accretionary wedges)
- How? (curricularly)
  - Focus on Basin Evolution
- How? (logistically)
  - share course time: 3 weeks each semester
Semester 1 (GEOL 215)

Deposition

• **Topics:**
  - Sediment genesis -- fluid dynamics -- trans/erosion/dep -- processes & products of dep environments
  - tectonics
  - orogenesis/basin genesis/types
  - correlation/dating

• **Skillsets:**
  - Grain/deposit description -- microscopy/sed pet -- rock ID -- field description/data collection/interpretation -- literature research

• **Products:**
  - Field reports of ~6-8 local units w/ lit research -- geologic history
Semester 2 (GEOL 317)

Deformation

• **Topics:**
  - Relationships between Global Tectonics, mountain belts and basins -- sequence stratigraphy, petroleum generation -- stress & strain -- brittle vs ductile -- superimposed structures -- cycles of deposition and deformation

• **Skillsets:**
  - structural field skills -- interpreting/constructing geologic maps
  - ability to qualitatively and quantitatively evaluate structural features

• **Products:**
  - synthesized into a comprehensive report:
    - Regional → local relationships
    - Depositional/Deformation sequences
    - Strat columns -- stereoplots -- geologic maps -- cross-sections
Capstone: Field Project/Report

- **Location:** Bighorn Basin Wyoming
- Tectonics, Stratigraphy & Structure similar to PA, except for “green” stuff
Field Project

- **Plan:** 5 field days -- 2.25 mi$^2$, student driven field plans
- **After 16 field projects in the previous 20 weeks**
The Ultimate Product
The Ultimate Product

80 to 120 page report:
- Geologic map
- Cross-section
- Strat column
- Stereoplots
- Sequence stratigraphy analysis
- Local and regional stress
- Regional tectonic history
- Antler through Laramide
- Depositional and deformational sequence
App Development
Background & Rationale

• Much of geology is a field science, yet interpretation has become very digital.

• Question is how to bridge analog field acquisition (field book and paper maps) with digital acquisition and processing?

• How to effectively use image bases that are widely available

• What benefits might this have?
Objectives

• To develop digital methods for recording field data
  • Structural: GeoFieldBook
  • Sed/Strat: StratLogger
• Use rapidly evolving tablet technology that could mimic, and possibly replace the use of traditional field notebooks.
  • Apple iPad

• Record ---> Transcribe ---> Excel ---> Google Earth --->
• Record ---> Map ---> Excel

Geologic map & Interpretation
Assumptions

• Smooth & accurate data transfer into mapping & processing programs

• Faster data collection & presentation -- more time for analysis & synthesis

• Increase iterative hypothesis capabilities in the field

• Pedagogical value in guiding student field observations and getting student feedback
• Every day, **during and after** field work
  • Hypothesis
  • Data set adequate?
  • Support the hypothesis?
  • Data Gaps
  • Revised hypothesis
  • Cognitive Domain
App Development Process

- NSF *Computation in the Curriculum* project through Prof. Chun-Wai Liew (Lafayette) w/ current support from ITS
- Geology/Computer Science iterative collaboration process – real world experience for CS students
- Programmers
  - Andrew Ho, Kumera Bekele, Kien Hoang, Prabhat Rimal, Carter Tillquest, Lucy McKnight, Franceska Xhakra, Emilie Grybos, Nicholas Escalona, Samuel Courtney, Raymond Machiria, Huy Nguyen, & Tim Yale
Common Features: GeoFieldBook & StratLogger

- Projects organized in Folders
Common Features: GeoFieldBook & StratLogger

- Observations stored by lithology
- Observations stored within folders
Common Features: GeoFieldBook & StratLogger

- Onboard GPS for location and time/date record
Common Features: GeoFieldBook & StratLogger

- Camera
StratLogger

- Bed-by-bed record for stratigraphic data
- Stratigraphic column built as lithologies are entered
- Fields prompt students to record complete data set
StratLogger

- Preset but modifiable lists for fields requiring input
- Promotes consistency
StratLogger

- Goal is to build a stratigraphic column in the field
- Allows students to:
  - hypothesize depositional environments while in the field and
  - test interpretations with subsequent observations
- The column can be exported in jpeg format or data can be used to construct column in Illustrator
GeoFieldBook

- Point-based approach for collection and mapping of structural data with the goal of creating a geologic map externally
- Field book replacement with field prompts
- Image base with real-time presentation of oriented data
- **Objective** is to get students to imagining structural relationships while they are still in the field
GeoFieldBook

- Currently select from 4 record types plus “Other”
- Also an ability to custom design 5 additional types
GeoFieldBook

- Page for each type: prompts for appropriate information
- Especially important for beginning field students
- Like StratLogger, preset but modifiable lists for fields requiring input
GeoFieldBook

- Collected data are then instantly displayed on the image base in correct orientation
- While not a geologic map with drawn contacts, the increasing number of observations allow students to visualize the map
- Can filter on record type…possible to show only contacts
GeoFieldBook

- Image base is also used as the mapping platform (no paper maps) – gps dot shows current location relative to all collected data...allows for field collection decisions!
- Instant access to previously collected information
Common Features: GeoFieldBook & StratLogger

- Export data files in csv format for use in other analysis or mapping programs (like Google Earth)
- Images are exported with reference within the csv file
- It is also possible to reimport data files and images
GeoFieldBook & StratLogger: Digital Efficacy

• Issue: what is the pedagogical efficacy of these methods
• Reflection Questions – customizable by user (professor)
• We are collecting data on:
  • data collection efficiency √
  • student learning – field functionality √
  • student perception of their learning (?)
  • how did this prepare you for future geologizing – post project evaluation (?)
The Ultimate Product

iPads-w/ maps

iPads-no maps

Pre-iPads
Data to Products

DEPOSITIONAL AND DEFORMATIONAL HISTORY IN THE VICINITY OF SHEEP MOUNTAIN, WITHIN THE BIGHORN BASIN, WYOMING
Field Issues and Upgrades

Anecdotal

• “I can’t imagine not using the collection and mapping App”

• A student from this past fall was required to use paper maps on a large field board for a semester abroad program: “We were 10 time less efficient gathering our data”

• Petroleum professional who also teaches masters students: “…report and maps equivalent to or better than theses I have supervised”

Geology 317, Wyoming, 2010
Field Issues and Upgrades

Questions to be answered

• Screen visibility in bright sun - adequate
• Durability – covers & field vests
• Heating up
• Enhancements:
  • Real-time cloud backup
  • Line drawing?
• Longevity?
  • iPad2s – purchased in 2011 – just retired (battery)
  • iPad3s – purchased in 2012 – still going strong
• Continued iOS support
Field Issues and Upgrades

FAQs

• How about loss of data?
  • “Export” saves a copy of .csv file in different space on the iPad
  • Real-time cloud backup coming in next version → probably Google Drive

• Enhancements:
  • Line drawing?
  • On maps, images?

• Do we use digital platforms for other applications?
  • Image Annotation
Questions?

- GeoFieldBook and StratLogger are available for Free at the Apple App Store
- iPads will be available during the break and at the end of the session
2.25 sq. miles
12 geologic formations
Relatively complex structure