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Insects as Teaching Tools

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Presenter, Department(s):
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Title:
Insects as Teaching Tools

Abstract:

In this talk I will present on projects in which insects were used as instructional tools. This presentation will give an overview of how insects can be used for teaching with a variety of student age groups and how inquiry instruction can be promoted with insects. I will present overviews of 3 projects including Bumble Boosters, Bugs in the Classroom, and Web-based insects identification tools.
Bumble Boosters created a community of researchers that studied bumble distribution and abundance and artificial nesting domicile preferences. Forty Nebraska high schools were involved in this project.

Bumble Boosters' teaching objectives were to raise public awareness of the environmental importance of pollinators, enhance students' understanding of scientific investigations, increase student's knowledge of insect biology and pollination ecology, and to engage students in networking with other students to solve a shared problem.

Bugs in the Classroom - Bugs in the classroom was a professional development initiative with the goal of empowering teachers to use insects in science inquiry instruction in elementary classrooms. This initiative included workshops for elementary educators on science inquiry and teaching with insects. This talk includes a description of the workshop as well as an evaluation of the impact of the workshop on participating teachers' knowledge of scientific inquiry, entomology knowledge, and inquiry practice.

Web-based Insect Identification Tools - The purpose of this study was to determine whether undergraduate students receiving web-based instruction based on traditional, key character, or classification instruction differed in their performance of insect identification tasks. Results of this study support that short web-based insect identification exercises can improve insect identification performance.

Insects as Teaching Tools

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IANR

Overview

- Bumble Boosters
- Bugs in the Classroom
- Insect ID

Bumble Boosters

Bumble Boosters

Bumble Booster Research Outcomes

- 36 schools contributed to 3,219 bumble bee specimens.
- 107 county records
- 1 new species to state *Bombus flavifrons*

Golick, D., M.D. Ellis (2006). An Update on the Distribution and Diversity of *Bombus* in Nebraska. Journal of the Kansas Entomological Society, *79* (4).

Bumble Booster Research Outcomes

- Very few nest habitats (2/400*) accepted by bumble bee queens

*Artificial domiciles and habitat modifications distributed to and created by participants

Golick, D., M.D. Ellis (2006). An Update on the Distribution and Diversity of *Bombus* in Nebraska. Journal of the Kansas Entomological Society, *79* (4).

Bumble Boosters Teaching Outcomes

- Teachers overall rating for project 4.03 (*SD* = 0.99)
- Website and networking (community building tools

M = 3.54 (*SD* = 0.99) and *M* =3.52 (*SD* = 1.37)

N= 34 (1-5, Likert scale)

Golick, D., Schlesselman, D.. Ellis, M., and Brooks. D. (2003).
Bumble Boosters: Students Doing Science.
Journal of Science Education and Technology. 12 (2).

Golick, D., Ellis, M. (2003). Bumble Boosters: Doing Science as a Community of Learners.
American Entomologist. 49 (2).

Bumble Boosters Teaching Outcomes

Comments from instructors:

- Students were disappointed with non-occupancy
- Students liked the lab aspect (inquiry)/ connection to contributing research
- Support and resources
- Appreciated the hands-on nature of workshops next year

Bumble Boosters Lessons Learned

- Model for contributing to research works
- Failure a learning tool
- Building of communities important (more emphasis needed)
- Science as inquiry is a powerful teaching method

Questions

Bugs in the Classroom Workshops

- Received a grant for funding the development of:
  - A course "Insects as Educational Tools"
  - Summer workshops for K-12 educators
  - A Web site for hosting instructional modules and curricula for educators
- Focus on science inquiry using insects

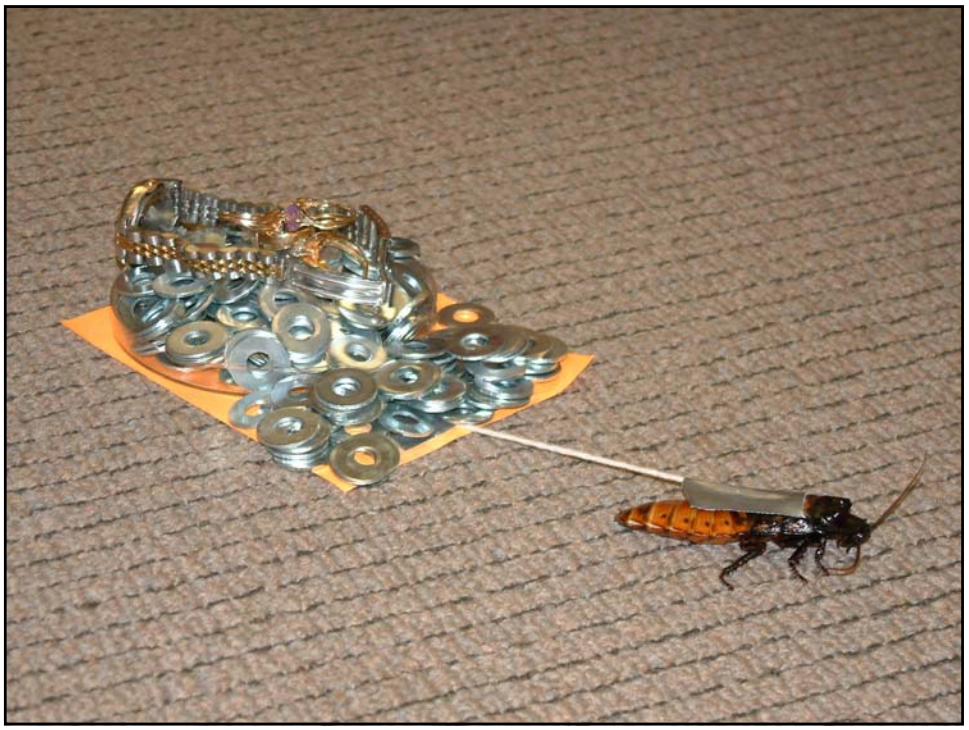
Golick, D. A., Heng-Moss, T.M., and Ellis, M.D. (2010).
Using Insects to Promote Science Inquiry in Elementary Classrooms. *NACTA Journal* 54:3.

Benefits to participants

- Learn about insects
- Learn how to use insects in science-inquiry
- Earn 1 hour credit – UNL
- Resource kit
- $50 stipend

Program - Day 1

- Overview and pre-test
- Ice breaker – Who am I?
- Why study insects
- Science as inquiry
- Insect orders
- Scavenger hunt



Program - Day 2

- Arthropod husbandry
- Collecting insects inquiry
- Social insects
- Social insect inquiries
- Conclusion and post-test

Food preference and trail making inquiries

Hypothesis – little black ants will prefer honey when offered a choice of honey or peanut butter

Why devote time and resources to evaluation?

- Independent evaluation required for many grants
- Focus on impact, not activities
- Requires pre, post and long-term measurement
- *Requires Curriculum & Instruction* faculty partnership

Evaluation structure

- Changes in teacher's understanding
  - What is science-inquiry?
  - How does one teach using science-inquiry?
  - What entomology content should I teach to meet the National Science Standards?
- Changes in teacher's behavior
  - Teaching entomology content
  - Teaching science-inquiry process
- Long-term science-inquiry application
  - In classroom with insects
  - In classroom with other subject material

An important consideration interpreting evaluation

- Real changes in the use of science- inquiry
- Changes in teacher perception of what constitutes science inquiry

Evaluation instrument

- Informed consent obtained
- Pre-quiz and opinion survey (before workshop)
- Post-quiz and opinion survey immediately (after workshop)
- Six-month follow-up survey

Evaluation design and data analysis

- Likert scale
  - Ratings, 1 = strongly disagree, 5 = strongly agree
  - Opinions
  - Frequency of category selection
- Quantitative data
  - Multiple choice, one correct response
  - Many possible choices, more than one response
  - Yes/No responses, frequency data

Pre-workshop test

- *Science-inquiry as a process*
  - List the six steps for conducting a science-inquiry
  - Which of the following is a testable hypothesis?
  - Which of the following is the best example of scientific inquiry?

Pre-workshop test

- *Entomology content*
  - Which one of the following is an insect
  - List the names of 3 insect orders
  - List 3 forms or types of insect communication
  - Name three social insect groups

Pre-workshop survey

- *Teacher understanding*
- My current level of understanding
  - Science-inquiry understanding is such that I can effectively incorporate science- inquiry activities into my classroom
  - Knowledge of insect biology is such that I can effectively use insects in science-inquiry lessons

Pre-workshop survey

- *Current use of science-inquiry*
- To what extent is science-inquiry used in your curriculum?
- During previous semester (2 quarters), how many lessons did you instruct that used insects for science-inquiry?

Post-workshop test

- *Teacher understanding*
- My current level of understanding
  - My understanding is such that I can effectively incorporate science-inquiry activities into my classroom
  - My knowledge of insect biology is such that I can effectively use insects in science-inquiry lessons

Post-workshop survey

- ***Workshop impact***
- As a result of the workshop
  - I am likely to incorporate more science-inquiry lessons ***using insects*** into my curriculum
  - I am likely to incorporate more science-inquiry lessons ***using organisms other than insects*** into my curriculum

Post-workshop survey

- ***Workshop impact***
  - Science-inquiry could be used in my non-life science curriculum
  - Has your definition of science-inquiry changed since the beginning of this workshop? (If yes, please explain)

Follow-up survey (6 month)

- Number of activities you have instructed this semester that used insects for science-inquiry
- To what extent is science-inquiry used in your curriculum (Likert scale)
- As a result of this workshop, I have incorporated more science-inquiry lessons using insects into my curriculum (Likert scale)

Follow-up survey (6 month)

- As a result of this workshop, I have incorporated more science-inquiry lessons ***using organisms other than insects*** (Likert scale)
- As a result of this workshop, I have ***used science-inquiry in my non-life science curriculum*** (Likert scale)
- Please provide comments about the value of this workshop in terms of its impact on your teaching

Results

Wilcoxon Signed Ranks Test

	Pre-quiz		*Post-Quiz*			
	M	*SD*	*M*	*SD*	*z*	*p*
Six steps science inquiry	3.25	1.65	5.51	.70	6.00	.000
Three insect orders	.90	1.27	2.05	1.22	4.86	.000
Three ways insects communicate	1.71	1.05	2.56	.53	4.20	.000
Three insect social groups	2.17	1.10	2.92	.43	4.17	.000

N = 59

Results

McNemar Tests

	W1 W2	*R1 W2*	*R1 R2*	*W1 R2*	c^2	*p*
Testable Hypothesis	6.77%	0%	44.06%	49.15%	27.03	.000
Best Science Inquiry Example	11.86%	6.78%	72.88%	8.47%	---	1.00
Which picture is the insect	0%	5.08%	89.83%	5.08%	---	1.00

N = 59

Self-Assessment of Understanding: Level of Agreement to Confidence Statements

	Pre-workshop		*Post-workshop*			
	M	*SD*	*M*	*SD*	*z*	*P*
My current level of insect biology understanding is such that I can effectively incorporate science inquiry using insects into my instruction.	2.93	.96	4.08	.77	-5.145	0.01**
My current level of science inquiry understanding is such that I can effectively incorporate science inquiry into my classroom.	3.37	.95	4.27	.72	-4.960	0.01**

Likert scale (1 = strongly disagree, 5= strongly agree).

NS, *,**, ***, Nonsignificant or significant at *P=0.05, 0.01, or 0.001*, respectively using Wilcoxon signed-ranks test

Results

Yes/No Questions

	Yes	*No*
As a result of this workshop my definition of science inquiry has changed	69.5%	30.5%

N = 59

Results inquiry use

Yes/No Questions

	Yes	*No*
As a result of this workshop, I have used science inquiry in my non-life science curriculum.	92.1%	7.9%

N = 38

Results inquiry use

Paired samples *t* test

	Pre-Survey		*Six Month*				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Number of inquiry lessons	3.38	5.44	4.69	5.59	47	1.18	.241

N = 48

Conclusions short-term

- Knowledge of entomology content improved
- Knowledge of science-inquiry increased
- Teachers reported that their perception of science-inquiry changed

Conclusions short-term

- Teachers reported that as a result of the workshop they now could and would incorporate more science- inquiry using insects into curriculum
- Optimistic about using science-inquiry in the classroom after the workshop

Conclusions long-term

- Teachers reported using insects for science- inquiry to a lesser extent than they said they would after the post-workshop survey
- However, they did report using it to a greater extent than before the workshop
- Most reported they did use science-inquiry in their non-life science curriculum as a result of the workshop

Conclusions long-term

- Significantly improved teacher knowledge
  - Entomology content and science-inquiry
- Teachers used significantly more science-inquiry in their classroom
- However, to observe true inquiry use, measures such as direct observation or other proof is needed

Questions

Insect Identification Problem

- Even though a variety of different instructional techniques are traditionally employed to teach insect identification, many students remain unable to identify some prepared specimens.
- The specific reasons for failing to correctly identify prepared insect specimens are often assumed by instructors, but are rarely examined experimentally.

Improving Identification

- Targeting why students fail
  - Difficulty learning to look for morphological characters
  - Little access to specimens outside of class
    - Do not practice identifying specimens
  - Failure to properly study for quizzes

Approach to Improving Insect Identification

- Web-delivered
  - Access outside of class
  - Interactivity
  - Display of pictures
  - Data collection easy

Intervention

- 3 instruction types
  - Traditional (line drawings with characters)
  - Key Character identification instruction (w/line drawings)
  - Classification (w/line drawings)
- Each exercise focusing on a particular arthropod or insect group

Research Questions

- Do differences exist in students' ability to identify specimens based on the type of Web-based instruction they received?
- Do differences exist in student performance at the class, order, or family levels of classification?

Research Questions (Cont.)

- Do differences exist in the ratio of misspelled and misidentified specimens as a result of the different types of Web-based instruction students received?
- If students err in prepared specimen identification, are a greater percentage of the errors due to misspellings or misidentifications?

Experiments

- 3 Experiments
  - 2 undergraduate students taking insect id course
  - 1 novice group, never taken an id lab/course on insects

  n = 48, 62, & 43

Study Overview

week 1 class

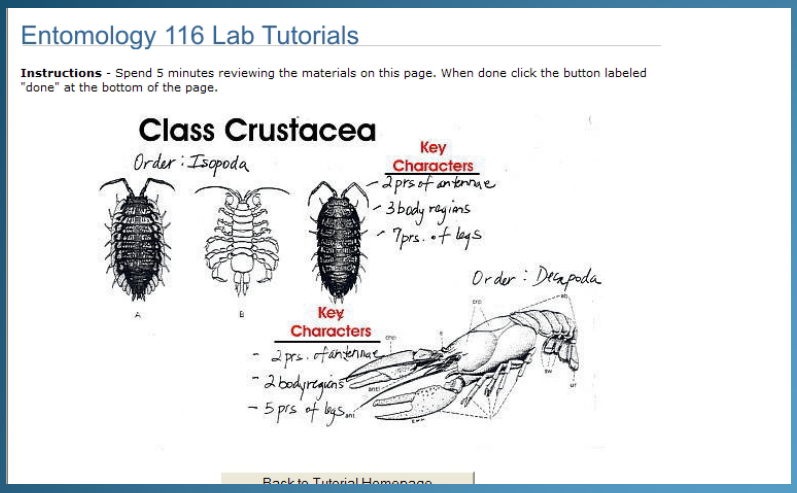
1. Quiz over previous week's groups
2. Lecture – introduction to new group
3. Hands-on work with specimens

Website Exercises (Homework)

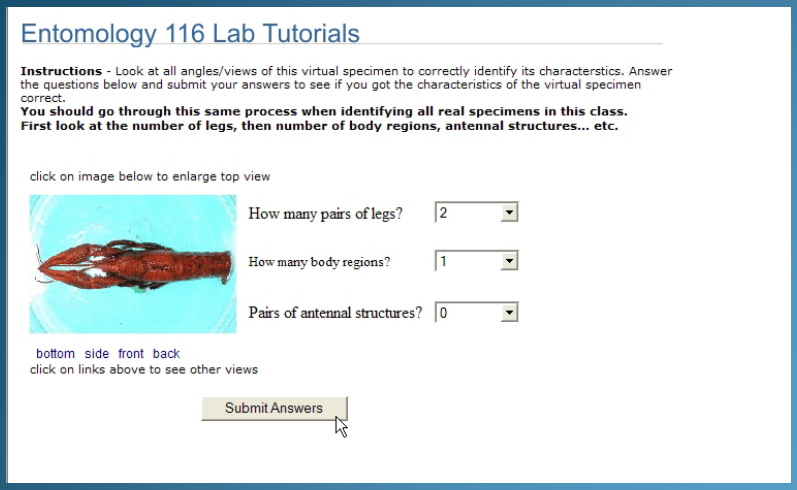
week 2 class

1. Quiz over previous week's groups
2. Lecture – introduction to new group
3. Hands-on work with specimens

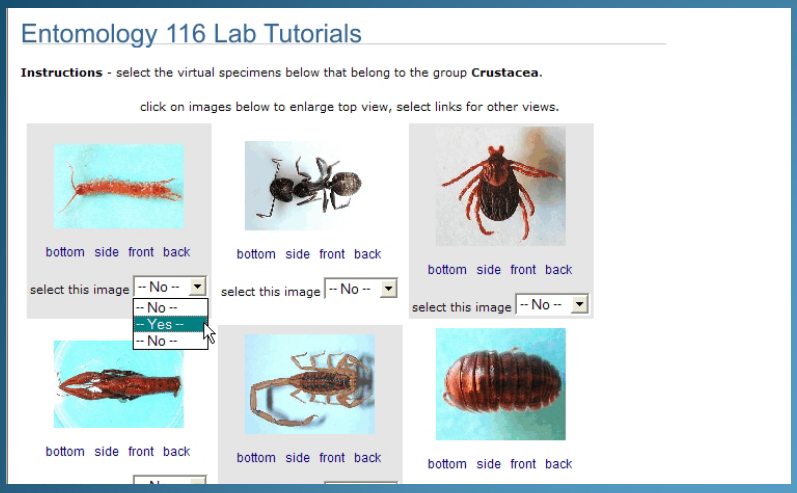
Web Tutorials (Traditional)



Web Tutorials (Key Character)



Web Tutorials (Classification)

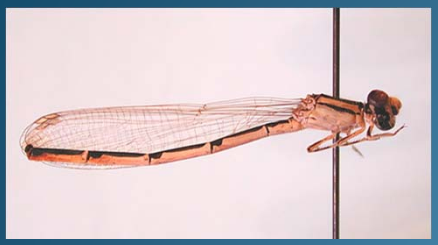


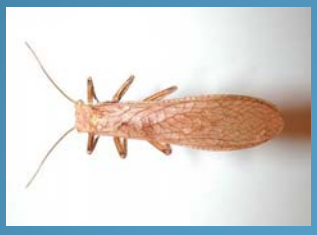
Arthropod Classes



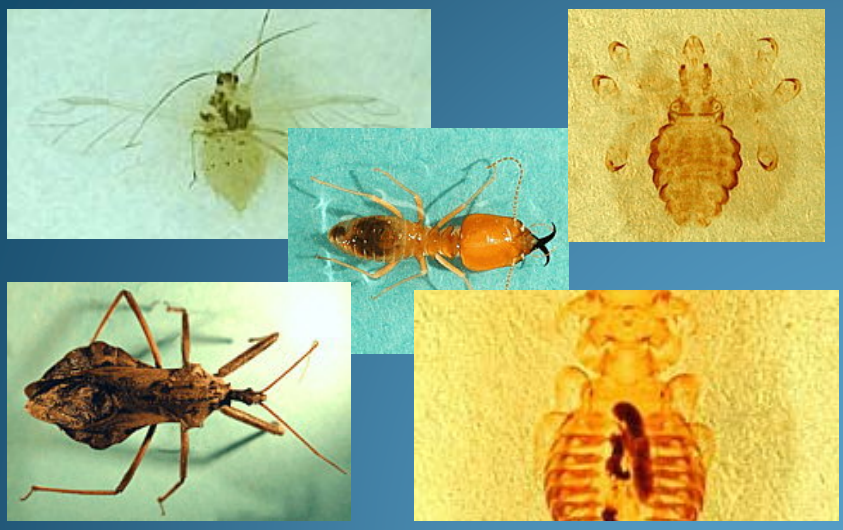


Insect Orders (1)



Insect Orders (2)



Insect Families

Web-based Pictorial Specimen quizzes

Table 5.1.
Summary of Significant Differences in Pre-quiz and Post-quiz Change Scores for Web-based Pictorial Specimens.

	M	*SD*	*t*	*df*	*d*	Sig. (2-tailed)
Experiment 1						
Arth. Classes	.80	1.262	4.484	49	.641	.000
Insect Orders (1)	.82	.330	3.846	49	.549	.000
Insect Orders (2)	1.30	.286	5.111	49	.730	.000
Insect Families	1.80	.307	6.834	49	.976	.002
Experiment 2						
Arth. Classes	.95	1.316	5.008	63	.631	.000
Insect Orders (1)	1.92	2.379	6.462	63	.814	.000
Experiment 3						
Arth. Classes	1.30	1.531	5.644	44	.851	.000

Web-based ID Quiz Results

- Statistically significant improvement in ID performance for all groups pre and post web-based quizzes

In-Class Prepared Specimen Quizzes

Mixed randomized repeated analysis of variance

	Λ	*df*	*F*	*p*	η^2
Classification Level	**.480**	**3, 141**	**16.258**	**.000***	**.52**
Treatment		2, 47	2.252	.116	
Classification X Treatment	.837	6, 141	1.396	.225	

*$p \leq .05$

In-Class Prepared Specimen Quizzes Post-Hoc

Table 4.1.
Experiment 1 In-Class Prepared Specimens
Post Hoc Analysis Classification Level Main Effect

	M	*SD*	*t*	*df*	Cohen's *d*	Sig.	
Arth. Classes - Orders 1	.044	.330	.138	49	.121	.354	
Arth. Classes - Orders 2	.089	.286	2.202	49	.328	.032	*
Arth. Classes - I. Families	.297	.307	6.834	49	.864	.000	*
Orders 1 - Orders 2	.045	.398	.807	49	.149	.424	
Orders 1 – I. Families	.253	.358	5.008	49	.650	.000	*
Orders 2 – I. Families	.208	.365	4.028	49	.733	.000	*

*sig. Holm's sequential Bonferroni Procedure

% Misspelled and Misidentified Specimens

Table 5.6.
Summary of Significant Differences in Percentage of Misspelled and Misidentified Specimens

	Misspelled		Misidentified		
	M	*SD*	*M*	*SD*	*p*
Experiment 1					
Arth. Classes	12.2	21.2	87.8	21.2	.000
Insect Orders (1)	36.5	45.9	63.5	45.9	.107
Insect Orders (2)	15.3	26.0	84.7	26.0	.000
Insect Families	19.3	28.6	80.7	28.6	.000
Experiment 2					
Arth. Classes	31.9	38.7	68.1	39.7	.001
Insect Orders (1)	36.7	40.8	63.3	40.8	.041
Experiment 3					
Arth. Classes	39.3	26.0	60.7	26.0	.011

Results

- More specimens misidentified at family level
- Significantly more misidentified specimens than misspelled specimens

Student Survey

- 92.3% of students responded that they believed Web-based instruction improved their performance
- 92.0% said they used Web-based exercises in studying for quizzes
- Compared to other instructional materials in class students thought it had a small impact in helping them to learn insect ID (M = 4.40, SD= .50)

Research Questions

- Do differences exist in students' ability to identify specimens based on the type of Web-based instruction they received?
- Do differences exist in student performance at the class, order, or family levels of classification?

Research Questions (Cont.)

- Do differences exist in the ratio of misspelled and misidentified specimens as a result of the different types of Web-based instruction students received?
- If students err in prepared specimen identification, are a greater percentage of the errors due to misspellings or misidentifications?

Implications

- Shows evidence of improvement in student performance (web-based)
- Shows how students err
- Implications for distance delivery situations
- Applicable to other areas of identification

Future Research

- Examine other types of instruction
  - Making students better observers and focus on perceptual cues
- Monitor student use of Web-based exercises
- More research with naïve audiences

Thank you

http://entomology.unl.edu/tmh/ent116/tutorials.shtml

Questions