Tuning USA Final Report – Utah

February 28, 2011

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1. Introduction

This report is a final report of the Utah Tuning Pilot Project begun in March 2009. It supplements the interim report dated November 18, 2009. That report is attached to this one as Appendix E. Accordingly, the activities covered in that report are not repeated here, but we have tried to report on all aspects of the project that have been carried out since the interim report.

We have derived degree-level learning outcomes from the discipline-specific and general competencies identified in the interim report (Sections 2 and 3).

Major progress was made since the interim report on consultation with stakeholders, a significant component of the Tuning methodology. In particular, we have collected and analyzed general competencies surveys, and we have carried out an in-depth focus group with employers of history graduates. These results and reports are included in the present final report (Section 4).

We report on numerous presentations to disciplinary, professional, and educational groups in which we have shared our experiences of Tuning the disciplines of history and physics (Section 5).

The Tuning teams have worked together to clarify the story of the Tuning project and the presentation of results. This work has included discussions of approaches to taking the results to their departmental colleagues and sharing of discussions and outcomes at the departmental level. This effort is still in early stages, and future plans are outlined along with a summary of progress in Section 6.

Finally, we have made contact with the two major private institutions of higher education in Utah: Brigham Young University and Westminster College. Prospects for future work including these additional institutions are reported in Section 7.

2. Utah History Learning Outcomes

Using the competencies developed in the first part of this project (see Appendix E), the History Team wrote the following Learning Outcomes for Bachelor's degrees in history:

HISTORICAL KNOWLEDGE

I. (Range of historical information)
   A. Identify the key events which express/define change over time in a particular place or region.
   B. Identify how change occurs over time
   C. Explain historical continuity and change
   D. Describe the influence of political ideologies, economic structures, social organization, cultural perceptions, and natural environments on historical events
   E. Discuss the ways in which factors such as race, gender, class, ethnicity, region, and religion influence historical narratives

HISTORICAL THINKING

II. (Recognize the past-ness of the past)
   A. Explain how people have existed, acted, and thought in the past
   B. Explain what influence the past has on the present

III. (Emphasize the complex nature of past experiences)
   A. Interpret the complexity and diversity of situations, events, and past mentalities
   B. Compare eras and regions in order to define enduring issues

IV. (Emphasize the complex and problematic nature of the historical record)
   A. Recognize a range of viewpoints
   B. Compare competing historical narratives
   C. Challenge arguments of historical inevitability
   D. Analyze cause-and-effect relationships and multiple causation

HISTORICAL SKILLS

V. (Develop skills in critical thinking and reading)
   A. Evaluate debates among historians
   B. Differentiate between historical facts and historical interpretations
   C. Assess the credibility of primary and secondary sources

VI. (Develop research skills)
   A. Formulate historical questions

B. Obtain historical data from a variety of sources
C. Identify gaps in available records

VII. (Develop the ability to construct reasonable historical arguments)
A. Construct a well-organized historical argument
B. Support an interpretation with historical evidence from a variety of primary and secondary sources

3. Utah Physics Learning Outcomes

Using the competencies developed in the first part of this project (see Appendix E), the Physics Team wrote the following Learning Outcomes for Bachelor's degrees in physics:

1. The Nature of Science and Nature of Physics

- Give examples of what constitutes convincing evidence for a scientific explanation; analyze the roles of experiment, interpretation of experimental results, and argument in establishing evidence
- Explain how experimental evidence can falsify scientific hypotheses and how it can contribute to acceptance of scientific concepts
- Categorize the variety of approaches to research in physics; analyze the distinctive roles each approach plays in the development of physical explanations
- Define physical cause and effect; suggest how cause-effect relationships can be inferred from experimental data
- Identify main points of scientific ethics and responsibility relating to laboratory practice, work with students and collaborators, co-authorship, publication and public advocacy
- Explain how science is a community effort and argue both the necessity of scientific cooperation and the advantages and disadvantages of solitary science
- Identify and relate the major historical threads in the development of physics

2. Mathematical Skills, Modeling Skills, and Problem Solving Skills

- Solve correctly typical algebraic problems and calculus problems from typical bachelor's degree physics texts
- Interpret the meaning of the mathematics that occurs in a particular physical context from typical bachelor's degree physics texts:
  - Explain what physical quantities are represented by the algebraic symbols
  - Explain the physical meaning of vector algebra
  - Discuss the context for the equations, i.e. assumptions and simplifications, and explain how the equations would change with different assumptions
- Estimate orders of magnitude of physical quantities; estimate orders of magnitude of solutions to physics problems; explain how to identify quickly whether a problem solution or other physical quantity is of reasonable magnitude
- Graph related physical quantities in ways that illuminate underlying physical interpretations; interpret graphs from typical bachelor's degree physics texts
- Build a physical model for an effect from a typical bachelor's degree physics text; identify the most important concepts in the phenomena that must be included in the model
  - Analyze what one can learn from simple models and what their limitations are
- Build and work with mathematical models by
  - Casting a story problem from a typical bachelor's degree physics text into a mathematical model
  - Identifying the physical concepts in a given mathematical model
  - Distinguishing problem solving and modeling, identifying differences and relationships
- Map a selected problem from a typical bachelor's degree physics text to a new problem with similar mathematics but different physics
- Organize a problem from a typical bachelor's degree physics text by identifying the relevant physical principles, identifying relevant vs. irrelevant quantities, and making appropriate

diagrams
- Organize quantitative information in a problem from a typical bachelor's degree physics text by clearly stepping through the mathematics of the problem solution

3. Understanding of Physics Concepts

- Explain the major threads of physics concepts: conservation laws, forces (gravity, e&m), fields, Newton's laws, work and energy, optics, thermodynamics, relativity, quantum mechanics
- Identify key elements in the functioning of a physical system and relate them to the construction of a physical model

4. Laboratory Skills

- Identify practices necessary for safety in using particular undergraduate research or teaching laboratory equipment
- Suggest how safety could be improved in a particular undergraduate research or teaching laboratory
- Carry out error analysis on laboratory data; explain what the errors mean for data interpretation
- Evaluate the quality of laboratory data; explain the importance of such evaluation
- Design a laboratory measurement to answer a physical question on the level of typical bachelor's degree physics texts
- Analyze the connections between what one measures and how one infers the physical interpretation of the measurements

5. Scientific Communication Ability (written, oral, and visual communication)

- Write essays on physics topics and problem explanations in complete, correctly punctuated sentences that are well organized and clearly express careful arguments
- Explain physics concepts clearly in writing without mathematics
- Present physics topics clearly to peers and in the more formal setting of local or regional meetings
- Impart knowledge of physics understandably to less advanced students in a teaching situation

6. Computational and Information Skills

- Demonstrate the use of any of the scientific software packages associated with the usual bachelor's degree curriculum
- Create a simple computer program to calculate physical effects
- Demonstrate the use of a spreadsheet to solve physics problems; demonstrate the use of Maple, MatLab or a similar computer algebra system to solve physics problems
- Explain the major issues of numerical analysis, such as error estimation, in the context of a problem from a typical bachelor's degree physics text or in the context of a computer program related to such a problem
- Find information in the physics research or teaching literature on an assigned topic from a typical bachelor's degree physics text

7. Research

- Apply physics competencies semi-independently in a research laboratory setting by designing an experiment that involves multiple concepts, interpreting experimental results that involve multiple concepts, suggesting an hypothesis for a physical effect and how to test it, or building a

mathematical model that gives a coherent interpretation of a physical effect

- Synthesize physics principles and applications to explain a novel effect observed in the laboratory or in a thought experiment
- Present research results clearly and coherently, identifying significant motivations for the work, describing and interpreting the findings, and explaining the significance of the results

4. Consultation with Stakeholders: Surveys and Focus Group

The Utah teams carried out both surveys and an employer focus group. The survey report includes responses from 1828 general education students, 431 majors in history or physics, 27 graduate students in history or physics, 48 faculty members, and 26 employers. The latest update of the survey report follows. It is followed by the focus group report that included 12 employers of history majors.

These reports provided both confirming data and food for thought regarding the priorities the Tuning teams had given to general and discipline-specific competencies. They will be used in discussions with departmental faculty to provide support for the competencies and learning outcomes proposed by the Tuning teams (see Section 6).

We had contemplated, as part of the grant's no-cost extension, setting up a meeting with an employer group (Salt Lake Chamber and Utah Technology Council) to explain what we have done, get feedback, and establish relationships for future collaboration. The prospective participants in this proposed meeting overlapped sufficiently strongly with the LEAP (AAC&U) meeting held in April 2010 that we judged that we could carry out employer consultations more effectively through focus groups, as reported below. In addition, our November 2010 Conference on "What Is an Educated Person?" included employer representatives and discussion of their expectations. In light of these overlapping activities, we did not pursue the tentatively planned larger employer meeting.

A. <u>Utah Tuning Surveys Report</u>

February 28, 2011 (Update)

Utah Tuning Surveys Report Executive Summary

In 2009 and 2010, the Utah System of Higher Education (USHE) conducted surveys of general competencies with students, faculty, and employers as part of Tuning history and physics with support from the Lumina Foundation for Education. The following summary conclusions are representative of the information found throughout the report:

- Most important competencies for both disciplines, nearly all survey groups, included
    - Capacity to learn and update learning
    - Essential knowledge and understanding of academic subjects and profession
    - Reasoned decision-maker
    - Able to identify, pose and resolve problems
    - Oral and written communication

  At least four of the survey groups included each of these five competencies among their most important.

- Even for competencies that both physics and history groups rated among their most important, the order of importance differed between the disciplines, as one might expect.

- History majors and faculty rated the following competencies as most important:
    - Essential knowledge and understanding of academic subjects and profession
    - Able to search for, process and analyze information
    - Capacity to learn and update learning
    - Oral and written communication
    - Reasoned decision-maker

- Physics majors and faculty had a different set of priorities for most important competencies:
    - Able to identify, pose and resolve problems
    - Essential knowledge and understanding of academic subjects and profession
    - Able to apply knowledge in practical situations
    - Capacity to learn and update learning
    - Abstract thinking, analysis and synthesis

- Physics graduate students were distinct in their bias toward research, as expected from their discipline:
    - Creativity, able to generate new ideas
    - Able to undertake research at an appropriate level
    - Able to identify, pose and resolve problems
    - Abstract thinking, analysis and synthesis
    - Essential knowledge and understanding of academic subjects and profession

- Employers valued a set of competencies that have clear relevance to the workplace. Here are employers' most important general competencies in descending order:
    - Able to evaluate and maintain the quality of work produced
    - Able to identify, pose and resolve problems
    - Determination and perseverance in tasks and responsibilities
    - Able to plan and manage time
    - Able to work in a team

- Top five priorities among the general competencies were consistent with the most important competencies ratings. At least five of the survey groups included each of the following five competencies among their top priorities:
    - Capacity to learn and update learning
    - Able to apply knowledge in practical situations
    - Essential knowledge and understanding of academic subjects and profession
    - Oral and written communication
    - Abstract thinking, analysis and synthesis

  Three of these overlap with the five rated most important, and the other two from the most important ratings (Reasoned decision-maker and Able to identify, pose and resolve problems) were also high priority. The two competencies added here (Able to apply knowledge in practical situations and Abstract thinking, analysis and synthesis) appear in most important ratings by several of the subgroups.

- The low importance rated competencies were as consistent among the survey groups as the high importance competencies. Between five and nine of the survey groups identified the following general competencies as of low importance:
    - Commitment to environmental conservation
    - Communication in a second language
    - Able to work in an international context
    - Commitment to workplace safety

  As for the high importance ratings, there were differences between the disciplines in relative priorities and in the other low-rated competencies. In fact, workplace safety was seen as of low importance for history respondents generally, while of high importance for physics respondents.

- As can be seen from the graphs in the report, Importance ratings and How Well Developed ratings are positively correlated for all the groups with *N* large enough to do this analysis, except for Utah Technology Council Employers. The employers did not distinguish How Well Developed appreciably, while seeing a considerable range of differences among Importance of different competencies.

- Importance ratings by UTC Employers correlate well with those by Physics Majors + Graduate Student

Utah Tuning Surveys Report

February 28, 2011 (Update)

INTRODUCTION

As part of the Tuning Process for History and Physics in Utah we conducted consultations in 2009 and early 2010 by surveying the following groups on their judgment of the relative importance and relative current production quality of the general competencies in these two disciplines:

- Students in Lower Division History Courses (General Education, *N* = 804)
- Students in Lower Division Physics Courses (General Education, *N* = 1024)
- Upper Division History Majors (*N* = 302)
- Upper Division Physics Majors (*N* = 129)
- Graduate Students in History (*N* = 10)
- Graduate Students in Physics (*N* = 17)
- Faculty (Mixed General Education Disciplines, *N* = 34, History, *N* = 14)
- Employers (*N* = 26)

Copies of the survey instruments are attached to this report.

<u>Data Reporting</u>

This report does not include raw data, although these are available upon request. We report the analysis of survey responses below by discipline and by the following groups:

- General Education Students
- Discipline Majors
- Graduate Students
- Faculty
- Employers

<u>Data Analysis</u>

The data analysis reported here consists of the following summary information:

- Top Five Priorities according to the total ranking of general competencies (It was clear in looking at the survey results that some people listed Top Five Priorities in priority order, while others listed them in numerical order. Accordingly, we have simply counted the number of times each general competency was listed among the Top Five in the survey responses, not retaining the order in which these were listed. We then ranked the resulting list.)
- Bottom Five Priorities according to the total ranking of general competencies
- Most Important General Competencies by average score according to the assignment of importance 1 (= no importance) to importance 4 (= strong importance)

- Least Important General Competencies by average score according to the assignment of importance 1 (= no importance) to importance 4 (= strong importance)
- Best Developed General Competencies by average score according to the assignment 1 (= not well developed) to 4 (= strong)
- Least Well Developed General Competencies by average score according to the assignment 1 (= not well developed) to 4 (= strong)

In addition, we include some scatter plots showing the correlation for general competencies between importance and how well developed and between importance according to employers and according to physics majors + graduate students. We identify outliers in the scatter plots and comment in the Executive Summary.

Executive Summary

The Executive Summary at the beginning of this document provides both a summary of findings and interpretive discussion. In particular, we compare the top and bottom priorities among the different groups of respondents to evaluate the degree of consensus about general competencies.

History General Education Students Response to General Competencies

N = 804 (Top Five Priorities: *N* = 592)

Top Five Priorities (in descending order)

31 (182) Capacity to learn and update learning
27 (170) Able to plan and manage time
17 (159) Able to apply knowledge in practical situations
5 (152) Essential knowledge and understanding of academic subjects and profession
2 (142) Oral and written communication

Bottom Five Priorities (in descending order)

7 (37) Communication in a second language
11 (30) Able to work in an international context
28 (30) Initiative, spirit of enterprise
29 (30) Commitment to workplace safety
18 (29) Able to design and manage projects

Most Important General Competencies by average score (in descending order)

31 (3.69) Capacity to learn and update learning
5 (3.63) Essential knowledge and understanding of academic subjects and profession
30 (3.56) Reasoned decision-maker
17 (3.56) Able to apply knowledge in practical situations
27 (3.54) Able to plan and manage time

Least Important General Competencies by average score (in descending order)

29 (3.04) Commitment to workplace safety
11 (3.04) Able to work in an international context
18 (3.01) Able to design and manage projects
24 (2.92) Commitment to environmental conservation
7 (2.37) Communication in a second language

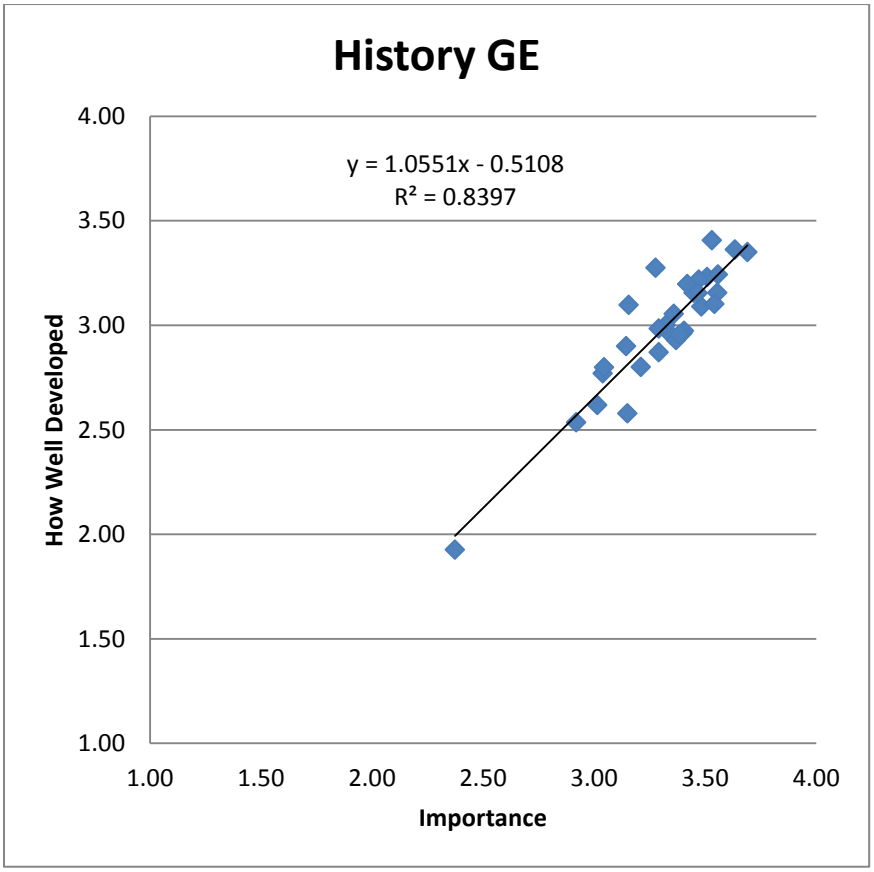
Best Developed General Competencies by average score (in descending order)

6 (3.41) Appreciation of and respect for ethnic, cultural and other diversity
5 (3.36) Essential knowledge and understanding of academic subjects and profession
31 (3.35) Capacity to learn and update learning
1 (3.28) Shows awareness of equal opportunities and gender issues
30 (3.24) Reasoned decision-maker

Least Well Developed General Competencies by average score (in descending order)

11 (2.77) Able to work in an international context

18 (2.62) Able to design and manage projects
25 (2.58) Able to work in a team
24 (2.54) Commitment to environmental conservation
7 (1.93) Communication in a second language



Physics General Education Students Response to General Competencies

N = 1024 (Top Five Priorities: *N* = 898)

Top Five Priorities (in descending order)

17 (413) Able to apply knowledge in practical situations
19 (376) Able to identify, pose and resolve problems
31 (275) Capacity to learn and update learning
13 (262) Creativity, able to generate new ideas
20 (253) Abstract thinking, analysis and synthesis

Bottom Five Priorities (all zero ranked)

7 (36) Communication in a second language
24 (32) Commitment to environmental conservation
1 (31) Shows awareness of equal opportunities and gender issues
11 (30) Able to work in an international context
6 (25) Appreciation of and respect for ethnic, cultural and other diversity

Most Important General Competencies by average score (in descending order)

31 (3.68) Capacity to learn and update learning
17 (3.67) Able to apply knowledge in practical situations
19 (3.64) Able to identify, pose and resolve problems
5 (3.58) Essential knowledge and understanding of academic subjects and profession
30 (3.55) Reasoned decision-maker

Least Important General Competencies by average score (in descending order)

24 (2.79) Commitment to environmental conservation
1 (2.68) Shows awareness of equal opportunities and gender issues
11 (2.67) Able to work in an international context
6 (2.66) Appreciation of and respect for ethnic, cultural and other diversity
7 (2.15) Communication in a second language

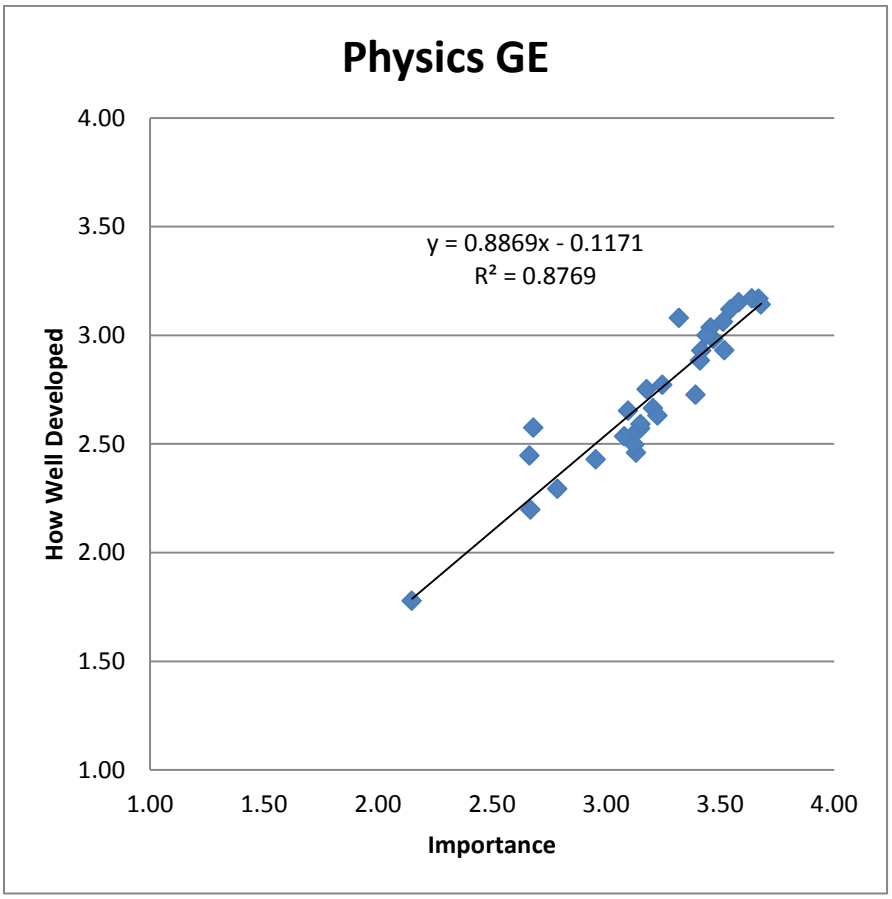
Best Developed General Competencies by average score (in descending order)

19 (3.17) Able to identify, pose and resolve problems
17 (3.17) Able to apply knowledge in practical situations
5 (3.15) Essential knowledge and understanding of academic subjects and profession
31 (3.14) Capacity to learn and update learning
30 (3.12) Reasoned decision-maker

Least Well Developed General Competencies by average score (in descending order)

6 (2.45) Appreciation of and respect for ethnic, cultural and other diversity

16 (2.43) Social responsibility and civic awareness
24 (2.29) Commitment to environmental conservation
11 (2.20) Able to work in an international context
7 (1.78) Communication in a second language



History Majors Response to General Competencies

N = 302 (Top Five Priorities: *N* = 271)

Top Five Priorities (in descending order)

14 (103) Able to search for, process and analyze information
5 (91) Essential knowledge and understanding of academic subjects and profession
17 (90) Able to apply knowledge in practical situations
20 (83) Abstract thinking, analysis and synthesis
2 (82) Oral and written communication
31 (82) Capacity to learn and update learning

Bottom Five Priorities (in descending order)

28 (18) Initiative, spirit of enterprise
15 (16) Information and communications technologies skills
18 (9) Able to design and manage projects
24 (8) Commitment to environmental conservation
29 (4) Commitment to workplace safety

Most Important General Competencies by average score (in descending order)

5 (3.83) Essential knowledge and understanding of academic subjects and profession
14 (3.80) Able to search for, process and analyze information
31 (3.73) Capacity to learn and update learning
2 (3.73) Oral and written communication
30 (3.66) Reasoned decision-maker

Least Important General Competencies by average score (in descending order)

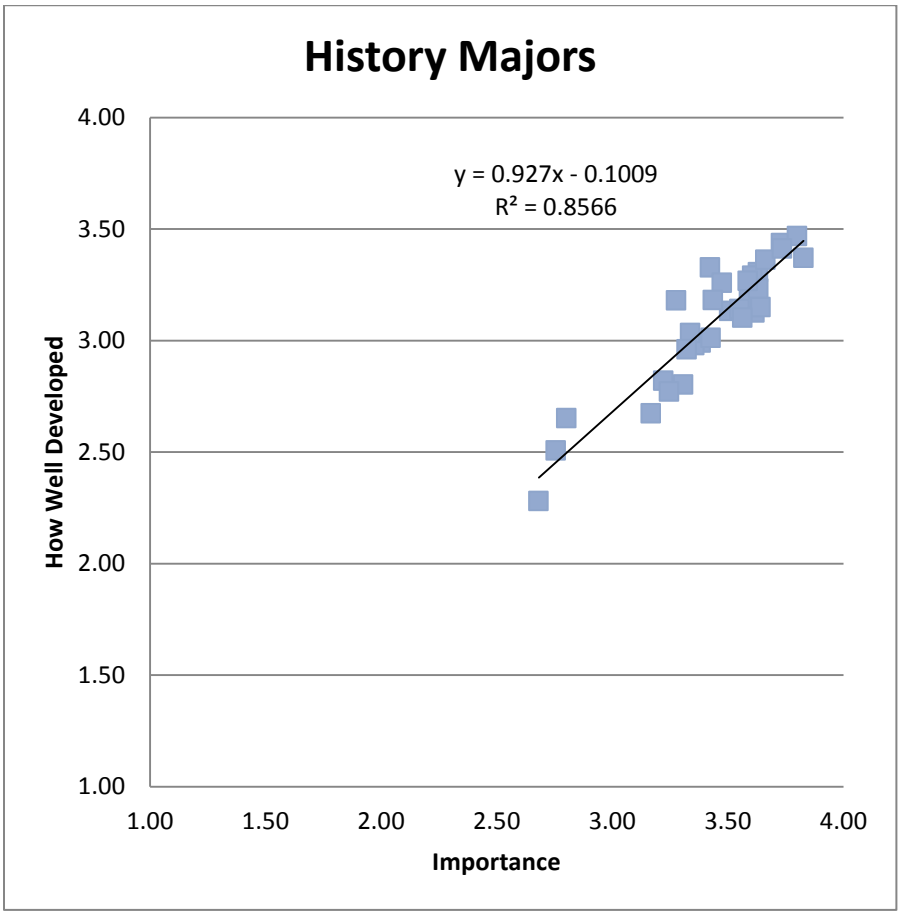
18 (3.22) Able to design and manage projects
25 (3.17) Able to work in a team
29 (2.80) Commitment to workplace safety
24 (2.76) Commitment to environmental conservation
7 (2.68) Communication in a second language

Best Developed General Competencies by average score (in descending order)

14 (3.47) Able to search for, process and analyze information
2 (3.44) Oral and written communication
31 (3.41) Capacity to learn and update learning
5 (3.37) Essential knowledge and understanding of academic subjects and profession
30 (3.36) Reasoned decision-maker

Least Well Developed General Competencies by average score (in descending order)

22 (2.77) Able to motivate people and move toward common goals
25 (2.67) Able to work in a team
29 (2.65) Commitment to workplace safety
24 (2.51) Commitment to environmental conservation
7 (2.28) Communication in a second language



Physics Majors Response to General Competencies

N = 129 (Top Five Priorities: *N* = 118)

Top Five Priorities (in descending order)

19 (63) Able to identify, pose and resolve problems
17 (49) Able to apply knowledge in practical situations
20 (44) Abstract thinking, analysis and synthesis
13 (43) Creativity, able to generate new ideas
5 (41) Essential knowledge and understanding of academic subjects and profession

Bottom Five Priorities (in descending order)

1 (4) Shows awareness of equal opportunities and gender issues
11 (4) Able to work in an international context
24 (4) Commitment to environmental conservation
7 (2) Communication in a second language
29 (2) Commitment to workplace safety
6 (1) Appreciation of and respect for ethnic, cultural and other diversity

Most Important General Competencies by average score (in descending order)

19 (3.29) Able to identify, pose and resolve problems
5 (3.28) Essential knowledge and understanding of academic subjects and profession
17 (3.22) Able to apply knowledge in practical situations
31 (3.22) Capacity to learn and update learning
20 (3.21) Abstract thinking, analysis and synthesis

Least Important General Competencies by average score (in descending order)

16 (2.48) Social responsibility and civic awareness
24 (2.40) Commitment to environmental conservation
1 (2.27) Shows awareness of equal opportunities and gender issues
6 (2.14) Appreciation of and respect for ethnic, cultural and other diversity
7 (1.70) Communication in a second language

Best Developed General Competencies by average score (in descending order)

30 (2.87) Reasoned decision-maker
19 (2.80) Able to identify, pose and resolve problems
31 (2.77) Capacity to learn and update learning
26 (2.729) Determination and perseverance in tasks and responsibilities
3 (2.727) Able to work autonomously
5 (2.727) Essential knowledge and understanding of academic subjects and profession

Least Well Developed General Competencies by average score (in descending order)

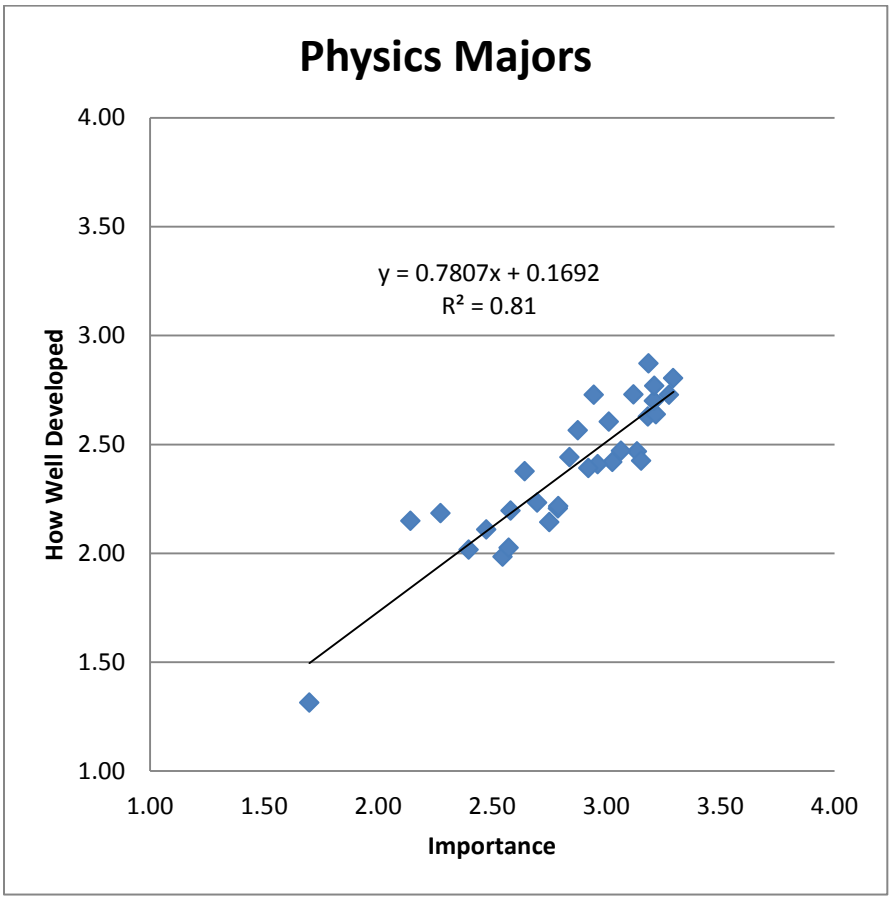
16 (2.11) Social responsibility and civic awareness

22 (2.03) Able to motivate people and move toward common goals

24 (2.02) Commitment to environmental conservation

11 (1.98) Able to work in an international context

7 (1.31) Communication in a second language



History Graduate Students Response to General Competencies

N = 10 (Top Five Priorities: *N* = 6)

Top Five Priorities (in descending order)

4 (4) Able to evaluate and maintain the quality of work produced
13 (3) Creativity, able to generate new ideas
20 (3) Abstract thinking, analysis and synthesis
2 (2) Oral and written communication
5 (2) Essential knowledge and understanding of academic subjects and profession
8 (2) Communication with non-experts in one's field
27 (2) Able to plan and manage time
31 (2) Capacity to learn and update learning

Bottom Five Priorities (all zero ranked)

1 Shows awareness of equal opportunities and gender issues
3 Able to work autonomously
9 Adaptability to new situations
10 Ethical reasoning
11 Able to work in an international context
14 Able to search for, process and analyze information
15 Information and communications technologies skills
16 Social responsibility and civic awareness
18 Able to design and manage projects
21 Able to be critical and self-critical
25 Able to work in a team
26 Determination and perseverance in tasks and responsibilities
29 Commitment to workplace safety

Most Important General Competencies by average score (in descending order)

2 (3.90) Oral and written communication
5 (3.90) Essential knowledge and understanding of academic subjects and profession
20 (3.90) Abstract thinking, analysis and synthesis
31 (3.90) Capacity to learn and update learning
14 (3.80) Able to search for, process and analyze information
19 (3.80) Able to identify, pose and resolve problems

Least Important General Competencies by average score (in descending order)

18 (3.10) Able to design and manage projects
11 (2.90) Able to work in an international context
29 (2.70) Commitment to workplace safety

24 (2.50) Commitment to environmental conservation
7 (2.30) Communication in a second language

Best Developed General Competencies by average score (in descending order)

2 (3.80) Oral and written communication
14 (3.78) Able to search for, process and analyze information
1 (3.70) Shows awareness of equal opportunities and gender issues
5 (3.70) Essential knowledge and understanding of academic subjects and profession
20 (3.70) Abstract thinking, analysis and synthesis
23 (3.70) Interpersonal and interaction skills
30 (3.70) Reasoned decision-maker

Least Well Developed General Competencies by average score (in descending order)

17 (2.89) Able to apply knowledge in practical situations
8 (2.70) Communication with non-experts in one's field
18 (2.67) Able to design and manage projects
7 (2.60) Communication in a second language
24 (2.30) Commitment to environmental conservation

Physics Graduate Students Response to General Competencies

N = 17 (Top Five Priorities: *N* = 17)

Top Five Priorities (in descending order)

13 (11) Creativity, able to generate new ideas
20 (8) Abstract thinking, analysis and synthesis
12 (7) Able to undertake research at an appropriate level
17 (7) Able to apply knowledge in practical situations
5 (6) Essential knowledge and understanding of academic subjects and profession
25 (6) Able to work in a team
31 (6) Capacity to learn and update learning

Bottom Five Priorities (all zero ranked)

6 Appreciation of and respect for ethnic, cultural and other diversity
8 Communication with non-experts in one's field
11 Able to work in an international context
16 Social responsibility and civic awareness
22 Able to motivate people and move toward common goals
24 Commitment to environmental conservation
30 Reasoned decision-maker

Most Important General Competencies by average score (in descending order)

13 (4.00) Creativity, able to generate new ideas
12 (3.941) Able to undertake research at an appropriate level
19 (3.941) Able to identify, pose and resolve problems
20 (3.941) Abstract thinking, analysis and synthesis
5 (3.938) Essential knowledge and understanding of academic subjects and profession

Least Important General Competencies by average score (in descending order)

10 (3.18) Ethical reasoning
24 (3.18) Commitment to environmental conservation
11 (3.13) Able to work in an international context
7 (3.00) Communication in a second language
16 (3.00) Social responsibility and civic awareness

Best Developed General Competencies by average score (in descending order)

14 (3.47) Able to search for, process and analyze information
5 (3.38) Essential knowledge and understanding of academic subjects and profession
12 (3.35) Able to undertake research at an appropriate level
30 (3.35) Reasoned decision-maker

3 (3.31) Able to work autonomously

<u>Least Well Developed General Competencies by average score (in descending order)</u>

16 (2.47) Social responsibility and civic awareness
22 (2.47) Able to motivate people and move toward common goals
10 (2.41) Ethical reasoning
7 (2.13) Communication in a second language
24 (2.12) Commitment to environmental conservation

Faculty Response to General Competencies (Mixed General Education Disciplines)

N = 34 (Top Five Priorities: *N* = 34)

Top Five Priorities (in descending order)

2 (20) Oral and written communication
20 (14) Abstract thinking, analysis and synthesis
5 (12) Essential knowledge and understanding of academic subjects and profession
30 (11) Reasoned decision-maker
31 (11) Capacity to learn and update learning

Bottom Five Priorities (all zero ranked)

11 Able to work in an international context
22 Able to motivate people and move toward common goals
24 Commitment to environmental conservation
28 Initiative, spirit of enterprise
29 Commitment to workplace safety

Most Important General Competencies by average score (in descending order)

2 (3.76) Oral and written communication
30 (3.71) Reasoned decision-maker
31 (3.68) Capacity to learn and update learning
5 (3.65) Essential knowledge and understanding of academic subjects and profession
10 (3.59) Ethical reasoning

Least Important General Competencies by average score (in descending order)

22 (2.79) Able to motivate people and move toward common goals
11 (2.76) Able to work in an international context
24 (2.71) Commitment to environmental conservation
29 (2.53) Commitment to workplace safety
7 (2.42) Communication in a second language

Best Developed General Competencies by average score (in descending order)

Least Well Developed General Competencies by average score (in descending order)

Not Available

Faculty Response to General Competencies (History – Utah State U)

N = 14 (Top Five Priorities: *N* = 13)

Top Five Priorities (in descending order, *N*=13)

20 (7) Abstract thinking, analysis and synthesis
2 (6) Oral and written communication
12 (6) Able to undertake research at an appropriate level
14 (5) Able to search for, process and analyze information
21 (5) Able to be critical and self-critical

Bottom Five Priorities (all zero ranked, *N*=13)

1 Shows awareness of equal opportunities and gender issues
3 Able to work autonomously
9 Adaptability to new situations
16 Social responsibility and civic awareness
22 Able to motivate people and move toward common goals
24 Commitment to environmental conservation
25 Able to work in a team
27 Able to plan and manage time
28 Initiative, spirit of enterprise
29 Commitment to workplace safety

Most Important General Competencies by average score (in descending order)

2 (4.00) Oral and written communication
4 (3.92) Able to evaluate and maintain the quality of work produced
12 (3.79) Able to undertake research at an appropriate level
14 (3.79) Able to search for, process and analyze information
30 (3.79) Reasoned decision-maker
31 (3.79) Capacity to learn and update learning

Least Important General Competencies by average score (in descending order)

28 (2.64) Initiative, spirit of enterprise
24 (2.62) Commitment to environmental conservation
25 (2.50) Able to work in a team
22 (2.46) Able to motivate people and move toward common goals
29 (1.92) Commitment to workplace safety

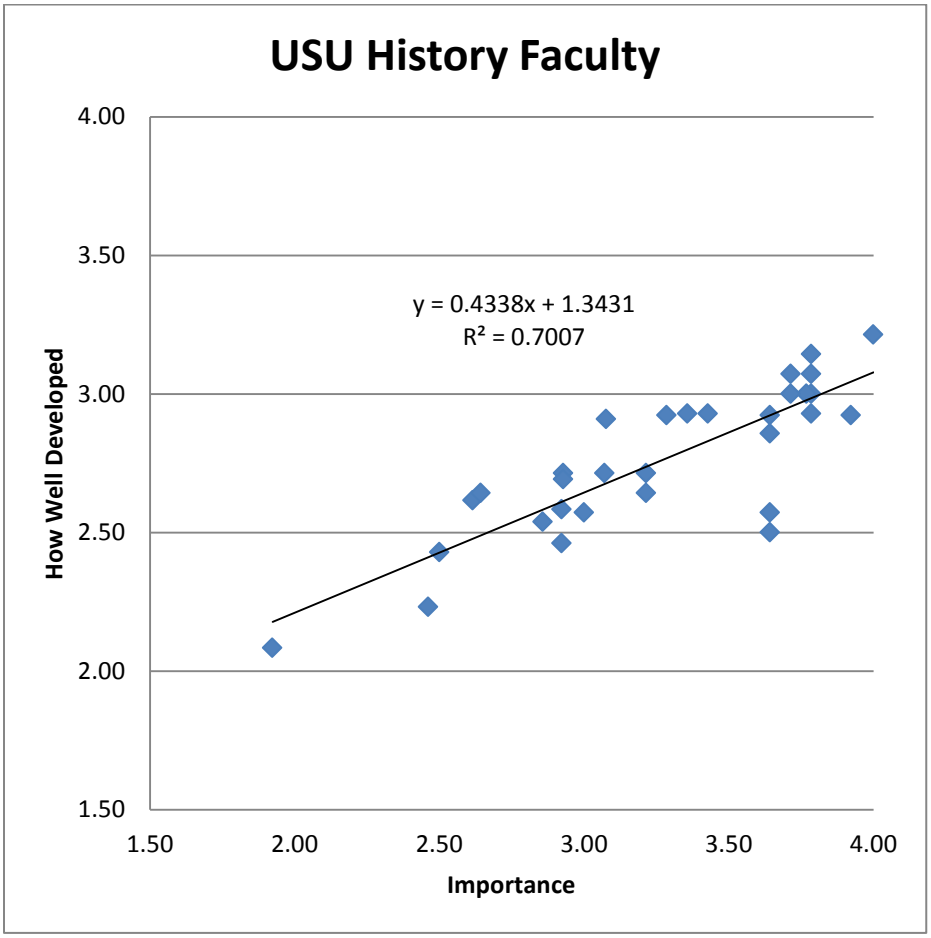
Best Developed General Competencies by average score (in descending order)

2 (3.21) Oral and written communication
31 (3.14) Capacity to learn and update learning

5 (3.07) Essential knowledge and understanding of academic subjects and profession
30 (3.07) Reasoned decision-maker
14 (3.00) Able to search for, process and analyze information
20 (3.00) Abstract thinking, analysis and synthesis
26 (3.00) Determination and perseverance in tasks and responsibilities

Least Well Developed General Competencies by average score (in descending order)

21 (2.50) Able to be critical and self-critical
18 (2.46) Able to design and manage projects
25 (2.43) Able to work in a team
22 (2.23) Able to motivate people and move toward common goals
29 (2.08) Commitment to workplace safety



Employer Response to General Competencies (Both Disciplines, Emphasis on Technical Disciplines)

N = 26 (Top Five Priorities: *N* = 21)

Top Five Priorities (in descending order)

25 (10) Able to work in a team
2 (8) Oral and written communication
19 (8) Able to identify, pose and resolve problems
26 (7) Determination and perseverance in tasks and responsibilities
27 (7) Able to plan and manage time

Bottom Four Priorities (all zero ranked)

1 Shows awareness of equal opportunities and gender issues
6 Appreciation of and respect for ethnic, cultural and other diversity
16 Social responsibility and civic awareness
24 Commitment to environmental conservation

Most Important General Competencies by average score (in descending order)

4 (3.81) Able to evaluate and maintain the quality of work produced
19 (3.81) Able to identify, pose and resolve problems
26 (3.81) Determination and perseverance in tasks and responsibilities
27 (3.81) Able to plan and manage time
25 (3.77) Able to work in a team

Least Important General Competencies by average score (in descending order)

1 (2.85) Shows awareness of equal opportunities and gender issues
16 (2.50) Social responsibility and civic awareness
11 (2.27) Able to work in an international context
24 (2.04) Commitment to environmental conservation
7 (1.66) Communication in a second language

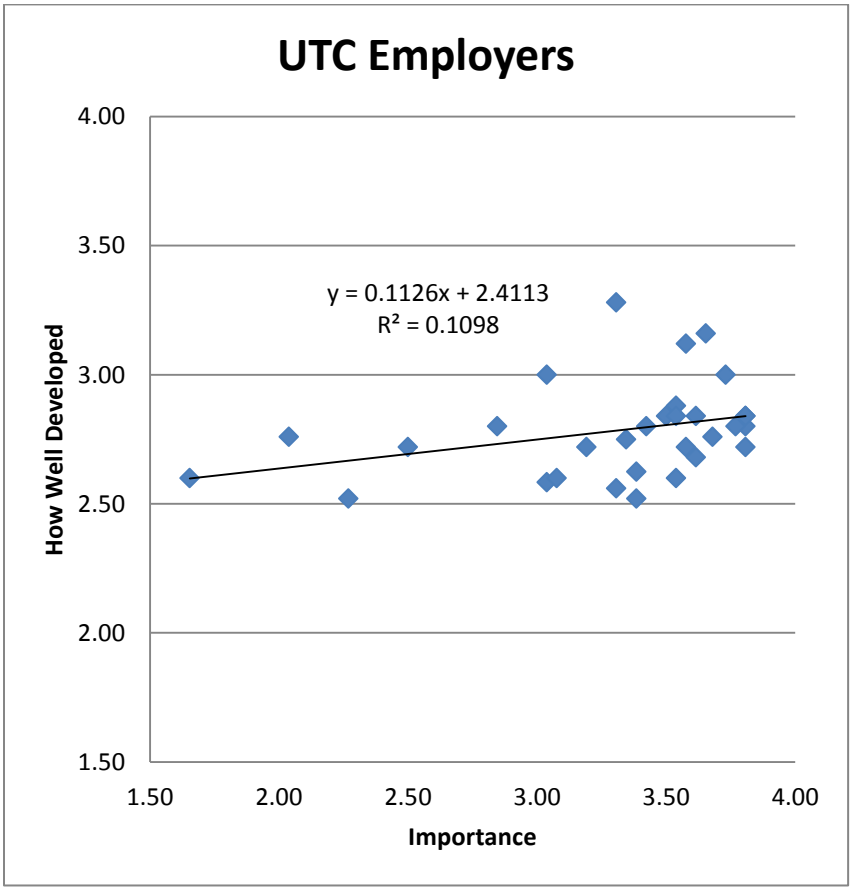
Best Developed General Competencies by average score (in descending order)

5 (3.28) Essential knowledge and understanding of academic subjects and profession
15 (3.16) Information and communications technologies skills
31 (3.12) Capacity to learn and update learning
12 (3.00) Able to undertake research at an appropriate level
14 (3.00) Able to search for, process and analyze information

Least Well Developed General Competencies by average score (in descending order)

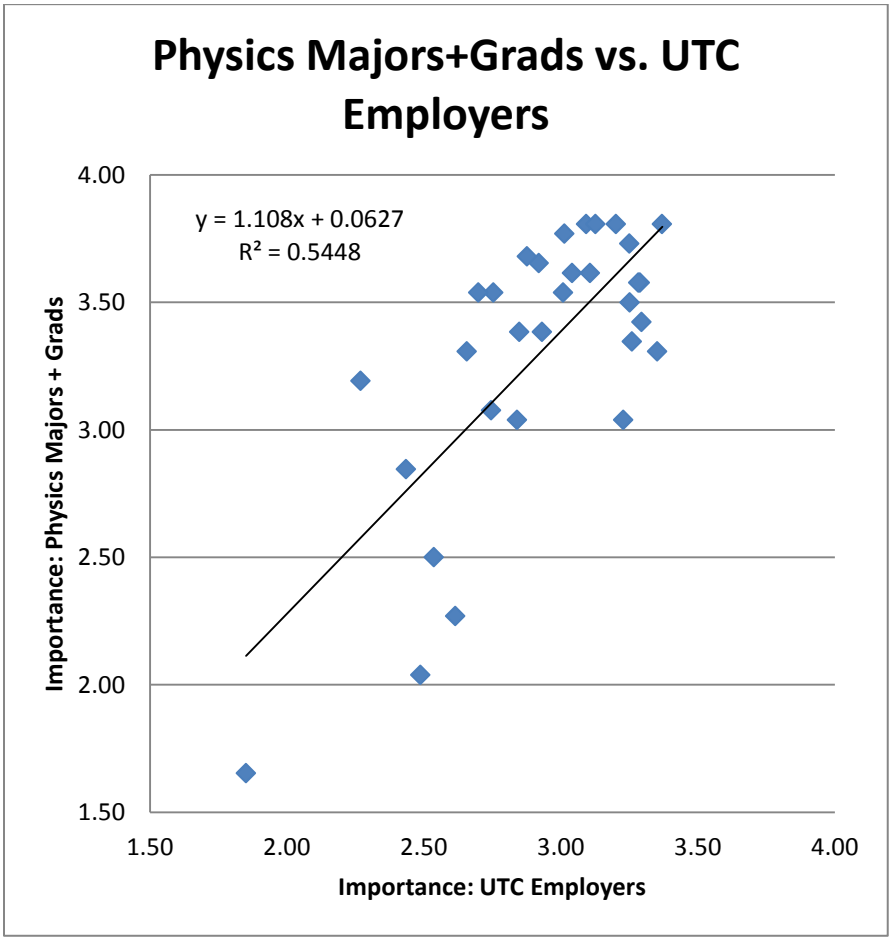
7 (2.60) Communication in a second language

9 (2.60) Adaptability to new situations
29 (2.60) Commitment to workplace safety
8 (2.58) Communication with non-experts in one's field
22 (2.56) Able to motivate people and move toward common goals
11 (2.52) Able to work in an international context
21 (2.52) Able to be critical and self-critical



Comparison of Utah Technology Council Employer Importance Ratings and Physics Majors + Graduate Students

N = 146



These two groups gave well-correlated responses. For outliers below the trend line, employers value the competency relatively more than physics majors. These include only low importance competencies:

7 Communication in a second language
24 Commitment to environmental conservation
11 Able to work in an international context
12 Able to undertake research at an appropriate level

Outliers above the trend line indicate that physics majors value the competency relatively more than employers. There is one such primary outlier, of low to middle importance:

6 Appreciation of and respect for ethnic, cultural and other diversity

TYPICAL SURVEY INSTRUMENT

Draft

Survey on Essential Characteristics of an Educated Person - Students in General Education History classes

This survey presents a series of questions related to the skills and competencies that may be important as you pursue higher education.
Please answer all the questions. The answers will be very valuable in improving course planning for future students of history. ***Many thanks for your help***

For each of the skills listed below, please estimate:
-the **importance** of the skill or competency, in your opinion; and
-the **level** to which each skill or competency is developed by the Gen Ed history course you are taking.

Please use the following scale: 1 = none; 2 = weak; 3 = considerable; 4 = strong

Skill/Competency	Importance				How well developed			
	1	2	3	4	1	2	3	4
1. Ability to show awareness of equal opportunities and gender issues	O	O	O	O	O	O	O	O
2. Ability to communicate both orally and through the written word in native language	O	O	O	O	O	O	O	O
3. Ability to work autonomously	O	O	O	O	O	O	O	O
4. Ability to evaluate and maintain the quality of work produced	O	O	O	O	O	O	O	O
5. Knowledge and understanding of the subject area and understanding of the profession	O	O	O	O	O	O	O	O
6. Appreciation of and respect for diversity and multiculturality	O	O	O	O	O	O	O	O
7. Ability to communicate in a second language	O	O	O	O	O	O	O	O
8. Ability to communicate with non-experts in one's field	O	O	O	O	O	O	O	O
9. Ability to adapt to and act in new situations	O	O	O	O	O	O	O	O
10. Ability to act on the basis of ethical reasoning	O	O	O	O	O	O	O	O
11. Ability to work in an international context	O	O	O	O	O	O	O	O
12. Ability to undertake research at an appropriate level	O	O	O	O	O	O	O	O
13. Capacity to generate new ideas (creativity)	O	O	O	O	O	O	O	O
14. Ability to search for, process and analyze information from a variety of sources	O	O	O	O	O	O	O	O
15. Skills in the use of information and communications technologies	O	O	O	O	O	O	O	O
16. Ability to act with social responsibility and civic awareness	O	O	O	O	O	O	O	O
17. Ability to apply knowledge in practical situations	O	O	O	O	O	O	O	O
18. Ability to design and manage projects	O	O	O	O	O	O	O	O
19. Ability to identify, pose and resolve problems	O	O	O	O	O	O	O	O
20. Ability for abstract thinking, analysis and synthesis	O	O	O	O	O	O	O	O
21. Ability to be critical and self-critical	O	O	O	O	O	O	O	O
22. Ability to motivate people and move toward common goals	O	O	O	O	O	O	O	O
23. Interpersonal and interaction skills	O	O	O	O	O	O	O	O
24. Commitment to the conservation of the environment	O	O	O	O	O	O	O	O
25. Ability to work in a team	O	O	O	O	O	O	O	O
26. Determination and perseverance in the tasks given and responsibilities taken	O	O	O	O	O	O	O	O
27. Ability to plan and manage time	O	O	O	O	O	O	O	O
28. Spirit of enterprise, ability to take initiative	O	O	O	O	O	O	O	O
29. Commitment to safety	O	O	O	O	O	O	O	O
30. Ability to make reasoned decisions	O	O	O	O	O	O	O	O
31. Capacity to learn and stay up-to-date with learning	O	O	O	O	O	O	O	O

IN ADDITION, please rank below **the five most important competencies** in your opinion. Mark on the first line the number of the most important competency, on the second line the number of the second most important and so on.

1. Item number: |__|__|
2. Item number: |__|__|
3. Item number: |__|__|
4. Item number: |__|__|
5. Item number: |__|__|

EMPLOYER SURVEY INSTRUMENT

2009 Workforce Survey

Essential Characteristics Survey

This survey presents a series of questions related to the skills and abilities that are important to employers when they hire graduates of higher education programs in Utah. It is part of a study by the Utah System of Higher Education.

Please answer all the questions. The answers will be very valuable in improving course planning for future students.

Many thanks for your help

17. For each of the items listed below, please estimate the **importance** of the skill or ability, in your opinion:

Please use the following scale: 1 = none; 2 = weak; 3 = considerable; 4 = strong

	1	2	3	4
1. Shows awareness of equal opportunities and gender issues	○	○	○	○
2. Oral and written communication	○	○	○	○
3. Able to work autonomously	○	○	○	○
4. Able to evaluate and maintain the quality of work produced	○	○	○	○
5. Essential knowledge and understanding of academic subjects and profession	○	○	○	○
6. Appreciation of and respect for ethnic, cultural and other diversity	○	○	○	○
7. Communication in a second language	○	○	○	○
8. Communication with non-experts in one's field	○	○	○	○
9. Adaptability to new situations	○	○	○	○
10. Ethical reasoning	○	○	○	○
11. Able to work in an international context	○	○	○	○
12. Able to undertake research at an appropriate level	○	○	○	○
13. Creativity, able to generate new ideas	○	○	○	○
14. Able to search for, process and analyze information	○	○	○	○
15. Information and communications technologies skills	○	○	○	○
16. Social responsibility and civic awareness	○	○	○	○
17. Able to apply knowledge in practical situations	○	○	○	○
18. Able to design and manage projects	○	○	○	○
19. Able to identify, pose and resolve problems	○	○	○	○
20. Abstract thinking, analysis and synthesis	○	○	○	○
21. Able to be critical and self-critical	○	○	○	○

22. Able to motivate people and move toward common goals

23. Interpersonal and interaction skills

24. Commitment to environmental conservation

25. Able to work in a team

26. Determination and perseverance in tasks and responsibilities

27. Able to plan and manage time

28. Initiative, spirit of enterprise

29. Commitment to workplace safety

30. Reasoned decision-maker

31. Capacity to learn and update learning

18. For each of the items listed below, please estimate the **level** of the skill or ability, in your opinion:

Please use the following scale: 1 = none; 2 = weak; 3 = considerable; 4 = strong

	1	2	3	4
1. Shows awareness of equal opportunities and gender issues				
2. Oral and written communication				
3. Able to work autonomously				
4. Able to evaluate and maintain the quality of work produced				
5. Essential knowledge and understanding of academic subjects and profession				
6. Appreciation of and respect for ethnic, cultural and other diversity				
7. Communication in a second language				
8. Communication with non-experts in one's field				
9. Adaptability to new situations				
10. Ethical reasoning				
11. Able to work in an international context				
12. Able to undertake research at an appropriate level				
13. Creativity, able to generate new ideas				
14. Able to search for, process and analyze information				
15. Information and communications technologies skills				
16. Social responsibility and civic awareness				
17. Able to apply knowledge in practical situations				
18. Able to design and manage projects				
19. Able to identify, pose and resolve problems				
20. Abstract thinking, analysis and synthesis				

21. Able to be critical and self-critical

22. Able to motivate people and move toward common goals

23. Interpersonal and interaction skills

24. Commitment to environmental conservation

25. Able to work in a team

26. Determination and perseverance in tasks and responsibilities

27. Able to plan and manage time

28. Initiative, spirit of enterprise

29. Commitment to workplace safety

30. Reasoned decision-maker

31. Capacity to learn and update learning

19. IN ADDITION, please rank below the **five most important skills and abilities** according to your opinion. Mark on the first line the number of the most important item above, one the second line the number of the second most important, and so on. (Example: if you enter the number 3 in the first line - you are ranking "Able to work autonomously" as the most important)

1. Item number (1st most important): _____

2. Item number:

3. Item number: _____

4. Item number:

5. Item number (5th most important):

B. REPORT ON RESEARCH WITH EMPLOYERS OF GRADUATES WITH HISTORY MAJORS

Executive Summary

In 2009, the Utah System of Higher Education (USHE) began the Tuning project, intended to determine what is most important for graduates with a major in history to know, understand, and be able to do. A team of history professors, composed of one history faculty member from each USHE institution, worked together to determine critical learning outcomes and the competencies that support those outcomes that would be common to all college and university programs in the state. The project directors administered a survey to employers, and a focus group was conducted with 12 employers who specifically hire history majors. The following summary conclusions are representative of the information found throughout the report:

- The top 6 skills desired by those hiring history majors were ability to research, good communication (written and oral), critical thinking, ability to organize, passion for the subject, and knowledge of the subject area. The ranking of these varied according to the nature of the institution, and the ability to research was the only skill listed in the top 5 by all 12 participants.

- In hiring a new employee, various participants look for personality, qualifications, experience, training in specific areas in addition to the basic history courses, customer service skills, and the ability to manage a project.

- Indications of skills in an applicant included references, a good cover letter, and information obtained from the applicant's Facebook site.

- Because of the variety of the work of the participants, they all felt that some on-the-job training was necessary. The consensus was that this was best done through robust internships.

- The strengths of recent hires have been organization skills, technology skills, strong training in Mormon history (specific to the participants from the church), writing skills, and a work ethic.

- Some gaps in the training of graduates are that they need to be more diversified, to have more coursework in Utah history, western history, and public history, and to be better able to analyze primary documents.

- Within Utah, participants hire from the University of Utah, Brigham Young University, and Utah State University. They reported hiring from schools throughout the country, seeking graduates from programs meeting their specific needs.

- Participants recommended that curriculum in history include introduction to public history at the undergraduate level and a strong master's program in public history. Emphasis in a specific area of history would be useful although they did value diversity and adaptability. A strong internship program with cooperation between faculty and mentors was suggested. Research skills, particularly with primary sources, are critical.

- Use of the focus group provided insights not found through the use of the survey. Future use of focus groups with other disciplines and stakeholders is strongly recommended.

REPORT ON RESEARCH WITH EMPLOYERS OF GRADUATES WITH HISTORY MAJORS

Introduction to the Study

Working on a grant from the Lumina Foundation for Education, the Utah System of Higher Education (USHE) began the Tuning project, intended to determine what is most important for graduates with a major in history to know, understand, and be able to do. A team of history professors worked together to determine critical learning outcomes and the competencies that support those outcomes that would be common to all college and university programs in the state. In order to determine what employers were seeking, the project directors conducted research using a survey similar to one that had been used in Europe. A focus group was also conducted with 12 employers who specifically hire history majors. This report is based on information from the focus group, but it also includes results from the previous survey. A second objective of this research was to determine the value of focus groups for the current research. The focus group was conducted by Shannon Fletcher from Lighthouse Research. The research team consisted of the following individuals:

Bill Evenson, Ph.D., Tuning Project Director, Utah
Teddi Safman, Ph.D., Assistant Commissioner for Academic Affairs, Utah System of Higher Education
Norm Jones, Ph.D., Chair, Department of History, Utah State University
Janice Gygi, Ph.D., Tuning Project Associate Director, Utah

Guiding Questions

In order to verify the results of the survey and to determine if other issues should be considered, the research team developed a list of 7 key questions that would help guide the history team to confirm and prioritize their current learning objectives. The questions are:

1. What skills do you expect from a history major? What is unique about the training of a history major?
2. What do you look for when you are hiring a new employee? What is the most useful indicator of what the applicant can do?
3. What type of on-the-job training do you expect to do with any new hire? Do history majors necessarily need less on-the-job training than other majors? What type of educational background makes this training easier?
4. In evaluating the education of history majors, what do you find to be the most useful skills that they possess? What are the universities doing really well?
5. Are there gaps in what you have expected and what the graduates can do? What are the specific problem areas that you would like to see improved?
6. From what colleges and universities do you hire?
7. If you were the person in charge of setting the curriculum for Utah's university and college history majors, what would you do to make sure they are successful in the marketplace?

Data Collection Process

1. The history team was composed of a history professor from each state university and college in Utah. They worked with their departments to determine the outcomes that were appropriate for history majors. Secondary research was used to examine outcomes that had been developed

by professional organizations, such as the American Historical Association. A draft of the outcomes is attached in Appendix A.

2. A survey, based on that used in the Tuning Project in Europe, was administered to faculty, students, alumni, and employers. For the employer survey, the results from employers of both physics and history graduates were combined, with 26 respondents for the entire survey and 21 respondents for those that selected the top 5 competencies. Most of the respondents were from technical disciplines rather than history.

3. On December 8, 2010, 12 employers, who specifically hire history majors, participated in a two-hour focus group session at Lighthouse Research. The session was facilitated by Shannon Fletcher, Director of Market Research, PRC (Professional Research Certification) certified as expert. The research team watched the proceedings from the engineering room. Participants included one individual from a private firm doing history research, three from the Church of Jesus Christ of Latter-day Saints (LDS) Department of History, two from the Utah State Archives, two from the Utah State Historical Society, three from historical museums, and one from the archive section of a state university. Each participant was given $75, delivered immediately at the end of the session. The session was taped and DVD copies were provided to the Tuning research team. Additional copies were sent to the Lumina Foundation, the funding organization for the Tuning project.

Major Findings and Recommendations

Each question was analyzed using the focus group responses and the survey results. In some cases, the focus group responses varied depending on the way the question was posed. Each participant had a workbook in which they wrote the answers to many of the questions. Eleven of the 12 workbooks were collected after the session and were used for the evaluation. The results are discussed below.

1. What skills do you expect from a history major? What is unique about the training of a history major?

Each participant was asked to give the top skill on his or her list. Then participants were asked to offer any other skill that had not been listed. After the list was completed, participants were asked to vote for their top five. In several instances, skills that had been listed were consolidated. The subcategories below indicate the skills that were included in the major heading. The results (and the number of participants voting for each one) are:

1. Ability to research (12)
2. Good communication – written and verbal (10)
    a. Ability to write for an audience
    b. Publishing experience
3. Critical thinking (6)
    a. Creative problem solving
    b. Analytical thinking
    c. Analyzing problems
4. Ability to organize – index and catalog (5)
5. Passion for the subject – curiosity (5)

6. Knowledge of the subject (5)

An evaluation of the individual workbooks showed that the desired skills varied according to the particular institution that was hiring. While all 12 participants voted for research skills as one of their top 5, those who had research skills listed as number 1 were 6 individuals from the state historical departments and the LDS Church historical departments. The museum people listed traits such as good personality, customer service skills, ability to work with all age groups, passion for history, and frugality. (It appears that the museums struggle to obtain resources.)

When asked to rate the top 5 priorities on a scale of 1 to 7, where 1 is not at all important and 7 is very important, the skills desired were rated as follows:

1. Critical thinking (6.3)
2. Good communication (6.3)
3. Ability to organize (6.1)
4. Ability to research (6.0)
5. Passion for the subject/Knowing the subject (5.9)

Again, these represent averages, and individuals in different institutions rated the skills very differently. It was not unusual to have an individual rate 3 skills at the 7 level.

When asked to rate how the graduates from Utah universities and colleges actually perform on these skills on a scale of 1 to 7, where 1 was poor and 7 was excellent, the results were:

1. Passion for the subject/Knowing the subject (5.6)
2. Ability to research (4.9)
3. Ability to organize (4.8)
4. Good communication (4.7)
5. Critical thinking (4.4)

The top 5 priorities from the survey respondents were:

1. Ability to work in a team
2. Oral and written communication
3. Ability to identify, pose, and resolve problems
4. Determination and perseverance in tasks and responsibilities
5. Ability to plan and manage time

When asked to rate the importance of skills on a 1- to 4-point scale, with 1 being none and 4 being strong, the following skills emerged:

1. Ability to evaluate and maintain the quality of work produced (3.81)
2. Ability to identify, pose, and resolve problems (3.81)
3. Determination and perseverance in tasks and responsibilities (3.81)
4. Ability to plan and manage time (3.81)
5. Ability to work in a team (3.77)

As with the focus-group participants, the diversity amongst the respondents to the survey accounted for the differences in the priorities and the rankings of important skills. In the survey, respondents were allowed to select from 31 characteristics. In the focus group, the skills were limited to the 5 previously selected by the group. In addition, the survey had more respondents than the focus group, providing more diversity in the rankings.

When asked to rate a graduate's actual skill, the employers on the survey responded:

1. Essential knowledge and understanding of academic subjects and profession (3.28)
2. Information and communications technologies skills (3.16)
3. Capacity to learn and update learning (3.12)
4. Ability to undertake research at an appropriate level (3.00)
5. Ability to search for, process, and analyze information (3.0)

When asked the question, "If a person with a history degree was a type of vehicle, what brand of vehicle would he or she be? Why?" focus group responses were quite different from the skills listed above, and tended, perhaps, to be more indicative of work ethic or personality characteristics than academic skills. Six of the 10 indicated that versatility or flexibility was important. Other traits included reliability, dependability, easy to maintain, and can find out how to do something they don't know how to do.

According to these results, it appears that the one learning outcome that may be unique to history is the ability to research. All the participants indicated that they did want to hire history majors, and they discussed the specific skills, such as evaluation of primary sources, that are unique to history research. All of the other outcomes are expected of graduates with any bachelor's degree, including knowledge of a specific discipline. Employers seem to want "well educated" graduates with the skills learned through a liberal education.

2. What do you look for when you are hiring a new employee? What is the most useful indicator of what the applicant can do?

The traits and skills desired depend on the level at which one is employed. Less is expected of student hires than of hires with graduate degrees. Some of the traits the employers were seeking were:

Personality was suggested. "I have found in my experience it's much easier to teach a skill than to change somebody's personality. If they're not one that's inclined to want to talk to people and be outgoing, it's very difficult to work with that, whereas a skill and knowledge can always be trained." Another desired trait was to be able to work with others and be a part of a team.

One participant reported that in a previous job as a history consultant, subject matter and expertise were valuable, but more important was "finding people who could write well, who really knew the historical methodology, and we tried to measure that by making sure that they sent in writing samples, which we insisted were not published pieces, because we couldn't tell from a published piece how much editing had been done prior to that."

Qualifications and experience are very important, as is attention to detail.

"Well, my experience with public history is that having the subject area expertise in history and having passion for it is sort of a baseline. Beyond that then I would always look for people who've had additional training in archives and historic preservation and architecture and architectural history. In all the jobs I've had, there's always been a need for people who go beyond the traditional history training." Training is important in other areas such as library science, archives, historic preservation, and archeology. The broader their training the better qualified they are.

"In the library world, I think customer service is one thing. We had to have someone that can work with the public well. There are a lot of historians that can't." This was also important in the work in museums.

"One thing I haven't really looked for in my career, but I'm finding is critical today is the ability to manage projects. Project management is a new, big field that is important in a lot of businesses." Technology skills are also becoming increasingly important.

Some additional indicators of skills

References are important. Later in the discussion the participants indicated that they often hire from each other, and the recommendations and experience are critical.

The structure and breadth of the cover letter can be very telling. "It is always nice" to have correct punctuation and grammar.

"One of the things we've caught onto is to get onto their Facebook site. You see what kind of comments they are making back and forth. That can be a real indicator." There was considerable agreement about this among the participants.

3. **What type of on-the-job training do you expect to do with any new hire? Do history majors necessarily need less on-the-job training than other majors? What type of educational background makes this training easier?**

"Every organization is unique and . . . that's why we like interns that volunteer with us, because for free we teach them the job, and then, if we end up hiring them, they already know it. Every collection is very unique. It's hands on."

"To be effective, our volunteers or interns need to understand our relationships with the organizations above us and how they're organized, and where you to go to get stuff from what we call our higher headquarters. There are different staff functions in those organizations that are over us." Learning how to work within a bureaucracy effectively is important.

"We have the two programs, so we have to teach anyone that comes in records management, because no one teaches records management." But each institution has its own unique records management regulations and it's specific.

With government records, there is a presumption of openness, and that all records are public, but there is also the expectation of the public for privacy, so the processing of records (in state

institutions) is very complicated and must be taught. Some employees had not learned how to keep a research log and organize their work, so this had to be taught.

The libraries and archives have to teach referencing and where to find things. The technical skills that must be taught vary amongst the institutions, and include access, preservation, and presentation, as well as learning the applicable standards. In one of the museums, they must teach things such as churning butter, spinning yarn, and lighting a fire.

At one of the historical research agencies, "probably 70% of the historical work that we did . . . was in support of litigation, and so we had to train our employees about the life of a legal case, so when they were asked to write an expert witness report, they knew they were coming in at a certain part of the case, and they knew what had already gone on before and what they could expect the attorneys to be asking of them." So training in forensic history was important.

The participants indicated that the amount of on-the-job training was not dependent on the degree held by the individual. They thought that it was often more dependent on the individual and his or her skills.

In general, the participants encourage those hired with bachelor's degrees to pursue a further education, but few had any means of supporting this. In addition, they encouraged individuals to become active in professional organizations. Some of them buy memberships and encourage employees to attend conferences of the professional organizations.

4. In evaluating the education of history majors, what do you find to be the most useful skills that they possess? What are the universities doing really well?

Recent hires have been organized and know how to use technology.

"We've hired some people that are very bright and very well trained in Mormon history. . . . They're coming out of history departments that have religious study programs" (particularly Utah State University). They have a broad understanding of what other historians have done in other fields and of historical methodology and historiography.

"The last few interns we've had have had good writing abilities. That's something that we haven't always seen. They may be exceptions, but they've done very well."

Those who have hired professionals have found they have had a very good work ethic, though this is not always the case with those hired for summer museum jobs. The volunteers and interns have a passion already, so there's quite a bit of work ethic in that in the first place. "They just love being there."

5. Are there gaps in what you have expected and what the graduates can do? What are the specific problem areas that you would like to see improved?

Graduates need to be more diversified. Some want to just be curators or do individual research. They need to be able to work with the public. "You've got to do all kinds of stuff."

Some critical coursework appears to be lacking. For example, the employers tend to work with Utah history and would like the graduates to spend time on Utah history or western history, "rather than far eastern or medieval studies." Another course area that many felt was lacking was public history. Most of the employers deal with public history and did not feel that graduates had any background in that at all.

The employers want graduates who have experience in analyzing primary documents. They felt that students tend to read and analyze books but do not use the original documents. Graduates are willing to accept secondary research rather than doing their own primary research. Experience with directed primary research would be valuable.

When the museums hired temporary summer workers, they often felt the students had a poor work ethic.

6. From what colleges and universities do you hire?

Three Utah universities were mentioned: University of Utah, Brigham Young University, and Utah State University. One of the museums had hired 3 summer employees from Utah Valley University, and one participant indicated he was surprised no one had mentioned Weber State University, because "they have a strong history department."

The participants indicated that they often hired from outside the state. They were looking for schools that trained in such areas as library science, archives, public history, historic preservation, and English folklore. Schools that were mentioned as having supplied graduates were Santa Barbara, BYU Idaho, North Carolina, Colorado, York, and Eastern Illinois. They also indicated that they often hired from their interns and volunteers.

One individual said that "in 1985, the University of Utah had the best history program in the country. And now it has no reputation whatsoever in that way."

7. **If you were the person in charge of setting the curriculum for Utah's university and college history majors, what would you do to make sure they are successful in the marketplace?**

Several participants indicated that at least an introduction to public history at the undergraduate level would be important, and a master's program with a strong emphasis on public history would be valuable. They felt that "Utah university programs are doing nothing to distinguish them from any other public university or program." There are programs in other states that do distinguish themselves, so they're more likely to hire from those programs. They felt that a major that had a little more application to a specific area of history, rather than just a general history degree, would be useful.

On the other hand, they did want versatility, flexibility, and adaptability. A graduate would need to be able to fit into whatever position that was available.

A robust internship program was considered to be vital to the training of students. "I think I would like to follow the model that they use in education, where there's a real partnership between the faculty and the mentor in a student teaching situation. Often, the interns hear about an opportunity, and they just treat it as a part time summer job, and we treat it that way

as well. I think we could improve the internship experience if we had a relationship with the faculty, and some educational objectives were associated with the internship." Throughout the session, participants stressed the importance of internships. One stated that he saw his facility as "a laboratory to teach students to do at least some kinds of public history, like oral history, archives, and things like that. . . . That's really what's going to help graduates to have that hands-on experience." They valued a combination of the intellectual content with the practical application. In addition to providing experience for students, several participants indicated that they often hired from among their interns.

The participants felt that research skills were critical, and they wanted the students to be able to find and analyze primary sources. They indicated that graduates often have skill in analyzing secondary sources, but they needed some directed training in the use of primary resources.

Future Research Suggestions and Limitations of the Present Study

1) Participants in the present study represented employers who hire graduates specifically for their degrees in history. Many graduates find positions in firms or institutions where their skills are valued, but where they are not involved in projects concerning history. Other focus groups might be conducted with employers who have hired history majors, but who do not work in history.

2) Although there was some agreement between the focus group input and the previous survey on important skills for history graduates, the survey did not really include questions on discipline-specific skills such as research and knowledge of the subject. A second survey, including more discipline-specific questions would be valuable.

3) Because of the small number of participants, findings from a focus group cannot be generalized. However, often a contribution of even one individual can provide valuable insight into the issues of concern. The focus group provided good information about the important learning outcomes, but it also provided suggestions for improvements that could be helpful to the universities and colleges. Future use of focus groups in other disciplines is recommended. Faculty, students, and alumni, in addition to employers, could offer valuable insights.

4) The differences in ratings between the skills that employers value and the skills that graduates are perceived to possess should be evaluated. Is the discrepancy more important in some areas than others? Do employers expect to provide on-the-job training for some skills more than others? What is an "acceptable" level of skills?

5. Presentations to Professional, Disciplinary and Higher Education Groups

- Norman L. Jones, "Can We Know Our Outcomes?" *Perspectives on History* (AHA), March 2009

- Association for Institutional Research, June 2009, Atlanta, "Utah's Experience with the Bologna Process," William Evenson

- State Higher Education Executive Officers, August 2009, Denver, "Tuning in Utah: A Match Made in Heaven," Phyllis 'Teddi' Safman

- Utah Conference on "What Is an Educated Person?" October 2009, Orem, Utah, "Utah Tuning Project," William Evenson, Kathryn MacKay, Daniel McInerney

- Association of American Colleges and Universities, January 2010, Washington, DC, "Tuning the Disciplines: The Humanities; The Tuning Process in Two States: Indiana and Utah," Norman Jones, Marianne Wokeck, Daniel J. McInerney

- American Council on Education, March 2010, Phoenix, "Getting a Handle on Assessment: New Directions in the U.S. and Europe," Phyllis 'Teddi' Safman

- New England Educational Assessment Network, March 2010, Amherst, MA, Workshop: "Assessing Outcomes in History Degrees," Norman Jones

- Texas Kickoff for Tuning Engineering Disciplines, April 2010, Austin, "Navigating the Tuning Process," William Evenson, Phyllis 'Teddi' Safman, Brad Carroll, Brian Saam, Larry Smith

- Western Academic Leadership Forum (WICHE), April 2010, Rapid City, "Tuning History and Physics in Utah," Phyllis 'Teddi' Safman and William Evenson

- Daniel J. McInerney, "Rubrics for History Courses: Lessons from One Campus." *Perspectives on History* (AHA), October 2010

- American Physical Society Four Corners Section, October 2010, Ogden, Utah, "Perspectives on the Utah Physics Tuning Project," James Chisholm

- Conference of the Americas on International Education, October 2010, Calgary, "Tuning USA: Lumina Foundation for Education and Utah System of Higher Education," William Evenson

- Conference of the Americas on International Education, October 2010, Calgary, "Utah's Experience with the Bologna Process and Tuning," William Evenson

- National Governors' Association, November 2010, Washington, DC, "Lessons from the Bologna Process and Tuning in Utah," William Evenson

- Utah Conference on "What Is an Educated Person?" November 2010, Salt Lake City, Utah, "Gen Ed in Utah: The State of Play," Norman Jones

- Kentucky Tuning Kickoff, November 2010, Lexington, "Navigating the Tuning Process," William Evenson, Janice Gygi

- Meeting with Chair of NWCCU (Northwest Regional Accreditors), Cid Seidelman, along with Dean Mary Jane Chase (Westminster College, Salt Lake City), December 13, 2010, "Tuning and Accreditation," William Evenson and Janice Gygi

- Association of American Colleges and Universities, January 2011, San Francisco, "Tuning US Degrees – It Takes a Faculty," Phyllis 'Teddi' Safman, Norman Jones, Adina O'Hara, Marcus Kolb

- Association of American Colleges and Universities, January 2011, San Francisco, "Emerging State Models for Tuning in General Education and Transfer," Norman Jones, Ken O'Donnell, Adina O'Hara

- SnowPAC Conference, February 2011, Snowbird, Utah, "Tuning Physics" (mini-talk), James Chisholm

- American Physical Society, March 2011, Dallas, "Tuning Physics," Brad Carroll

6. Taking Tuning Results Into Discipline Departments

Members of the Tuning Teams agreed to discuss the results of Tuning their respective disciplines with their departmental colleagues and seek to apply these results in curriculum, pedagogy, and assessment. The teams had some discussion about strategy (see meeting notes in Appendix), but we are still feeling our way. Some departments have been very receptive, while faculty members at the other extreme don't want to be bothered. We are planning to have some statewide meetings of department chairs and regional meetings of faculty so that faculty members who understand the benefits of Tuning can help the reluctant ones catch the vision of this work.

This is an important part of making Tuning bear real fruit in Utah higher education. The Tuning teams took some months to catch the vision and come to an epiphany wherein they understood that they, as faculty and students, really had both the responsibility and the opportunity to define the curriculum and assessment in a new way. Similarly, we expect their faculty colleagues to require repeated exposure and multiple approaches in order to see the real values of Tuning. We are at early stages of a relatively long but promising effort in this regard.

As part of the discussions with departments and colleagues, we will seek to have departments rewrite their departmental degree profiles (see Interim Report), taking explicit account of the disciplinary learning outcomes.

7. Utah Private Institutions of Higher Education

We have approached Brigham Young University and Westminster College (Salt Lake City) informally about joining in the Tuning effort. They are eager to participate but would be more comfortable starting with new disciplines so they could be part of the process from the beginning. We plan to include them in new projects as part of a Tuning 2 grant.

8. Appendices

A. Utah Team Meeting Agendas Since December 2009

Utah Tuning Project
IP-Video, February 19, 2010, 3-5 pm
Agenda

1. Planning for No-cost Extension to Lumina Grant
2. Discussion of Future Grant Proposal
3. Bill & Teddi's Involvement with Texas Project to Tune Engineering Disciplines
4. National Task Force on Teacher Education in Physics
5. Review comments on November 2009 Project Report: Restatement of Learning Outcomes
6. Reporting to Individual Departments on Demonstrable Outcomes, Impact on Curricula and Programs, How to Implement
7. Next Meeting

B. <u>Utah Team Meeting Notes Since December 2009</u>

Utah Tuning Project

February 19, 2010 – Meeting Notes

1. **<u>Planning for No-Cost Extension to Lumina Grant:</u>** Bill Evenson reported that the Lumina Grant budget will still have about $50,000 at the end of its term (Feb. 28). We will request a "no-cost extension" to continue our Tuning work using that money. We will provide an addendum to the November 2009 Project Report at the end of the extension period. We discussed priorities for this grant extension, including
   - Support for Teddi Safman and Bill to make presentations on the project at American Council on Education (March), Texas Higher Education Coordinating Board (March), Western Academic Leadership Forum (April), perhaps others.
   - Additional work on surveys
   - Restatement of learning outcomes to communicate clearly to policymakers and even academics outside our disciplines.
   - Develop plans to take Tuning results into individual departments.
   - Possible event for employers and/or alumni. We noted that Holly McKiernan (VP of Lumina Foundation for Education) will be in Utah for a LEAP meeting on April 14. We may want to discuss our plans with her at that time. We could also meet with Utah Technology Council and the Salt Lake Chamber Education Committee.
   - Possible event for advisors or advisors with employers. This should probably have some pre-meeting introduction to Tuning for advisors.
   - Relationship of advising to Tuning
   - Work with teacher preparation for our disciplines. Cooperate with USU program working with American History teachers.

   Bill, Teddi, and Norm Jones will draft a proposal and send it to the Tuning Team for review and suggestions.

2. **<u>Discussion of Grant Proposal for Future Work:</u>** Bill reported that the Lumina Foundation for Education is prepared to entertain a new proposal for next steps. We discussed the following issues:
   - Work with disciplinary associations, other professional bodies, and regional accreditors. This would entail arranging meetings and presentations to appropriate groups.
   - Extending Tuning to other disciplines in Utah. We need disciplines with well established, willing working groups. We would give high priority to those with a prominent general education role so they are important at several levels of the curriculum. Possibilities include English, Mathematics, Education, Chemistry, Political Science, Engineering.
   - E-portfolios. These have complications of cost, training and motivating faculty, training and motivating students. We agreed that we need to Tune additional disciplines so we can use the Tuning results to build a framework for e-portfolios and to guide the selection of artifacts suggested for inclusion in e-portfolios.
   - Teaching majors for history (especially elementary level) and physics (especially secondary level). We must address quality as well as numbers of teachers.
   - Assessment instruments to use when taking Tuning into the departments.
   - Coordination with Utah Science and Mathematics Education Consortium (USMEC).

- Focus on writing outcomes.
- The intersection between general education and discipline expectations.
- Expectations/pre-requisites for students entering upper division major programs.
- Avenues for pedagogical improvement in the disciplines. How to integrate these. Critical assessment of pedagogies, flaws, needs, best practices. Pedagogical implications of Tuning when we think from the endpoint backwards.

Bill, Teddi, and Norm will draft a proposal and send it to the Tuning Team for review and suggestions.

3. **Outreach:** Bill reported on the work Lumina is planning for Tuning engineering in Texas and the role he and Teddi are playing. Norm reported that he will make a presentation to the New England Educational Assessment Network in March. Dan McInerney and Norm presented a session about History Tuning to AAC&U in January.

4. **National Task Force on Teacher Education in Physics:** Bill and Teddi shared a report from this week on teacher education in physics. It paints a grim picture that Tuning might be able to help us address. Bill will forward an email commenting on this report to all team members following the meeting.

5. **Comments on Learning Outcomes in November 2009 Project Report:** We reviewed and discussed comments on our November 2009 Project Report from Tim Birtwistle and Cliff Adelman. Cliff's comments were particularly helpful in providing examples of useful ways to restate discipline competencies as assessable learning outcomes. Bill pointed out that while we have done our work to this point to reach outcomes that will be clear to other physics faculty, our goal of reaching transparency about degree outcomes through Tuning requires that we work on restatements of the outcomes that will clarify our meaning and intentions for non-physics faculty, for students, the public and policy makers. The focus will not be primarily on using some "approved" language but on clarity for these broader groups.

   It was suggested that part of assessment should include having students reflect on their own learning – they should become aware of how they have achieved the learning outcomes (and be prepared to challenge the faculty if they do not achieve as advertized). To develop assessment instruments, we will need faculty discussions in our departments on how to achieve and assess the learning outcomes. The history rubrics developed at Utah State as well as the rubrics developed by AAC&U can guide us in building specific assessment instruments.

   The two discipline teams will meet individually to pursue these refinements and clarifications.

6. **Working with Individual Departments:** This is high on our agenda for the future. Once we have adequately clarified our statements of learning outcomes, we will consider strategies that can help us take our results successfully to our individual departments.

7. **Next Meeting:** Kathryn MacKay will send out a Doodle to find a meeting time for the history team and to show Bill how this works so he can do the same for the physics team.

C. <u>Physics Team Meeting Agendas Since December 2009</u>

Utah Tuning Project – Physics Team
IP-Video, April 7, 2010, 3-5 pm
Agenda

1. No-cost Extension to Lumina Grant: responsibilities
2. Texas Project to Tune Engineering Disciplines
3. Learning Outcomes
4. Taking Tuning Results to Our Departments
5. Future Grant Proposal
6. Next Steps

D. <u>Physics Team Meeting Notes Since December 2009</u>

Utah Physics Tuning Project

April 7, 2010 – Meeting Notes
CORRECTED (2)

1. **<u>No-Cost Extension to Lumina Grant: Responsibilities -</u>** We reviewed the No-Cost Extension Proposal and agreed on preliminary plans to follow up on what we proposed.
   a. Jim Chisholm agreed to look into contacts with the American Physical Society and its 4 Corners Section. We discussed using the *Physics Today* article as a springboard to encourage the APS Committee on Education to meet with us or invite us to present to them or to one of their sessions.
   b. Phil Matheson agreed to look into contacts with the Utah Academy of Sciences, Arts, and Letters. He will also follow up with the American Association of Physics Teachers and the AAPT Idaho-Utah Section.
   c. UVU (Phil) will try to complete an alumni survey to add to our survey data.
   d. Bill Evenson will contact BYU and Westminster College to invite them to join our team. We will schedule a meeting with them to bring them up to date.
   e. Bill and Teddi Safman will make preliminary plans for a meeting with an employer group and discuss these with the Physics and History Teams.

2. **<u>Texas Project to Tune Engineering Disciplines-</u>** Bill reported that he, Teddi, and three of our Physics Team (Brad Carroll, Brian Saam, and Larry Smith) will participate in a Texas kick-off meeting on April 20. He reviewed the agenda briefly. He explained some of the connections between Tuning and ABET engineering accreditation and agreed to send the ABET to Tuning briefing paper he has worked on when it is in final form.

3. **<u>Learning Outcomes-</u>** Bill suggested that team members reread Cliff Adelman's Issue Brief, "Learning Accountability from Bologna: A Higher Education Policy Primer" (red booklet). Bill noted that he had much greater understanding from a recent rereading than when he had read the Brief initially. Bill will send the pdf again for those who need it.

   Bill pointed out that the European use of the term, "Benchmarking," and Cliff's use of that term, is more like what Phil and Brian produced as levels of sophistication. Our team, on the other hand, has used benchmarking to describe expectations for individual learning outcomes. We should probably revert to the language in Cliff's Brief and describe our work with different levels of achieving the learning outcomes as "ratcheting."

   Bill referred to a chapter from the *Bologna Handbook* entitled, "Writing and Using Learning Outcomes: a Practical Guide." He will share this with the Utah teams.

   Brad observed that the structure of the Tuning process is becoming clearer. He suggested we try to create a diagram illustrating this structure to introduce it to new Tuners. Such a diagram should note elements of deliverables for a Tuning project, to whom these are addressed, their purpose, and hierarchical relationships. Bill will take a stab at this and circulate it.

4. **Taking Tuning Results to Our Departments-** We came up with several observations and suggestions in a discussion of how to introduce our results to our colleagues:
   - Use the *Physics Today* article to pique their interest and start a discussion
   - Evaluate the sources of resistance, both views/concerns and people; share these with this team and discuss how to overcome
   - Take the survey data to the departments and discuss
   - It has been 60 years since there were serious changes in the curriculum; start a discussion of what reforms are needed
   - Approach Tuning results as a potential recruitment tool for physics majors: transparent outcomes, degree profiles, employability maps
   - Emphasize that our physics competencies and other results do not imply a complete rewrite of our programs, but they provide a new view that we can use to improve what we do
   - Tuning can be presented as an item of interest to share, not an action plan
   - Work with BYU and Westminster and use those interactions as models to help organize plans to share Tuning with departmental colleagues
   - Connect our work to that of the Majors' Meetings
   - Share reactions of colleagues with each other in the Tuning team
   - Clarify what the value-added is from Tuning
   - Invite department chairs and outcomes assessment representatives from each department to a state-level meeting

5. **Future Grant Proposal-** We reviewed the suggestions from our February meeting. We liked the idea of emphasizing the connections between General Education and the majors. We could start small with a pilot program looking at mathematics and physics, for example. We might also consider how to bring together other departments with overlapping interests. Interest was also expressed in thinking about how to develop teaching expertise and what Tuning results can contribute to that end. Bill agreed to send the team copies of the Indiana and Minnesota November reports. It was suggested that Utah consider taking up some of the disciplines done by Indiana and Minnesota in the pilot project and building on their initial results.

6. **Next Steps-** It was suggested and agreed that the Texas visiting team will have a telephone conference before going to Texas to help everyone know the message we want to convey. The Physics Team will meet again in May or June after following up on today's discussion.

Physics Major's Meeting, Sept. 24, 2010, 11:00 AM

Minutes by Phil Matheson, UVU

Present: Bill Evenson (USHE); Lynn Higgs, Christof Boehme, Brian Saam, Inese Ivans, Jordan Gerton (U of U); Brad Carroll (Weber State); Trina Van Ausdahl (SLCC); David Kardelis (CEU); Charles Torre (USU); Jim Chisholm (SUU); Larry Smith (Snow); Phil Matheson (UVU).

Articulation Issues

Discussion of articulation of Modern Physics; at Snow this is PHYS 2710 – consistency check with USU. Does it still transfer to USU PHYS 2710 or to PHYS 3740? Trina reminded us that for

SLCC transfers, articulation is done on a case-by-case basis with the U of U PHYS 3740 being waived in favor of taking a different class.

Jim pointed out that SUU has “Quantum Mechanics” 3310 – is this the same as 3740? Probably should check the textbook and syllabi available online from the other USHE institutions.

Follow-up: Larry Smith needs to know AP credit policies of all the schools (so that he can get the post-it note off his computer monitor). Please send him what your school does.

Are there some numbering issues? PHYS 1800 is an energy class at UVU and a Principles of Technology course at USU. (A check of past Major’s Meeting notes should show that the articulation group reserved the number 1800 for an energy-type class.)

What about technical physics? The technology department at UVU resurrected the class in the curriculum with no review from the Physics Department (made UVU Physics a little peevish).

A question was also asked about numbering for meteorology, but it appears that Snow is the only school that teaches this class in the physics department.

Issues from Last Year

A) Acceptance of AS degrees from non-USHE schools. No one has seen a problem.
B) Distinctions between 1000 and 2000 level courses. No further discussion.
C) Cost of textbooks - Most schools now use an online homework service for PHYS 2210/2220, like “Mastering Physics”. Exceptions are SUU - with no online component and Snow and CEU that require some handwritten assignments (as does UVU). Does this make the choice of a textbook less important? Jim reports using an open source text at the 1010 level, but hand problems, and the text was a little bit beyond the student level and had some other irregularities. Dave reported that he has used “Physics for Future Presidents” at CEU with some success. It is a cheaper book. Bill reports having heard the author speak and having been impressed by his ability to reach students.

- Jordan pointed out later that the U Illinois has gone to a bookless-means of teaching the intro physics sequence, relying on internet multimedia delivery.

Follow-up: Dave requested a set of the SUU PHYS 1010 labs from Jim - perhaps these could be distributed to the whole group? SUU teaches the course only once every other year. CEU teaches about 40 students a semester. UVU has about three sections a semester.

Inese reported that U of U would introduce the cross-listed course ASTRO/PHYS “Foundations of Astronomy”. It is a precursor to the 3000 level course (defined by the Carroll-Ostlie text as a reference). It is intended for those that have had calculus and will explore the basic mechanics

of astronomy, such as gravitation, tides, etc. The selected book is by Riden and Peterson of Ohio State.

Follow-up: This group should probably formalize the articulation of the astronomy courses. Maybe other schools would like something similar.

Tuning

Brad will be speaking at the March APS Meeting in Dallas at a symposium on physics education. Brad reports that the symposium is nominally about graduate education. Jim is giving a Tuning talk next month at the APS 4CS meeting at Weber, where he will also sit on a panel discussion on physics education.

Follow-up: Brad would welcome any materials forwarded to him that might help with his APS talk. Bill can make his Tuning videos and other Tuning materials available to Brad and Jim. Bill also mentioned that a presentation by Marcus Kolb was available. Bill will forward that to us all.

Tuning survey results from employers, students and faculty will soon be ready. However, Bill states that the more he looks at them, the more skeptical he is of what can be gleaned from them. The student surveys particularly seem suspect due to student indifference in taking the survey. Report to come will give institution-by-institution results. (There have been no physics faculty surveys yet.)

Competencies: The Physics Tuning Team needs to restate the competencies in a way that can be assessed, as per Cliff Adelman's review. A subcommittee will look at that: Brad Carroll, Jim Chisholm, Larry Smith and Bill will constitute that committee and go over this by the end of the year.

There was a brief overview discussion about Tuning for the benefit of those present who had not been involved in the project. Some discussion was directed to Utah Department of Education efforts to establish common K-12 core competencies. Jordan pointed out that the Tuning efforts should be moved down to the K-12 arena, too. Christoph expressed some doubts of the process, seeing many negatives and few positives. Bill then explained the difference between "Tuning" and the "Bologna Process". Bill also told of the problems arising in trying to get a consistent set of competencies and outcomes in matching up state secondary math curriculum with higher ed math curriculum, stating there were several disconnects. Physics efforts need to be aware of these potential problems.

Follow-up: There was some discussion on how best to present Tuning to our departments. It was suggested that a presentation be prepared that could be given in a colloquium by some one of us, or many of us, to our departments in a colloquium-type setting.

All agreed that since Tuning is to be a faculty-driven process, then such a presentation should be heavily data driven in order to motivate the adoption of Tuning methods. Maybe the

presentation should focus on current student success at graduation, or be driven by the sorts of data being required by our accreditors. What other kinds of data can be gathered for such a presentation? We ask, “Are our students achieving good hiring outcomes?”, “Is there something systemic or programmatic that can improve their chances of success”. “What is the time to graduate?” How can such a presentation otherwise be made of interest to our faculties? The suggestion was made that the presentation should be coupled with a substantive proposal to organize some small scale, but state-wide program that would be of immediate benefit to our departments. One option is the adoption of a graduate tracking program to catalog a record of what kind of jobs or graduate positions our students move into after graduation. This might be harder for 2-year schools, but it was pointed out that in principle, at least, the State now has a student tracking number system that should enable 2-year schools to track the destinations of their graduates as long as they remain in the USHE system.

A goal for success is to get the employers to understand the strengths of physics majors – not for them to know the specific physics concepts the students learn.

We need a physics faculty survey addressing specific physics competencies. That would be a good part of such a state presentation. Bill suggested forming focus groups to identify specific obstacles to student success, and specific successes that some departments have had in their programs. --- But is this data collectible for a general colloquium presentation?

It was also recommended that a survey of graduate programs be done. What do you expect of your incoming grad students? Jim Chisholm asks whether the graduate schools in USHE see any trends in incoming students.

Follow-up: The Subcommittee of 4 will refine outcomes and competencies and send them out to us.

Other Issues

We discussed the AIP focus sheet that Lynn brought showing the strength of physics majors on pre-professional exams like MCAT and LSAT.

Do we need a mandatory end of senior year exam? Accreditation bodies would like this. Jim looked at the ETS Physics Major Field exam (based on physics GRE). Can look at ETS website Maybe this can satisfy some our Tuning assessment needs? Charlie liked the idea. Anyway, it is worth bringing forward to our departments.

The Dixie dean also stopped by to discuss concurrent enrollment. No changes mentioned.

E. November 2009 Interim Report

Please note that the November 18, 2009 Interim Report that follows refers to discipline-specific competencies as "learning outcomes." These are not correctly stated learning outcomes, but are competencies for history and for physics. The learning outcomes have been stated above in this Final Report.

Tuning USA Interim Report – Utah

November 18, 2009

Table of Contents

1. **Final list of Tuning participants**

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2. **Tuning Process in Utah** (See Sections 3 & 4 for items specific to History and Physics.)

   a. **Why did your state choose to participate in the Tuning project? What problems or issues did you hope to address?**
   Utah saw the Tuning project as a natural continuation of the work we had done for the previous 11 years to coordinate and define general education among the nine state institutions of higher education and with our "majors' meetings" coordinating courses and requirements in more than 30 disciplines.

   The kinds of issues we hoped to address fall into the categories of accountability / assessment, transparency, and equivalency. More specifically, we have been working for several years on accountability and assessment, and we saw the Tuning process as a possible way to define expectations in the disciplines so they are equivalent from institution to institution and are demonstrable, hence assessable. Only with demonstrated outcomes can institutions be accountable. But the adoption of demonstrable outcomes must come from faculty working together if these outcomes are to have a real impact. We already had faculty groups working through our annual majors' meetings, and we welcomed the extensions of that work made possible by Tuning. Many in our teams also saw Tuning as an opportunity to show students, parents, employers, other institutions of higher education, and government policy makers what our students are prepared to do, what they know, and what skills they have when they graduate with a degree in physics or history. This is the transparency advantage of Tuning. The idea that we would survey employers and bring some congruency between our work in higher education and the needs of employers was also attractive, especially since this interaction has been seriously neglected in the past.

   b. **What, if anything, happened in your state as a result of engaging in the Tuning process that might not otherwise have happened? (For example, were there unexpected outcomes of the collaboration among institutions, including work on transfer and articulation, conference/academic presentations, or other efforts or discussions that emerged as a result of Tuning?)**
   Tuning became a focus of our annual "What Is an Educated Person?" Conference in 2009 (a conference with about 150 participants from throughout the state). The 2008 conference focused on Essential Learning Outcomes, which connected in a natural way to the Tuning discussions of outcomes. We have had the opportunity to present information on Tuning to the State Board of Regents, the Higher Education Presidents' Council, the Higher Education Chief Academic Officers, and several deans from Utah institutions, as well as the "What Is an Educated Person?" Conferences. We have made presentations at the Association for Institutional Research (William Evenson, Atlanta, June 2009 – with Cliff Adelman) and State Higher Education Executive Officers Policy Conference (Teddi Safman, Denver, August 2009). We have been invited to present at the Western Academic Leadership Forum in April 2010.

The Tuning process has involved in depth discussion of outcomes and levels of expectation among representatives of history and physics departments across the state. There has also been discussion in the Tuning teams of correct strategies to involve their respective departments in local discussion of the outcomes and their curricular and assessment implications.

The two-year institutions were able to focus on the implications for their programs of preparing students to transfer to four-year programs. So far, this has been a very healthy discussion; we hope it goes further and affects curriculum and assessment.

Several members of the team began as serious skeptics. In particular, they did not believe that this would be a faculty-driven process, but assumed from all of the necessary learning about the process they were being fed up-front that this would be very centralized in practice, with the expectation that institutions would shift to a common curriculum when it was over. After a few months, these fears abated due to the way the project was conducted – i.e. with serious faculty discussion and give-and-take on outcomes, but explicit avoidance of prescribing curriculum or programs to achieve the outcomes. Due in part to the faculty initiative in the process, we have adapted Tuning to our own needs – some are slightly uncomfortable saying that what we have done is Tuning as defined in Europe. Nevertheless, the motivations and goals are consistent with the previous work in Europe, and we have worked through a process that has been rewarding and productive.

c. <u>How did Tuning complement work that already was going on in your state?</u>

Utah has conducted faculty discipline majors' meetings for 11 years now, with representatives from each of the nine Utah System of Higher Education institutions for each of 32 disciplines. These groups meet annually. They review syllabi and texts to coordinate courses among the institutions. They identify competencies for successful transfer within the System. They discuss and determine content, pedagogy, and assessment practices. These majors' meetings have reinforced faculty ownership of the curriculum in their disciplines and have initiated discussions at the discipline level that include faculty from community colleges to those from research universities. These meetings have thus developed a level of trust and respect among faculty from diverse institutions, something that was essential for the Tuning process. Furthermore, the groundwork that was laid in the majors' meetings on curriculum has made it possible to explore discipline outcomes much more efficiently than would have been possible otherwise. Tuning has fit into the evolving agenda of the majors' meetings as a natural next step.

Utah established a Regents' Task Force on General Education in 1997. This group, with representatives from each of the nine public institutions in Utah, oversees issues of transfer, articulation, and assessment in the state and has helped develop state policy on general education. They established the "What Is an Educated Person?" Conference series, now in its 12th year, that involves academics from around the state and some years has included government leaders and representatives of business and industry. They are now planning another major conference aimed specifically at business and industry and government leaders in

April 2010. They have instituted research in Utah on student success factors, and two years ago they brought Cliff Adelman to the "What Is an Educated Person?" Conference to tell Utahns about the Bologna Process and Tuning. This led to ideas for an "Educational Resumé," analogous to the Bologna Diploma Supplement and to emphasis on learning outcomes, beginning with the high level outcomes identified in the AAC&U LEAP Program. The Task Force has served as an informal advisory body for the Utah Tuning project, and their work dovetails nicely with the goals of the project.

The Regents' Task Force on General Education has been pursuing for about three years the implementation of student e-portfolios to serve as "Educational Resumés." These are envisioned to include assessable evidence of the achievement of the learning outcomes applicable to the student's course of study. They can be used to demonstrate achievement to prospective employers, transfer institutions, parents, and other interested parties, in addition to being a record for the student herself. Several pilot projects with e-portfolios are currently underway in the Utah System. Tuning is helping us to specify demonstrable outcomes and levels of expectation that will be documented in these Educational Resumés.

d. <u>How did the array of institutional diversity affect the project? Also, were the right people involved?</u>

We worked with faculty and student representatives from community colleges, four-year colleges, comprehensive universities, and research universities. This range of perspectives proved valuable, especially for the diversity of experience with students in the first two years. Different perspectives brought diverse questions to the table and helped us craft outcomes and process in a way that worked for all of these levels of institution. We did have the right people involved: our teams were selected from the majors' meeting participants who had been appointed by department chairs. In the process of forming the teams, we consulted chairs and deans and informed chief academic officers. These campus leaders helped us make substitutions from the majors' meetings groups where necessary. The advantage of forming our teams from the previously constituted majors' meetings groups was that these faculty members were already acquainted, had developed a level of respect, and trusted one another. Our student members were selected in consultation with department chairs.

e. <u>If your state picked an academic discipline or disciplines that had previously been "tuned," to what extent did you rely upon existing Tuning materials from Europe or elsewhere? How helpful was the advice from European experts?</u>

Both physics and history were previously "tuned" in Europe. They read the European reports. These reports guided us in the kinds of questions to ask and the form of the various elements of the process that we reached. The content of our results was not so influenced by the European reports, even though the reports gave us a starting point. Rather, we arrived at our results through discussion and analysis of the reality of teaching physics or history in our diverse set of institutions, a reality that is quite different from that in European higher education. So the European report and experts provided an important framework within which we carried out the

project. Without the report and the experts, we would not likely have achieved as much in these few months.

f. <u>If your state picked an academic discipline or disciplines that had not previously been "tuned," how did this affect the project?</u>

Not applicable.

g. <u>What barriers or obstacles did each group encounter? (For example, how did state budget cuts affect the project?) How were these challenges addressed?</u>

It was indeed fortunate that the Lumina Foundation for Education provided full funding for this project. Without that funding we could not have carried it out. With it, we were able to engage the process rather fully. Lumina paid the part-time salary of the project director; again a necessity in this difficult economy. Without being able to bring in this additional part-time person, we could not have managed the project in our System, where we have unfortunately lost personnel over the period of the project.

The other major challenge was simply the workloads of many of our team members. For some of the two-year institutions, the faculty member on our team is the only physics or history faculty member at the institution. The demands on these faculty members are heavy, and adding another project is very difficult. For this reason, we held many of our team meetings by IP-video, so we could at least eliminate the travel time to those meetings. Of course, we also adjusted assignments as needed.

As will be discussed in Section 10 on the surveys, it was initially somewhat complicated to get IRB approvals for our student surveys. This was done differently on every campus, but we were able to work out a standard procedure that was accepted by all the IRB Chairs in the System.

h. <u>What were viewed as the strengths/weaknesses of the process?</u>

One weakness of the process was the front-loading of a huge amount of information about a process that most of our teams were completely unfamiliar with at the beginning. Even the language of Tuning developed in Europe was entirely unfamiliar. That information had to be digested just to get started, and the process of learning about the process fed on fears that this was really a top-down project. We got over those fears, as discussed above, but we had to spend a lot of our limited time on the project learning about the process and putting it in proper perspective.

A second weakness was the initial focus on surveys. The faculty needed to discuss the expectations of their discipline, and the surveys diverted them to a somewhat mechanical aspect of the project. We moved on from that, as discussed elsewhere, but with the effect of delaying the survey part of the project beyond the 8-month (April-November) project timeline.

The Tuning process as outlined for us needs more attention to the role of employability in defining qualifications. Employability is important, but it must be kept in perspective so that degrees are not driven to become too narrow.

The most important strength of the process for us has been the opportunity for faculty rethinking and definition of the discipline. The teams took the project and made it their own, thereby reinforcing both faculty ownership of and faculty responsibility for the disciplines. This took some time, and there were skeptics on the team for the first 3-4 months. The fact that they were won over testifies that this process can work in the US context.

Another strength is that the in-depth faculty discussions established foundations for discussions within the departments in individual institutions. The team has reached this point eager to help their colleagues in their home departments begin to profit from the definition of measureable outcomes produced in this project.

The flip-side of the previous comment is that this project has also furthered the System-wide conversation that we have endeavored to foster through the Regents' Task Force on General Education, the "What Is an Educated Person?" Conferences, and the Majors' Meetings.

A final strength of the process is that it has brought us into participation with an international discussion, providing greater confidence in our results as well as access to a much wider pool of thought on educational processes.

i. <u>How does the process differ from other learning outcomes efforts?</u>

The Tuning process focuses explicitly on employer and alumni feedback for guidance, as well as student and faculty input. This focus is different from other learning outcomes efforts in the disciplines. While we have not finished gathering the survey information from employers and alumni, we are in process and intend to complete that work and factor it in to our efforts to implement the results of this process in the individual institutions.

Second, while some disciplines have established explicit learning outcomes for their majors, physics has not done so on a national basis. Furthermore, very few of the learning outcomes efforts have been carried out at the discipline level; more often, they have started at the institution level. Tuning complements overarching sets of learning outcomes at the institution level, like the Essential Learning Outcomes (ELOs) proposed by AAC&U's LEAP Project by drilling down to demonstrable outcomes appropriate to each discipline in addition to generic outcomes that are the wider responsibility of the institution, or the joint responsibility of several disciplines.

Finally, we seek to define measureable outcomes that allow us to provide a guarantee to transfer institutions, to employers, and to state policy makers of what our graduates represent. This goes well beyond other learning outcomes efforts.

j. **If one or more of your work groups deviated from the process outlined during the Chicago convening, please explain these changes and why they were made so that we have a better understanding of how Tuning applies in the Tuning process?**

As will be discussed in Section 10 on the surveys, we surveyed students early, to get ahead of the early semester ending in our institutions. The semesters ended in April, so we had a very narrow window to reach these students before fall. However, it quickly became clear that the surveys were taking too much attention away from the work of thinking through learning in the discipline. The Team needed to focus on learning outcomes and benchmarks for levels of expectation, so we put the other surveys on hold, to be handled as much as possible by the project director with whatever help he could find. So the surveys were de-emphasized, and some are still in process. But this allowed us to work through outcomes, benchmarks, and degree profiles in a more thorough and useful way.

k. **What lessons have you drawn from this project? What differences, if any, were there in how the process was perceived by the SHEEO office? Participating faculty members? Non-participating faculty members in the disciplines with participating faculty members?**

This project has reinforced our views of the need for faculty to grapple with their disciplines jointly, especially across a diversity of institutions. Faculty need the insights that come from alumni, employers, and students in their development of expectations in the disciplines. The system-wide discussion provides a foundation and develops leadership for departmental discussions at individual institutions.

3. History Tuning Process in Utah

a. How did Tuning complement work that already was going on in your state?

The historians welcomed the chance to bring further focus to concerns expressed in the state-wide majors meetings about the role of history programs in higher education.

b. How did the array of institutional diversity affect the project? Also, were the right people involved?

Because of the several years of meeting as colleagues across the state, the historians were able to build on a level of trust that united us across institutions.

c. How did each group go about formulating the outcomes that define the academic discipline? Please describe the approach used and submit meeting agendas, if possible.

The historians referred to the report of the history Tuning project from Europe, but turned to the learning outcomes recommended by our professional organization– the American Historical Association—since many of us had been aware of that work of many years (see Section 6). The historians did meet face to face, but also did much of our collaboration electronically.

d. Were disciplinary or professional organizations consulted?

See above. Also consulted was the work at Georgia State University and the QUE project through American Association of Colleges and Universities. We also consulted the AACU project Liberal Education and America's Promise (LEAP).

e. In what ways were students involved in your Tuning work? What input or feedback did students provide, and how was it provided? What weight was student participation and input given?

The student member of the History Tuning Team was an undergraduate student attending the University of Utah. He was present at all meetings and involved in the electronic discussions. Some historians have agreed to hold student focus groups early in Spring 2010 in order to add some depth to the student surveys.

4. Physics Tuning Process in Utah

a. How did Tuning complement work that already was going on in your state?

See above, Section 2.c. Specifically related to Physics Tuning, we discovered several efforts underway or in the thinking stages to review physics curricula. This project was welcomed as furthering those goals.

b. How did the array of institutional diversity affect the project? Also, were the right people involved?

See above, Section 2.d. All of the comments in Section 2.d apply strongly to the Physics Team – it was valuable to include community colleges to research universities, and the right people were involved, in every case leaders in their departments and people with influence on both curriculum and assessment.

c. How did each group go about formulating the outcomes that define the academic discipline? Please describe the approach used and submit meeting agendas, if possible.

The Physics Team met frequently (meeting agendas attached as an appendix) and considered categories of outcomes that are essential. They referred both to the report of physics Tuning from Europe and, mainly as individuals, to information from the professional organizations: American Institute of Physics, American Physical Society, and American Association of Physics Teachers. The team discussed proposed outcomes at length and achieved consensus on the main "themes" of physics learning outcomes and on the list of specific outcomes under each "theme." They arrived at seven "themes," each with multiple bullet points of specific outcomes attached. (See Section 7, below.)

d. Were disciplinary or professional organizations consulted?

The three relevant national physics organizations are American Institute of Physics (AIP), American Physical Society (APS), and American Association of Physics Teachers (AAPT). AIP, in particular, has collected considerable data on physics employment. None of these organizations prescribes curricula or learning outcomes, but APS and AAPT have committees dealing with physics education at various levels. We did not consult the organizations directly, but we used materials from their web sites. This was not done formally, but by individuals bringing this information into the team discussion. Given more time for the project, we would get more directly involved with the disciplinary organizations.

e. In what ways were students involved in your Tuning work? What input or feedback did students provide, and how was it provided? What weight was student participation and input given?

We had a student member on the Physics Tuning Team who participated fully. He gave thoughtful opinions in our discussions of outcomes and benchmarks, and he organized a meeting with other students to discuss the issues raised in the Tuning process. His report of that meeting is attached in the Appendix. The physics student was a mature re-entry student who

finished a BS in physics at Utah Valley University in Spring 2009, after the project began. He began graduate work in physics in the fall at University of Utah. Because he is now familiar with two rather different institutions in the Utah System, he has been able to offer especially useful insights. Given his age and perceptiveness, he was accepted as a colleague in the Tuning discussions.

5. **Suggestions of next steps for advancing these discussions.**

a. **Do your academic discipline work groups intend to continue this work? Why, or why not?**
Yes, with less frequent meetings. They will coordinate each year in the Majors' Meetings, and they will meet as they can in between. They will address the implications on what has been done so far of the surveys that are still underway. They will also share experiences and ideas about sharing the results of the Tuning process with their individual departments.

b. **What do your state's work groups view as the next logical steps for expanding and deepening the Tuning work?**
An important next step would be the development of an Educational Resumé e-portfolio template for students. Students would be required to give evidence in their Educational Resumé of accomplishing the learning outcomes at the levels specified in the benchmarks for their disciplines.

A second suggestion is to extend the Tuning work in physics to the PhD level.

Third, we would consider developing inventories in the disciplines of what we are doing well and what is not working in the current approaches relative to the Tuning outcomes and benchmarks.

Fourth, our groups believe it is important to give some attention to student workload issues related to our learning outcomes and how these relate to the current credit system in US higher education. The relationship between workload and credit hours varies between disciplines, due in part to historical developments, so this work could profitably begin in individual disciplines.

Faculty workload is another essential concern if we are to make real progress with the big issues raised by Tuning.

Finally, we believe it would be appropriate to expand the Tuning project to additional disciplines in our state and to selected disciplines in other states.

c. **If you could do further work in this area, what would it be?**
Educational Resumés, as discussed above. We would like to bring aspects of our work with the two disciplines, history and physics, to closure and then expand to other disciplines in Utah.

d. **Who needs to hear about this work, and why?**
Accrediting organizations and Higher education leadership groups so they can learn about the accountability and assessment possibilities in Tuning.
Discipline professional associations so they can work on a national disciplinary basis to develop learning outcomes and benchmarks.

State and federal policy makers, employer groups, Chambers of Commerce education committees so they can learn about the potential for transparency and accountability inherent in Tuning.

6. Clear expression of learning outcomes by academic discipline and level: History in Utah

The historians adopted the following learning outcomes as defined by the American Historical Association. http://www.historians.org/teaching/ACE/Taskforcereport.cfm
(See also: Katz and Grossman, "The History Major and Undergraduate Liberal Education, Report of the National History center Working Group to the Teagle Foundation," Sept. 29, 2008.
http://www.historians.org/perspectives/issues/2008/0812/0812nhc1.cfm

- *Historical Knowledge* --(a command of a substantial body of historical knowledge)
- *Historical Thinking* –
  - recognizes the "pastness" of the past (awareness of continuity and change over extended time spans) .
  - - recognizes the complex nature of past experience (a command of comparative perspectives, which may include the ability to compare the histories of different countries, societies, or cultures)
  - - recognizes the complex and problematic nature of the historical record (appreciation of the complexity of reconstructing the past, the problematic and varied nature of historical evidence)
- *Historical Skills* –
  - skills in critical thinking and reading (ability to read, analyze and reflect critically and contextually upon contemporary texts and other primary sources; an ability to read, analyze, and reflect critically and contextually upon secondary evidence, including historical writings and interpretations of historians)
  - - research skills (ability to gather and deploy evidence and data to find, retrieve, sort and exchange new information)
  - - construct reasonable historical arguments (ability to design, research, and present a sustained and independently-conceived piece of historical writing; ability to address historical problems in depth, involving the use of contemporary sources and advanced secondary literature)

The American Historical Association has also issued in 2008 "Internationalizing Student Learning Outcomes in History: A Report to the American Council on Education," which includes language which guided the History Tuning Group.
http://www.historians.org/teaching/ACE/Taskforcereport.cfm#skills

Discipline-specific outcomes – students taking history courses will come to:

- Recognize connections between the past and the present; i.e., locate both self and others in time and spaces
- Acquire familiarity with the uses—and the limitations—of historical comparison as an analytic tool
- Grasp temporal relationships and integrate multiple chronologies within the same analytical frame of reference

- Demonstrate the capacity to deal with differences in interpretation
- Critically analyze narrative structures and construct narratives
- Demonstrate an ability to recognize and interpret multiple forms of evidence (visual, oral, statistical, artifacts from material culture)
- Recognize the distinction between primary and secondary sources, understand how each are used to make historical claims

Transferable skills/general competencies

- the ability to recognize and analyze change over time and space,
- to handle diverse forms of evidence, and
- to master forms of written, oral, and visual expression that facilitate communication with peoples of other regions and cultures. The goal should be to provide all students with ways of approaching the world and thinking about themselves in the dimensions of time and space.

Benchmarks

As the History Tuning Group continues its discussions about specific outcomes and specific student experiences, we will be considering this model recently sent to Norm Jones, USU, from Margaret McGlynn, Associate Professor, Department of History, University of Western Ontario, http://www.ssc.uwo.ca/history/faculty/mcglynn/

Recommended expectations and outcomes for first year classes:

- Content delivery
    - Introduction to fundamental structures and transformations leading to the modern world.
- Familiarity with the library and electronic resources
- Full understanding of plagiarism and its problems
- Basic primary source skills
    - What are primary sources?
    - Authorship and audience
    - *Veritas et Utilitas*: Truth and Usefulness
- Basic secondary source skills
    - What are secondary sources?
    - Secondary sources as interpretation
    - Dealing with different interpretations
    - Synthesis of extensive reading
- Basic paper-writing skills
    - Organization
    - Footnoting
- Participation and communication skills
    - Small group discussion

[These aims might be best achieved with short, focused frequent assignments.]

Recommended expectations and outcomes for second year classes:

- Content delivery
    - The examination of nations, regions and historical themes
- Content diversification: the opportunity to experience
    - new fields
    - new approaches
- Intermediate primary source skills
    - Close reading
    - What do they tell us beyond the obvious?
- Intermediate secondary source skills
    - Identifying thesis and argument
    - Identifying sources
    - Critiquing [article-length texts]
- Basic research skills
    - Integration of primary and secondary sources
    - Framing research questions
- Intermediate writing skills
    - The thesis statement
    - Developing an argument
- Participation and communication skills
    - Effective argument and exchange

[These aims might be achieved by a combination of short assignments and a final "research paper" of c. 8-10 pages.]

Recommended expectations and outcomes for third year classes:

- Content delivery
    - intensified detailed and conceptual knowledge of more specialized subjects
- Primary source skills
    - analysing rhetoric
    - understanding the structure and presentation of a document
    - situating the source in relationship to other primary sources
- Secondary source skills
    - understanding and questioning author's evidence, thesis and argument
    - situating, analyzing and assessing historical works in their historiographical contexts and traditions
    - exposure to a variety of theoretical approaches to historical analysis
- Research skills
    - generating own research questions for written assignments
    - developing skills of detection and inquiry
    - combining a variety of sources (eg primary sources, secondary sources, oral history, works from different disciplines) in written and oral assignments
- Writing skills
    - writing effectively in longer assignments
    - integrating a wide variety of primary and secondary source materials into written work
- Participation and communication skills
    - student-led presentations and class discussions

    - self-directed learning
- Overall
    - reinforcing and refining skills developed in first and second year courses
    - devising individual explanations and interpretations
    - thinking laterally across disciplines, subjects, time, themes, regions and nations

Recommended expectations and outcomes for fourth year classes:

- Content delivery
    - The expectation is that students will add to their own knowledge base through active directed reading in highly focused courses.
- Primary source skills
    - Extensive and sophisticated engagement with primary sources is expected, possibly at an archival level.
- Secondary source skills
    - Students are expected to be familiar with the historiography of the field and to engage it directly in their own research and writing.
- Research skills
    - Students are expected to develop their own research questions in consultation with faculty and pursue them through all available and appropriate primary and secondary sources.
- Writing skills
    - The development of a complex and sustained historical argument, properly supported with evidence from primary and secondary sources.
    - The presentation of that argument in clear, correct and compelling prose.
    - The proper documentation of the research process through footnotes and bibliography.
- Participation and communication skills
    - Engagement with peers in discussion of both source material and the process of writing history.
    - The clear and effective presentation of the student's own research
    - Positive and effective discussion of other students' research.
- Overall
    - Drawing on the skills and insights of years one through three to produce historical work which is original to the student.

7. Clear expression of learning outcomes by academic discipline and level: Physics in Utah

a. discipline-specific outcomes for physics

For each of the competencies listed below, the student will demonstrate

1. Understanding of the Nature of Science and Nature of Physics

- Understanding of the role of evidence
- Understanding of the role of experiment in physics
- Understanding of the role of research in physics and the variety of approaches to research
- Understanding of cause and effect
- Understanding of scientific ethics
- Understanding of science as a community effort
- Understanding of major historical threads in the development of physics

2. Mathematical Skills, Modeling Skills, and Problem Solving Skills

- Algebra, calculus, and manipulation skills
- Understanding of the meaning of mathematics in physical context:
  - Ability to connect physical quantities and algebraic symbols
  - Understanding of the physical meaning of vector algebra
  - Understanding of the contexts for equations
- Estimation skills
- Graphical skills and interpretation
- Ability to build physical models by abstracting the most important concepts
  - Understanding of what one can learn from simple models
- Ability to build and work with mathematical models
  - Ability to cast story problems into mathematical models
  - Ability to explain the physics in a mathematical model
  - Ability to explain the differences between problem solving and modeling
- Ability to map problems to new problems with similar mathematics but different physics
- Ability to organize problems by identifying physical principles, identifying relevant vs. irrelevant quantities, and making appropriate diagrams
- Ability to organize quantitative information by clearly stepping through the mathematics of the problem solution

3. Understanding of Physics Concepts

- Basic understanding of the major threads of physics concepts: conservation laws, forces (gravity, e&m), fields, Newton's laws, work and energy, optics, thermodynamics, relativity, quantum mechanics
- Understanding of contexts of physics applications by identifying key elements in the functioning of an arbitrary physical system and relating them to model construction

4. Laboratory Skills

- Skills necessary for safe practice
- Understanding of and commitment to laboratory safety
- Ability to carry out error analysis, understanding what errors mean
- Understanding the primacy of data in physics

- Understanding how to evaluate data quality and the importance of such evaluation
- Understanding how things get measured
- Understanding the connections between what one measures and how one infers the physical interpretation of the measurements
- Understanding how to collect, organize, and present data and connect it to physical principles

5. Scientific Communication Ability (written, oral, and visual communication)

- Writing ability: complete, punctuated sentences, organization, good logic
- Scientific writing ability: be able to explain in words rather than equations
- Presentation skills: informal presentations to peers, formal presentations
- Teaching ability at BS/BA and MS/MA levels; ability to impart knowledge to others

6. Computational and Information Skills

- Ability to use scientific packages intelligently
- Knowledge of the rudiments of scientific programming
- Ability to use Excel or similar; Maple, MatLab or similar computer algebra
- Understanding of numerical analysis
- Information literacy at appropriate levels

7. Research

- Ability to apply physics competencies semi-independently
- Ability to synthesize physics principles and applications
- Ability to present research motivations, findings, and significance

Categories of Physics Competencies

Knowledge – Themes 1, 3, 6, and 7
Skills – Themes 2, 4, and 6
Social Responsibility – Themes 1 and 5
Communication – Themes 5 and 7

Levels of Sophistication Developed as Students Study Physics

At each of the levels of sophistication described below, students will be able to demonstrate the following:

1) Ability to identify physical laws by name and to provide definitions of important terms related to the physical laws
2) Understanding of the meaning of physical laws and knowledge of their general formulas
3) Ability to apply the general formulas or concepts to specific limited situations
4) Ability to design or describe experiments that could test a specific formula
5) Understanding of the limits of validity of general formulas and the domains of validity of physical theories

6) Understanding how empirical science functions, i.e. the supremacy of experiment and observation in establishing physical theory
7) Ability to apply physical laws across different subdisciplines of physics and appreciation of common threads
8) Ability to construct specific formulas for specific situations from established general formulas
9) Understanding of general physical principles outside the context of their mathematical expression
10) Ability to construct mathematical models from general principles without reference to other specific, limited-use formulas
11) Ability to teach effectively and see where common pitfalls in understanding occur

It should be possible to make metrics from these levels (or a revision of them). For instance, for the 2-year level, we design metrics that expect sophistication up to level 3, for the BS/BA level we design metrics to test for sophistication levels up to level 7 or 8, and for the MS/MA level we make metrics looking for sophistication up to level 11.

Benchmarks: Examples illustrating the levels of expectation for 2-year, BS/BA, and MS/MA programs for each of the above seven physics competency "themes"

The following examples of levels of expectation are not intended to be prescriptive of curriculum or of particular ways to demonstrate achievement of the outcomes. They are illustrative and should be adaptable to other example problems. Their concreteness is intended to clarify, in a way that should be accessible to all physics faculty, what level of expectation is appropriate for students at the 2-year level, the BS/BA level, and the MS/MA level.

1. Nature of Science, Nature of Physics

The 2-year student should demonstrate the ability to

- Understand that physics is possible because nature is predictable *and* understandable; physics is interesting because nature is not *too* simple. Physical theories are based on patterns in nature, discernible by patient and objective observation and experiment.
- Understand that physics is not a collection of facts or tables of numbers, or even a set of immutable laws, but rather a process to gain knowledge about the physical world.
- Understand that scientific theories must be testable because physics theories are only an approximation of the true, underlying behavior. The testing of a theory allows it to be modified and refined towards a more accurate representation of nature.
- Identify causes and effects in various situations.
- Understand that the acceptance of scientific theories is based on evidence rather than authority or popularity.
- Understand the difference between, and mutual dependence of, science and technology.
- Understand that physics is the most fundamental and foundational of the sciences.

- Understand that physics is a human enterprise that requires as much creativity and passion as other human endeavors.
- Identify the typical portrayal of scientists in the popular media as incomplete stereotype.
- Understand that science can be applied ethically or unethically.
- Recognize pseudo-scientific claims by their reliance on authority, lack of objective evidence or obfuscation of sources.
- Understand that mathematics is both a tool and a language with which the ideas of physics are expressed and investigated.

The BS/BA student should demonstrate the ability to

- Do everything on the 2-year student list in addition to the following:
- Understand the interplay between theoretical and experimental progress in physics.
- Understand that science is, and how it is, more self-correcting than other disciplines or realms of human activity.
- Put major advances in physics in historical context and know about the people involved.
- Understand the difference between dependent and independent variables and controlling (for) variables in experiments.
- Develop the knowledge and determination to behave ethically in the scientific arena.
- Explain the difference between observational and experimental science.
- Understand the role of science in society and the importance of universal scientific literacy.
- Give a coherent summary of the major laws of physics in mathematical form, and show by example several areas of physics united by similar mathematical forms.

The MS/MA student should demonstrate the ability to

- Do everything on the BS/BA list in addition to the following:
- Understand, detect, and avoid various ways of committing scientific fraud.
- Explain the importance of historical context in physics and relate some of the stories behind the physics.
- Explain science as a community effort, how scientists collaborate, and how scientific knowledge is shared.
- Advocate for ways to increase scientific literacy in the general population.
- Explain some philosophical conceptions of scientific knowledge, e.g., falsification vs. verification, correspondence theory of truth, various interpretations of QM, etc.
- Explain the nature of science and physics to school and community groups.

2. Mathematical Skills, Modeling, and Problem Solving (3 Examples)

(1)

The 2-year student should demonstrate the ability to

- Categorize a problem and explain it conceptually; for example, recognize that energy is conserved as a mass oscillates on a spring and explain at what point in the motion the energy is potential, kinetic, or both.
- Recognize the known and unknown quantities of the problem and assign the appropriate algebraic symbols to these quantities.
- Select the equations involving the known and unknown quantities that are appropriate to solving the categorized problem. For example, they should select the equations that describe the kinetic energy and potential energy of the mass/spring system.
- Set up the complete equation that mathematically describes their problem; in this example, the conservation of energy of the mass/spring system.
- Solve a basic conservation of energy problem assuming a massless spring and ignoring friction and drag. A student should be able to algebraically manipulate the basic equations to solve for the desired variable, showing each step from beginning to solution.
- Recognize if their numerical answer is reasonable for the given problem.

The BS/BA student should demonstrate the ability to

- Do everything on the 2-year student list in addition to the following:
- Distinguish between relevant and irrelevant quantities given in a problem. They should understand what approximations can be made (the massless spring, ignoring air resistance, etc.) and justify their decisions.
- Determine and numerically solve the differential equations of motion for multiple springs and masses, the mass/spring system swinging as a pendulum, and/or include any rotational motion, friction, and air resistance appropriate to the problem.
- Design an experiment testing the validity of the conservation of energy in a mass/spring system. They should be able to analyze data and explain sources of experimental error.
- Present solutions to a problem; graphically and numerically explain the problem and solution to others.
- Recognize if a problem needs to be solved numerically instead of analytically.
- Employ the scientific method in problem solving.

The MS/MA student should demonstrate the ability to

- Do everything on the BS/BA list in addition to the following:
- Apply the conservation of energy principles to more complex systems. A student should have a greater understanding of the differential equations and their applicability to a variety of problems.
- Understandably teach problem solving methods to 2-year and BS/BA students.
- Recognize deficiencies in their skill set necessary to solve the problem and know how to overcome them. For example, they should recognize they need to obtain a particular math concept, and know how to self educate such a concept from the available resources.
- Solve problems at every stage of the scientific process (i.e. hypothesize, etc.)

(2) Example of levels of expectation for organizing a physical problem. Reference numbers refer to Levels of Sophistication (above).

The 2-year student should demonstrate the ability to

- Identify the physical principles that underlie a problem from the 2-year physics curriculum
  - Identify the relevant physical laws and know their names, e.g. Coulomb's law or Gauss's law (1)
  - Know the definitions of important terms or symbols in the relevant physical laws (1)
  - Be able to identify what formulas are relevant (2)
  - Be able to identify when a specific problem solving approach is the most expedient way of solving a given problem, e.g., when to use conservation of energy vs. forces/kinematics (3)
- Express the meaning of the relevant physical laws or principles in words (2, 9)
- Express the elements of the problem in terms of the symbols in the relevant formulas(3)
  - Correctly formulate the problem in mathematical terms (3)
- Draw appropriate schematic diagrams showing relationships among the elements of the problem, e.g. free-body diagrams (3)
- Estimate the order of magnitude of the expected result from general physical principles, independent of calculating from a formula (3)

The BS-level student should demonstrate the ability to

- Do everything on the 2-year student list, but for the <u>more sophisticated problems</u> in the B.S. curriculum. In addition, the B.S.-level student should be able to:
- Suggest experimental tests of the validity of the model embodied in the problem as the student has set it up (4, 5)
- Recognize the same mathematical problem or model in different physical contexts, e.g. gravitational fields and electrostatic fields (7)
- Specialize general formulas for specific problems (8)
- Determine mathematically the conditions under which simplifying assumptions can be made, e.g., when the Coriolis effect can be neglected for projectile motion (5)
- Set up problems in more complicated geometries, e.g. two- and three-dimensional problems or curvilinear coordinates
- Estimate the order of magnitude of expected results for problems involving multiple physical concepts

The MS-level student should demonstrate the ability to

- Do everything on the BS-level student list, but for the <u>still more sophisticated problems</u> in the MS curriculum. In addition, the MS-level student should be able to:
- Set up problems combining several subfields of physics, e.g. mechanics and electricity & magnetism (7)
- Use curvilinear coordinates extensively and with facility in physics problems
- Teach problem organization and solving effectively to 2-year and BS-level students (11)
- Incorporate advanced mathematics (e.g., complex analysis, group theory) into problem solving (8,10)

(3) [Note: This is drawn significantly from Knight's *Instructor Guide for Physics for Scientists and Engineers* where he quotes from the physics education research.] **<u>Problem Solving Skills</u>**

1. Given a variety of problems, can the student sort them into meaningful categories? Can the student identify the underlying physical principles, and determine whether the problem would be best solved by using Newton's laws, one or more of the conservation laws, etc.? Benchmarks could be set for the 2-year, BS/BA, and MS/MA levels by the complexity of the problems.
2. Re-describe the problem. Describe the physical systems – particles, interactions, charges, fields, and whatever else is relevant.
3. Use quality arguments to plan solutions
   - Recognize patterns in the information.
   - Identify simplifying assumptions, such as whether to use a particle or a continuum model, whether or not to include air resistance, etc.
   - Determine what is relevant versus what is irrelevant.
   - Begin building physical models by abstracting the most important concepts.
   - Make decisions by first exploring their consequences.
4. Elaborate qualitative arguments in greater mathematical detail.
   - Draw some sort of sketch, make appropriate diagrams
   - Clarify geometrical relationships, usually with the aid of a coordinate system
   - Add details as needed such as free-body diagrams
   - Graphical skills and interpretation
   - Be able to cast story problems into mathematical models
   - Understand the meaning of the mathematics in the physical context:
     - Identification of physical quantities with algebraic symbols
     - Understanding the contexts for equations
   - Recognize the physics in a mathematical model
5. Organize quantitative information: clearly step through the mathematics of the problem solution. Determine whether the symbolic or numeric answer is reasonable.

Benchmarks could be made for each of the different steps of the problem solving skills, varying levels of difficulty for the 2-year, BS/BA, and MS/MA students.

3. <u>Physics Concepts (3 Examples)</u>

(1) Physics Concept: Conservation of Energy

The 2-year student should demonstrate the ability to

- Understand the definitions of kinetic energy, potential energy, and work. (1)
- Understand energy as the capacity to do work (definition of energy). (2)
- Understand the notion that energy can change form but cannot be created or destroyed in a closed system (definition of conservation law). (1,2)
- Make a clear distinction between the *principle* of energy conservation and the *identification* of various sources of potential energy (gravitational, mechanical, electrical, etc.). (1,8)
- Understand conversion of energy into dissipative forms (friction) and the resulting energy deficit; understand that this energy is not destroyed but is converted to microscopic random motion. (3,5)
- Understand the notion of conversion efficiency; be able to discuss this in contexts such as power generation. (3)
- Relate energy conservation to the notion that you can't get something for nothing (no perpetual motion or efficiency greater than unity). (2,9)

The BS/BA student should demonstrate the ability to

- Do everything on the 2-year student list in addition to the following:
- Understand the relationship between Newton's laws and energy conservation and the intrinsic advantage of scalar vs. vector formulations of a problem. (2)
- Understand the meaning of graphically presented potential curves and landscapes, turning points, forbidden regions. (9)
- Understand the role of energy conservation in the "crises" that led to the advent of quantum mechanics, e.g., the ultraviolet catastrophe. (6)
- Understand energy conservation in the context of quantum mechanics; specifically: (2,10)
    - The meaning of the wave function in forbidden regions and its connection to the Uncertainty Principle.
    - The Hamiltonian formulation and the connection between commutation relations, simultaneous eigenvalues, and integrals of motion.
- Understand energy conservation as applied to thermodynamics and statistical mechanics; specifically: (1,5,7)
    - The definition and role of temperature and entropy in the formulation of thermodynamic potentials.
    - The role of energy conservation in defining statistical ensembles (microcanonical, canonical, grand canonical, etc.).
- Understand the generalization of energy conservation to include energy incorporated in mass (special relativity). (5,8)
- Identify the role of energy conservation n in other advanced topics in physics, e.g., radiative transitions, photoelectric effect, radioactive decay. (7,8)

The MS/MA student should demonstrate the ability to

- Do everything on the BS/BA list in addition to the following:
- Relate energy conservation to general principals of symmetry and reversibility; understand the relationship between energy conservation and time-invariance of physical laws. (2,9)

- Understand the connection between conservation laws and the action principle (Hamilton's principle). (2,10)
- *Begin* to understand the ways in which symmetries and associated conservation laws place constraints on general theories, including those that are competing theories and/or not yet generally accepted. (5,7,10)
- Demonstrate the capacity to explain the concept of energy conservation to 2-year and BS/BA students (11).

(2) Gas laws and simple thermodynamics competencies

The 2-year student should demonstrate the ability to

- Discuss the impact of the principles of conservation of energy and the 2nd Law of Thermodynamics in modern society, relating them to things such as, but not limited to, the production of commercial electricity, transportation, and environmental issues. Appreciate the power of these laws to uncover pseudo-scientific snake oil!
- Calculate the changes in length and volume of solids, liquids and gases as functions of temperature, and use these ideas to explain, for instance, the workings of a thermometer, or the common manifestation of such things as cracked roads, and creaky houses.
- Explain the concepts of heat capacity and latent heats, and to use these to describe and sketch the temperature of a substance as a function of added heat (or as a function of time) as it evolves from a solid, through a liquid and into the gas phase.
- Use and explain the conservation of energy, or 1st Law of Thermodynamics, written as $dU = dQ - PdV$, or $dU = TdS - PdV$, identifying each term in sample gas law or calorimetry problems.
- Articulate and discuss the difference between the internal energy of a system and temperature. Explain thermal equilibrium in terms of these concepts. Understand that for an ideal gas, the internal energy is simply related to average kinetic energy of a molecule in the gas.
- Use the ideal gas law, $PV = NRT$, or $P=nk_BT$ to discuss the behavior of a finite amount of gas undergoing changes in Pressure, Temperature or Volume.
- Understand and perform simple heat diffusion calculations using $dQ/dt = kAdT/dx$, and connect this equation to the use of R-values in modern construction.
- Explain both an adiabatic process, $dQ = 0$ and an isothermal process, $dT =0$. Follow the calculus derivation of a gas expanding from one pressure and volume to the next, either adiabatically or isothermally, and explain that the work done by or on the gas can be represented by the area under the P(V) curve.
- Explain Entropy as an ordering principle, and recognize that it is related to the quality of energy in a system – the higher the entropy, the lower the quality of the energy in the system.

The BS/BA student should demonstrate the ability to, in addition to the traits and competencies above,

- Solve the heat diffusion equation, for simple geometries and discuss the notion of heat flux – solve the particle diffusion equation and explain diffusive properties in terms of microscopic models of particle concentrations and their energies , i.e., answer questions like, "why does heat flow from hot to cold", based on the motions of microscopic particles.

- Explain quantitatively and illustrate modes of energy transfer through radiation, conduction and convection, and explain for instance, the order in which these processes may occur, i.e., why the onset of convection when conduction and radiation are insufficient modes of heat transfer.
- Use statistical mechanics to define the entropy from the density of states and connect this form to the 2nd Law when expressed as $dS = dQ/dT >= 0$.
- Explain the Carnot cycle as a limiting case of a reversible process with $dQ = 0$ and $dS = 0$. Demonstrated knowledge should include quantitatively reproducing the Carnot cycle on a PV-diagram, and using the ideas of the Carnot efficiency and refrigeration COP in examples such as in the PV-cycle of real heat engines, refrigerators, appliances and power stations.
- Obtain quantitatively the partition function for simple systems, and use it to derive the average energy and Helmoltz free energy of those systems.
- Show facility with partial derivatives, being able, for instance to define heat capacity as partials of either the entropy, energy or enthalpy, with respect to temperature, holding the appropriate quantity fixed, and being able to define by transformation, the Gibbs Free Energy and chemical potential.
- Discuss the meaning of and use of partition functions and distributions, particularly the Maxwell-Boltzmann distribution, and the Fermi and Bose-Einstein distributions.
- Explain examples of the applications of statistical mechanics such as the workings of a laser, the magnetization of materials or the gas-liquid phase transition of simple fluids.
- Discuss the difference between Bose and Fermi particles and cite examples of how distributions of either type of particle are manifest in various physical systems, such as in semiconductors for Fermi particles, and in the formation of Cooper pairs in superconductivity.

The MS/MA student should demonstrate the ability to, in addition to the traits and competencies above,

- Explain the role that statistical mechanics plays in the foundations of quantum mechanics, through the use, for instance of the formalism of Hamilton-Jacobi, Poisson brackets, ensemble averaging, etc.
- Show proficiency in statistical mechanics, particularly as it is used in modeling magnetic and fluid systems.
- Use statistical mechanics for calculating the rates of reaction for interacting systems, based upon the principles of minimizing the energy and entropy production rate.
- Assemble a model necessary to perform a calculation for a particular research need, in condensed matter physics or other solid state application.

(3) Benchmarks for Rotation and Angular Momentum

The 2-year student should demonstrate the ability to

- Define and calculate the angular momentum for moving point masses or rotating symmetrical objects.
- Define and calculate the moment of inertia for symmetrical objects.
- Apply the law of conservation of angular momentum to simple situations (where the direction of the angular momentum vector does not change).
- Calculate the torque applied to an object given the force vectors acting on it.
- Calculate the change in angular momentum for a constant torque.

The BS/BA student should demonstrate the ability to, in addition to the traits and competencies above,

- Calculate the principal axes and the moment of inertia tensor for an object.
- Calculate the free rotation of a rigid body.
- Apply the law of conservation of angular momentum to more complex situations.
- Use Eulerian angles to describe rotation.
- Calculate the precession and nutation of a gyroscope.
- Use the kinematic equations for rotations and know when they apply (constant angular acceleration).
- Describe how rotational kinetic energy fits into overall energy conservation.

The MS/MA student should demonstrate the ability to, in addition to the traits and competencies above,

- All of the above at a deeper level.
- Students at this level should be able to explain and teach the above concepts to two-year and BS/BA students.

4. <u>Laboratory Skills:</u> the simple pendulum as a test example

All students at the 2-year level and beyond should be able to follow instructions and complete a cookbook style lab. But a 2-year student and beyond should be able to do much more in an open-ended lab.

The 2-year student should demonstrate the ability to

- Reduce uncertainties in taking data
  - Timing the pendulum for several swings rather than one swing
  - Starting timing after the pendulum has been released
  - Use a visual cue to start timing rather than a verbal cue from a partner
  - Start and stop at the top of the swing rather than the bottom of the swing
- Take consistent measurements
  - Always measuring to the center of mass of the bob, rather than the length of the string, as the masses may be different sizes
- Design experiments, understanding that they should only change one variable at a time(whenever possible)
  - Measure the periods for different lengths, leaving the mass and angle of swing alone
- Graph the results using Excel or a similar program
- Determine the functional dependence on the variables (fit a trendline)
  - Mass doesn't matter; angle of swing doesn't matter; but length does:
    T proportional to $(\text{length})^{-1/2}$
- Make a prediction based on their experimental data
  - What is the period of a 4 m long bowling ball pendulum?
- Take measurements using the appropriate apparatus necessary for the experiment
- Decide what apparatus is appropriate.
  - A stop watch will do; a photogate is more precise but is not necessary for this experiment
- Come up with an appropriate technique to do the experiment. The technique includes most of the above ideas.
- Compare their results to the theoretical predictions
  - Did we get a length to the -½ power; is the constant = $(2\pi\sqrt{9.8})$?
- Evaluate the level of uncertainty of the data
  - For example, they get a power = -0.48 instead of -0.50. Is this good, bad or within uncertainties? If they used the photogate with the microsecond resolution timer, then the result is bad. If they used the precision stopwatch, then it's a good result within uncertainties, and if they used the unreliable $2 stopwatch, the results are definitely within uncertainties. (I have a set of stopwatches from WalMart that, when the students use them, the times are all over the place, ±0.7s. The same students with precision watches agree within ±0.2 s, which is approximately human reaction time.)
- Explain in a written report what was done in the lab, what was used, what could be improved.

The BS/BA student should demonstrate the ability to, in addition to the traits and competencies above,

- Carry out full uncertainty analysis on their data and calculations
- Evaluate from their data whether the small differences are systematic or real
    - Is the slight upward trend in the period vs starting angle real or just uncertainty? It turns out to be a real effect.
- Correct their data for systematic uncertainties
    - Measured the lengths of the string rather than to the center of mass
- Model the experiment in software, and see if theory agrees with experiment
    - In fact, if I have time, I have my students do an Excel spreadsheet carrying out numerical integration for their various starting angles, find the period from the spreadsheet, and compare that to their actual data. Amazingly, the spreadsheet data falls right on top of the actual data.
- Develop equipment to make measurements (a capstone-type project)

The MS/MA student should demonstrate all of the traits and competencies above, plus develop a full experiment and demonstrate the ability to

- Find in the literature what comparable experiments have been carried out previously
- Gather the necessary equipment
- Build/design any equipment that is not otherwise available
- Develop the procedure to do the experiment and analysis

5. Scientific Communication (written, oral, and visual communication)

"Scientific Communication" in this context refers to any way students communicate their physics knowledge to fellow students, professors, and the public, in either an oral or written manner.

In the examples below, "undergraduates" refer to students who are taking coursework towards the 2-year or BS/BA level of competency. Students at the MS/MA level are assumed to be graduate students.

The 2-year student should demonstrate the ability to

- **Homework:** Write out, with appropriate diagrams as necessary, a complete solution to an assigned homework problem (appropriate for this level), explaining in complete sentences the steps used. Explain orally, to a fellow student or their professor, this solution.
- **Lab Report:** Write out a clear and grammatically correct laboratory report concerning an experiment they have performed in lab, including: Introduction, Experimental Setup, Data, Results and Conclusions. Student is expected to do this for a pre-arranged experiment. A reader should be able to comprehend the purpose and results of the experiment without reference to any other materials (such as the lab manual the experiment is derived from).

The BS/BA student should demonstrate the ability to

- **Homework:** Write out, with appropriate diagrams as necessary, a complete solution to an assigned homework problem (appropriate for this level), explaining in complete sentences the steps used. Student should be able to cogently argue for any approximations made in the course of the problem, backing them up with calculations. Students should recognize situations were more information is needed to solve a particular problem.
- **Lab Report:** Write out a clear and grammatically correct laboratory report concerning an experiment they have performed in lab, including: Introduction, Experimental Setup, Data, Results and Conclusions. Student is expected to do this not only for pre-arranged experiments, but also those of their own devising.
- **Presentation:** Orally communicate the contents of a written lab report, class project, or original research in the form of a short, informal talk. A reader/listener should be able to comprehend the purpose and results of the experiment without reference to any other materials (such as the lab manual the experiment is derived from). The oral presentation should include visual aids, such as electronic slides, that are visually attractive and effective in clearly communicating the scientific ideas involved.
- **Literature:** Summarize, either in written or oral form, the contents of a scientific paper they have read or a talk they have attended. Students should know the required elements of a proper citation of scientific sources.
- **Thesis:** Should the student be involved in a research project, student should be able to write an extended report discussing their research ("Senior Thesis"). This should be formatted like a scientific paper, including: Abstract, Introduction, (Body), Conclusions, and References.
- **Teaching (Tutor/Teaching Assistant):** Should the student be so inclined and have the opportunity, student should assist students at the 2-year level in all competencies of physics

through the form of tutoring, either as a private tutor or acting as a teaching assistant in a discussion/recitation section.

The MS/MA student should demonstrate the ability to

- **Homework:** Write out, with appropriate diagrams as necessary, a complete solution to an assigned homework problem (appropriate for this level), explaining in complete sentences the steps used. Student should be able to cogently argue for any approximations made in the course of the problem, backing them up with calculations, and to explain any new formulas or models used in solving the problem.
- **Lab Report:** Write out a clear and grammatically correct laboratory report concerning an experiment they have performed in lab, including: Introduction, Experimental Setup, Data, Results and Conclusions. Student is expected to do this not only for pre-arranged experiments, but also those of their own devising.
- **Presentation:** Orally communicate the contents of a written lab report, class project, or original research in the form of a short, informal talk. A reader/listener should be able to comprehend the purpose and results of the experiment without reference to any other materials (such as the lab manual the experiment is derived from). The oral presentation should include visual aids, such as electronic slides, that are visually attractive and effective in clearly communicating the scientific ideas involved.
- **Literature:** Summarize, either in written or oral form, the contents of a scientific paper they have read or a talk they have attended. Students should know the proper way to cite scientific sources.
- **Thesis:** Should the student be so required, student should be able to write an extended report discussing their research ("Master's Thesis"). This should be formatted like a scientific paper, including: Abstract, Introduction, (Body), Conclusions, and References, and be of high enough quality to be published in a peer-reviewed journal.
- **Teaching (Tutor/Teaching Assistant):** Assist undergraduates in all competencies of physics through the form of tutoring, either as a private tutor or acting as a teaching assistant in a discussion/recitation section.
- **Teaching (Lab Assistant):** Organize and supervise a laboratory session for undergraduates using a pre-arranged experiment. Student should be able to instruct undergraduates on the proper methods of Scientific Communication at the levels listed above.

6. Computational and Information Skills

The 2-year student should demonstrate the ability to

- Read and collect data via an interactive laboratory experiment using Labpro or other similar program
- Read, graph and explain spreadsheet data
- Read and calculate mean, median, mode and standard deviation from spreadsheet data
- Fit data to simple functions such as a line or a Gaussian distribution
- Estimate and recognize functions that are candidates for fitting a function
- Read and employ finite difference algorithms in a spreadsheet to generate data

NOTE: The above competencies are intended to implement existing utilities in a program such as Excel, not to require students to write their own programs.

In addition to the above, and assuming the above become refined during the BS/BA years of study, the BS/BA student should further demonstrate the ability to

- Understand the difference between a symbolic manipulator and a procedural language
- Read, understand, and implement an algorithm written in pseudo-code
- Write and build code from a standard language such as C++
- Execute a wide range of mathematical operations in a symbolic environment
  - E.g. algebra, integration, differentiation, simplification of expressions
  - Solve simple differential equations
  - Write and build code in some symbolic environment
- Employ both a symbolic manipulator and procedural language to solve a system of linear equations and matrices
  - Example: Solve the resistor cube problem for variable resistors and currents
- Find the eigenvalues and eigenvectors for a large system of equations
  - Example: Use finite difference rotations to diagonalize a matrix in order to find the eigenvalues
- Employ both a symbolic manipulator and procedural language to solve finite difference problems
  - Example: Calculate the maximum height and range of a baseball hit at differing altitudes, when considering drag, gravity, mass, and size of the ball
- Implement the Fast Fourier Transform on data
- Fit functions
- Solve problems employing Newton's method programmatically
- Implement mathematical functions symbolically on the computer, such as finding divergence, curl and/or gradient of a differentiable function in spherical coordinates

In addition to the above, the MS/MA student should demonstrate the ability to

- Generate and evaluate digital signal data
- Understand and explain the concept of accuracy in computing
- Carry out local interpolation and cubic splines
- Evaluate definite integrals by the trapezoidal rule, Romberg integration and Gaussian quadrature

- Solve linear and nonlinear ordinary differential equations
- Solve initial value problems using Runge-Kutta and adaptive methods
- Solve boundary value problems by shooting and finite-difference methods
- Solve partial differential equations: parabolic (diffusion), elliptic (Poisson), and hyperbolic (wave/advection)
- Implement finite-difference and finite-element spatial discretization
- Implement explicit, semi-implicit and implicit time-stepping schemes
- Carry out stability analysis

7. Research

Example research project using spectroscopy to analyze the color of tea, with goals to understand the factors affecting the color of tea and to propose a commercially viable scheme for characterizing tea color

The 2-year student should demonstrate the ability to

- Understand the nature of the sub-discipline in which they are carrying out research – how it fits into physics as a whole
  - Example: Understanding the basic theory of light, color and spectroscopy as an application of introductory physics concepts.
- Understand the qualitative nature of one or more open problems in this sub-discipline
  - What is the array of possible tea colors? How is tea color currently characterized in the industry? Why might one want a more scientific characterization? How could one use spectroscopy to illuminate this problem?
- Read the literature aimed at "the scientifically literate" (e.g. Scientific American, popular books) as well as more scientific documents (more advanced textbooks, American Journal of Physics) and make connections to ideas learned in introductory courses.
- Learn what are the "tools of the trade" and how to use them
  - What is the Standard Reference Method (SRM) for determining color? What is a spectrometer?
- Begin to understand the nature of physics work outside of the artificial classroom environment, where everything is cut and dried, where every question has an answer at the back of the book

In addition to the above, the BS/BA student should further demonstrate the ability to

- Read the scientific literature: journals – to some limited extent – as well as advanced textbooks which go beyond undergraduate curriculum. Begin to learn how to teach oneself needed material.
  - American Journal of Physics, spectroscopy journals, texts on theory of color and light
- State precisely the nature of the research problem
  - How to adapt the SRM method to characterization of the color of tea
- Carry out standard laboratory, mathematical, or computational tasks necessary to the kind of research project being undertaken
  - E.g. in order to build equipment, the student may need to learn machine shop, plumbing, or vacuum technology skills. For a theoretical project, the student may need to learn advanced mathematical or computation skills.
- Take direction to attack some small portion of the problem – build equipment, take data, analyze data, run (maybe code) canned programs
  - Assist in the design, building, calibration of the spectroscopy system. Learn/use/program canned data acquisition programs. Assist in the taking of data with the spectrometer. Process the spectrometer data and present the results, e.g., in graphical form. Interpret how different teas manifest different colors based upon these results.
- Present the research problem, explain the work performed and state how it fits into the context of the problem. Clearly state results, if any. Written and oral presentation. Audiences: experts, professional physicists, students.
- Learn how to synthesize elements of several sub-disciplines and to investigate a problem and create new knowledge
  - Light, color, optics, spectroscopy,...

In addition to all of the above, the MS/MA student should demonstrate the ability to

- Understand scientific literature pertaining to research project and understand current status of this problem/issue
- Self-teach new concepts, subjects, techniques as needed by the research project
  - Theory of light, color, spectroscopy. Existing approaches to characterizing color. Design and/or improve apparatus for doing the spectroscopy
- Take ownership of the research problem: be able to identify open problems and make proposals for future work
  - Note that the spectral results depend upon the age of the sample. Try to figure out what is causing this. Propose/make new measurements which might explain this.
- Add value to knowledge pertaining to the chosen research problem, either by extending existing results, solving open problems, or adding additional clarity to known results
- Contribute to research-level publication in scientific journal; explain project and results to professionals and students

b. <u>transferable skills/general competencies</u>

These are mainly included above. E.g. demonstrated ability to communicate effectively can be seen in the competency theme on scientific communication. The most important general competencies are identified in Section 10 of this report, Survey Results.

8. **Map of history degrees to employment fields or professions, with explanations of how potential jobs for graduates were identified**

The American Historical Association publishes *Careers for Students in History.* http://www.historians.org/pubs/Free/careers/Index.htm. Most of the Utah history departments use it to guide their advisement of majors. It lists the following:

- **Historians as Educators**
  - Elementary Schools
  - Secondary Schools
  - Postsecondary Education
  - Historic Sites and Museums
- **Historians as Researchers**
  - Museums and Historical Organizations
  - Cultural Resources Management and Historic Preservation
  - Think Tanks
- **Historians As Communicators**
  - Writers and Editors
  - Journalists
  - Documentary Editors
  - Producers of Multimedia Material
- **Historians As Information Managers**
  - Archivists
  - Records Managers
  - Librarians
  - Information Managers
- **Historians As Advocates**
  - Lawyers and Paralegals
  - Litigation Support
  - Legislative Staff Work
  - Foundations
- **Historians in Businesses and Associations**
  - Historians in Corporations
  - Contract Historians
  - Historians and Nonprofit Associations

The historians expect further guidance for their discussions about history degree employment will be available upon completion of the employer and alumni surveys.

9. Map of physics degrees to employment fields or professions, with explanations of how potential jobs for graduates were identified

We have unsystematic data from our various institutions on where our alumni have gone. However, we also have excellent reports from the American Institute of Physics (AIP) that have been compiled from careful surveys. We have relied primarily on these reports for the employment information at the BS/BA and MS/MA levels.

Two-Year Students:
There are no formal degrees in physics at the two-year level. Of the nine institutions in Utah, five (Southern Utah University, Snow College, Dixie State College, College of Eastern Utah, and Salt Lake Community College) do not offer bachelor degrees in physics. All five provide two-year preparation for students who wish to transfer to a bachelor-granting institution to study physics. In these two-year physics programs, "employment" is universally to **continue education at a BS/BA institution**.

BS/BA Degrees:
The other four Utah institutions (University of Utah, Utah State University, Weber State University, and Utah Valley University) all offer BS/BA degrees in physics.

1. **Summary of the findings of the "Initial Employment Survey of physics bachelor's, classes of 2005 and 2006,"** from the AIP Statistical Research Center.

- After receiving their degrees, new physics bachelors follow two main career paths: continuing their education at the graduate level or entering the workforce. In recent years, a little less than half of the degree recipients chose to immediately enter the workforce. A significant number of these individuals will enroll in a graduate program after working for a year or two.

- The paths that physics bachelor's pursue differ by the highest physics degree offered by the department from which they received their degree. Physics bachelor's receiving their degrees from departments that also grant graduate-level physics degrees are more likely to pursue graduate study in physics than are bachelors who receive their degrees from departments where a bachelor's is the highest degree offered. It is unclear the extent to which this difference is the result of the undergraduate experiences they had in the physics department or career goals that they had prior to starting college.

- In the classes of 2005 and 2006, the majority of the new physics bachelor's chose to immediately continue their education at the graduate level. Of them, nearly two-thirds chose to continue their studies in physics or astronomy. The balance of the students enrolled in a variety of graduate programs with engineering being the most frequently chosen field.

- Physics bachelor's who continue their education in physics and astronomy tend to be better supported by their graduate departments than the students who pursue other fields. Also, physics bachelor's who enroll in a PhD program, regardless of field, tend to be better supported than students enrolling in a master's program.

- The private sector continues to be the single largest employer of physics bachelor's hiring 57% of the bachelor's who secured full-time employment directly after receiving their degree. A significant proportion (13%) of new physics bachelor's took positions as high school teachers. Seventy percent of these new teachers indicated they were teaching at least one physics class.

- Science, Technology, Engineering and Math (STEM) continue to be the most common fields in which new physics bachelor's work. In the private sector, nearly two-thirds of physics bachelor's work in STEM fields. A significant proportion (~1/3) of the new physics bachelor's accepted positions in the private sector that are non-STEM related. These non-STEM jobs cover a wide variety of positions including retail sales and finance.

2. Employers in Utah that recently hired new physics bachelor recipients

- Air Force Civil Service
- Black Diamond Equipment, Ltd
- BlueHost, Inc.
- DHI Computing Services
- General Electric
- K-tec
- L-3 Communications
- Simco Electronics
- Sohl Source Consulting
- Solitude Mountain Resort
- Sylarus Technologies
- U.S. Army Dugway Proving Ground
- University of Utah Hospital and Clinics
- Wasatch Front Regional MLS
- Wasatch Photonics
- Watson Pharmaceuticals

Note: This is only a portion of the employers who hired recent physics bachelors into technical positions.

Source: AIP Statistical Research Center, Initial Employment Surveys, classes 2006 thru 2008.

3. Type of Employment of Physics Bachelors, 5 to 8 Years After Graduation
Source: AIP Statistical Research Center, 1998-99 Bachelors Plus Five Study
Based on physics bachelors with no additional degrees who are not primarily students

- Software 24%
- Engineering 19%
- Science & Lab Technician 9%
- Management, Owner & Finance 20%
- Education 12%
- Active Military 6%

- Service and Other Non-Technical 10%

4. Employment Map for Physics BS/BA Degrees in Utah

BS Physics Pre-Professional:	Graduate school in science or engineering Industrial research National laboratory research Other technical employment Business
BS Physics:	Lab technician Engineering aide Business, marketing, sales Patent law Consulting
BA Physics:	Science writing Law school Patent law Medical school, dental school, veterinary school, etc. Business, marketing, sales
BS Physics/Mathematics:	Actuarial science Applied mathematics Graduate school in science or mathematics
BS Physics Pre-Medical:	Medical school, dental school, veterinary school, etc. Biomedical industry Patent law Business, marketing, sales
BS Physics Applied:	Industrial research Patent law Business, marketing, sales Graduate school in science or engineering
BS/BA Physics Teaching:	Secondary education
BS Physical Sci Composite Teaching:	Secondary education

<u>MS/MA Degrees:</u>
University of Utah and Utah State University offer MS/MA degrees in physics.

1. **Summary of the findings of the "Initial Employment Survey of Physics Master's, classes of 2005 and 2006,"** from the AIP Statistical Research Center.

- Overall, about 60% of the master's entered the workforce, with only a small percent not having secured some type of employment in the winter following the year they received their degree. A much larger proportion of the US citizens immediately entered the workforce than non-US citizens (76% vs 24%).

- The remaining master's immediately continued their graduate education at another department. Two-thirds of these choose to remain in the field of physics. As noted above, initial outcomes of physics master's vary greatly by citizenship with foreign citizens being 3 times more likely to continue with graduate study than their US counterparts.

- The private sector continues to employ about half of new physics master's that enter the workforce. The vast majority (93%) of physics master's employed in the private sector indicated working in the fields of natural science, technology, engineering, or mathematics (STEM).

- Physics master's recipients accept positions in a variety of employment sectors. The master's employed at colleges and universities, which includes 2-year colleges and University Affiliated Research Institutes, are often laboratory coordinators, programmers, and instructors. Two-thirds of the master's employed as high school teachers are primarily teaching physics with the balance primarily teaching mathematics or another science. The master's employed in the active military came from both military academies and non-military schools.

2. Employment Map for Physics MS/MA Degrees in Utah

MS/MA Physics:	Industrial research and development Doctoral program in physics or related field
MS Computational Physics:	Industrial research and development Biomedical industry
MS Instrumentation Physics:	Industrial research and development
MS Upper Atmospheric Physics:	National or military laboratory research Industrial research
MS Industrial Physics:	Industrial research and development

10. Survey results from students, recent graduates, employers and faculty members and how these were used in deliberations

As explained in the previous sections, we delayed most of the surveys while we thought through the learning outcomes and related disciplinary issues. We did carry out the student surveys early as discussed below. The status of the other surveys is also discussed below.

a. How did you go about surveying students?

Each team member arranged to survey several classes near the end of Winter Semester 2009. These surveys were done in class on bubble sheets. We talked with several IRB Chairs or institutional officers about the approval process for these surveys. By emphasizing that we collected no identifying information, we were able to simplify IRB approvals considerably. In most cases, campus testing centers or institutional research offices set up computer programs to read the bubble sheets and provided computer files of the results. We discuss the results below.

We surveyed general education (first two years of study) and discipline majors groups separately.

b. How did you identify recent graduates to survey?

This was done primarily in collaboration with Alumni Offices. In some departments, the departments themselves have kept good records of their graduates, from which lists have been compiled. These surveys are currently in process and should have results to report in January, 2010.

c. How did you identify employers to survey? Who responded to your employer surveys? HR? Hiring managers? How might this have affected outcomes?

First, we worked with Utah Technology Council (UTC), a trade organization, who agreed to survey their membership for us. This survey is currently out to technology organizations and to venture funding organizations, including banks and other financial institutions. It is anticipated that we will have responses from a mix of CEOs and HR or hiring managers. We expect, given the nature of UTC's relationships with the companies, that about half of the respondents will be CEOs, which should give an interesting picture of the views of company leaders. We should have results available for discussion by mid-December. The financial companies, at least, should give us information useful to the History Team as well as the Physics Team.

We have also compiled a list of other major employers in Utah, including education and government sectors. UTC has agreed to cross-reference this list with their membership to avoid duplication with the survey UTC is conducting for us. We are waiting for the response to finalize this list of additional employers. We expect to survey the additional group in January, 2010.

d. **Did you use the European survey or design your own? Why, or why not? If you used the European survey, did you add optional questions? Why or why not? Were problems encountered, if any? How could these have been avoided?**

We used the European survey items for general competencies, primarily for uniformity and comparability. We prepared our own versions of the explanatory paragraphs in order to avoid terminology problems and make the surveys as friendly as possible to our audiences. We did not add optional questions because of the short time frame for this project.

We did not (so far) use the European survey staff to set up and analyze our surveys. This was due, first of all, to the short time window we had for student surveys, requiring us to handle them locally and on paper. Then we found that in working with Alumni Offices, these offices, with us paying the costs, were set up to identify the relevant alumni and handle the surveys. Finally, the employer surveys also worked out locally when we made our connections with UTC, described above. Faculty surveys have so far been small and handled directly by the team members.

e. **Are there other approaches Tuning participants should explore in the future for gathering this information?**

Our approaches have worked well, even though most of the results are expected in the next 2-3 months. We would recommend taking the time to review the general competencies listing to adapt it for the US higher education context and perhaps even for local (i.e. state) needs.

f. **How were the survey results used to come up with the set of transferable skills graduates at various levels should have?**

The only survey results available to us early in the process were the student surveys of general competencies. These were used primarily by individual team members bringing the summary information from their students into the discussions of learning outcomes. The priorities for general learning outcomes as seen in the student surveys influenced the related discipline-specific learning outcomes developed by the teams.

A particularly important aspect of the survey results was the identification of important competencies that are not well developed and low priority competencies that are perhaps better developed than they are worth. These vary greatly from institution to institution, and the overall analysis of this view of the results is continuing. These issues were seen by the teams as indicators of particular needed curricular reforms.

Survey Results

These will be provided to Lumina Foundation early in 2010 when the additional surveys are completed and the results can be put in a common format. (Every institution used a different format!) The common format will allow preparation of a statewide summary of results. (Individual institution results of student surveys are now available, and these are what have been used in the activities described above.)

11. **Profiles of degree programs by institution. (It may be helpful to view these as half- or full-page pitches for your programs that are grounded in learning outcomes, including outcomes the program emphasizes beyond those agreed upon as part of Tuning. These also should include descriptions of where graduates are finding employment related to their degrees.)**

[Note: Many of these degree profiles are expressed in terms of credit hours and courses, the US higher education currency. As we continue the Tuning work, the Utah Teams intend to work toward expressing their degree and program profiles in terms of the learning outcomes in Sections 6 & 7.]

Utah System of Higher Education
History Degree Profiles

Utah State University (USU) Department of History Degree Profile

UNIVERSITY OVERVIEW

Utah State University fulfills a unique role in the Utah System of Higher Education as the state's land-grant and space-grant university. The land-grant designation makes Utah State responsible for programs in agriculture, business, education, engineering, natural resources, sciences, and the traditional core of liberal learning—humanities, arts, and social sciences. The university gives particular emphasis to programs involving the interaction of land, people, and the environment. USU is a "Doctoral Research University / high research activity" institution as designated by the Carnegie Foundation, providing doctoral and master's level education and supporting significant research efforts by its faculty.

The institution has 850 faculty who provide education for more than 23,000 undergraduate and graduate students, including 10,000 in its continuing education sites located throughout the state of Utah. The University has seven colleges, more than 200 majors, and 130 research-related classes. USU also has 3 branch campuses and Extension offices in all of Utah's 29 counties. Utah State is accredited by the Northwest Commission on Colleges and Universities.

HISTORY DEPARTMENT

At Utah State University, the Department of History's primary mission is to train undergraduates to research, analyze, synthesize, and communicate accurate conclusions about change over time by using the historical method. At the same time we aim to inculcate cultural literacy and provide the knowledge necessary for informed decision making by citizens of Utah, the United States, and the world.

On the undergraduate level, the History Department serves the campus through general education, general interest courses, the History major, the History Teaching major, minors in History and Classics, and interdisciplinary programs, all of which give our students crucial work skills as well as enriching their lives. History offers BA/BS degrees, with a general history emphasis and a History Teaching emphasis. It offers minors in the same programs, along with minors in Classical Civilization, Latin, and Greek.

Our total enrollment of majors and minors, including Religious Studies and Classics, is 426. Of these, 353 are History majors and 25 are History minors; Religious Studies has 13 majors and 3 minors; Classics enrolls about 35 students. The number of History majors has grown rapidly. In 2005 there were 249 majors; by Fall 2009, the number increased 47% to 366 majors in History/Religious Studies. Nearly 80% of the students we teach are not "declared" in the department. Gen Ed accounts for many of these, but our upper division courses are taken by people from all colleges. A significant portion is for other majors that require our courses, such as International Relations and American Studies.

On the graduate level, the History Department prepares MA and MS students to research, teach, edit, and administrate by further enhancing their ability to ask hard questions, research them, and communicate their conclusions clearly. In addition we emphasize the acquisition of the skills of open inquiry and debate as well as team work and collaboration. Each year, we admit 10-12 new graduate students into our program. Most work with the department as graduate assistants as they pursue their coursework and research.

History participates in American Studies major and minor, and in the Folklore minor, as well as the British and Commonwealth Studies minor and the Latin American Studies Program. The Religious Studies Program (administratively connected to the department) offers the BA/BS in Religious Studies, with a minor; the program began enrolling students in the fall of 2006. Both of the endowed chairs connected with the Religious Studies Program will hold tenure in History.

History has 20 tenure-track faculty on its Logan and RCDE campuses along with one senior lecturer. All have PhD's and offer a wide range of courses. With a standard load of 2/2 on the Logan campus (one large survey, one small seminar, and two upper division courses), faculty members teach a mix of courses that are defined geographically, chronologically or thematically. The Department has its greatest depth and strength in the modern American West, the classical world, and early modern Europe.

BACHELORS DEGREE (BA, BS)

The History Department models its work with undergraduates on seven critical learning outcomes. As students move from survey courses, through upper-division classes (with a more focused chronological, regional, or thematic structure), to their senior capstone class, they develop competencies . . .

in terms of ***Historical knowledge***:
(1) pursuing coursework that examines a broad range of historical experience

in terms of ***Historical thinking***:
(2) recognizing the past-ness of the past and appreciating the unfamiliar structures, cultures, and belief systems of historical actors
(3) understanding the complexity and diversity of historical situations, events, and past mentalities
(4) recognizing the complex, problematic, and constructed nature of the historical record itself

and in terms of ***Historical skills***:
(5) developing skills in critical thinking and reading
(6) developing research skills
(7) developing the ability to construct reasonable historical presentations that are carefully structured, clearly expressed, and persuasively argued

Students in the History major complete their work in a capstone class that focuses on the creation of a senior thesis based on primary source evidence and readings in major secondary sources. Students with a History Teaching Emphasis complete their capstone experience in a class that focuses on pedagogical theory and practice; in addition, they take the Praxis exam to demonstrate their mastery of a wide range of historical subjects.

EMPLOYMENT: While pursuing undergraduate studies, our majors may apply for various types of employment in the department as: undergraduate teaching fellows, rhetoric associates, supplementary instructors, and academic tutors. Students who complete the bachelors degree with a History major report that they are most likely to seek employment after graduation (71%) while 42% will pursue further education in graduate or professional school. Three-quarters of graduates report employment in areas related closely or somewhat closely to their degree. Roughly 60% state they will be working in business, 25% in education, and 8% in government. Most plan to work in Utah.

MASTERS DEGREE (MA, MS)

In line with the recommendations of our discipline's key professional organization (the American Historical Association), our masters program focuses on five essential learning outcomes: http://www.historians.org/projects/cmd/2005/Report/index.cfm

Historical knowledge

(1) A base of historical knowledge, combining both a breadth and depth of knowledge, a familiarity with more than one historiographic tradition, and the ability to synthesize different types of historical knowledge (such as might be required to construct a survey course). Master's programs should incorporate a comparative, if not a global, perspective on history. Program graduates should be "educated history generalists."

Historical thinking

(2) Learning to think like a historian, which includes "historical habits of mind" and "historiographic sensibilities" (i.e., a critical and self-conscious approach to the constructed nature of historical knowledge).

(3) The foundations for a professional identity as a historian, including a familiarity with the historical development of the discipline, an introduction to ethical standards and practices, and an awareness of the multiple contexts of professional practice.

Historical skills

(4) Research and presentation skills, evidenced by the completion of a substantial research project demonstrating content mastery, a familiarity with primary research, and competent historical analysis.

(5) A solid introduction to historical pedagogy, in the broadest sense of the term: the cognitive processes involved in teaching and learning history; appreciating how learners of different ages attain their understanding(s) of history; and understanding how historians present the past to different audiences. Most students work as "graduate assistants," receiving practical training in the "presentation of history to non-specialists."

The Department identifies three particular areas of strength in its graduate studies: U.S. Western history environmental studies, and religious studies.

Masters students pursue either the M.A. or the M.S. degree. The former requires competency in a foreign language (equivalent to having completed two years of a foreign language at the undergraduate level); M.S. students may be required to incorporate computer science, statistics, or environmental or other applied science in their research.

EMPLOYMENT: USU graduates relocate all over the world in a variety of undertakings. Some acquire jobs in historical societies, museums, and publishing. One graduate manages the architectural archives of the LDS church; another works as the associate director of the Cayman Islands National Museum; a third works for Research and Educational Programs in the U.S. Bureau of Land Management. Some pursue careers in high school teaching. One of these has become the Director of Religious Education for the Diocese of Utah. Others teach at the junior-college level. One recent student went from his master's at USU to New Zealand as a Fulbright Scholar. A number of master's graduates choose to go on for their Ph.D.'s. Some have pursued Ph.D.'s at Northwestern University, Georgetown University, Arizona State University, Washington State University, Michigan State University, UCLA, UC-Davis, and the Universities of Wisconsin, Minnesota, Colorado, Oklahoma, and Arizona. Among our master's graduates who later completed doctorates are faculty members at the University of Arizona, Kent State University, Brigham Young University, Southern Oregon University, Middlebury College, BYU-Idaho, Case-Western Reserve, and Cal Poly-Pomona. A few of our master's graduates go on to law school.

The History Department at Weber State University offers the following American Institutions course:

- American Civilization

The History Department awards three Bachelor's Degrees

- History
- History Teaching
- Social Science Composite Teaching Major

and offers minors in:

- History
- History Teaching
- Public History
- Asian Studies

The History Department graduates about 30 majors per year with half going into teaching, a few going to graduate school, and the rest finding employment in fields which recognize their skills in reading, writing, research and analyzing information.

The History faculty at the University of Utah strives to make outstanding scholarly contributions to the discipline and to instill historical knowledge, perspective on human experience, critical thinking skills, and effective writing in all our graduate and undergraduate students. We are also a community of citizens engaged in service and devoted to the enrichment of intellectual and public life at the University, throughout Utah, and beyond. We offer the B.A., M.A., and Ph.D. degrees. History students can explore periods and regions ranging from ancient Mesopotamia, Greece, and Rome to the modern Middle East, Asia, Europe, and the Americas.

Our faculty specializes in topics that include politics, diplomacy, warfare, and intellectual life as well as gender and women's history, medicine and science, colonialism and intercultural contact, religious expression and practices, and environmental history. Our curriculum reflects long-standing disciplinary tradition in its organization by region, nation-state, and time period, but it also embodies a newer orientation toward transnational, comparative, and thematic courses. Faculty involvement in Middle Eastern Studies, Gender Studies, Asian Studies, Ethnic Studies, International Studies, Latin American Studies, and Environmental Studies reflects the department's long-standing commitment to interdisciplinary programs. History courses emphasize written and oral skills, analysis and critical thinking, and the ability to assess conflicting interpretations. These skills prepare students for the responsibilities of citizenship and cultivate an awareness of the complexities of life. History provides valuable preparation for careers in university and college teaching and research, primary and secondary education, law, government, public service, journalism, libraries and museums, international business, and medicine.

History provides valuable preparation for careers in university and college teaching and research, primary and secondary education, law, government, public service, journalism, libraries and museums, international business, and medicine. Students of history explore periods and regions ranging from ancient Mesopotamia, Greece, and Rome to the modern Middle East, Asia, Europe, and the Americas. Areas of emphasis include politics, diplomacy, warfare, and intellectual life, as well as gender and women's history, medicine and science, colonialism and intercultural contact, religious expression and practices, and environmental history. Our curriculum reflects long-standing disciplinary tradition in its organization by region, nation-state, and time period, but it also embodies a newer orientation toward transnational, comparative, and thematic courses.

The History Department offers the following general education courses:

Diversity

- History 4700-1 African American History Since 1890
- History 4670-1 Native American History

Humanities Exploration

- History 1100 History of Western Civilization to 1300
- History 1110 History of Western Civilization Since 1300
- History 1220 Asian Civilizations: Modern History and Societies
- History 1310 Latin American Civilization Since the 1820s
- History 1460 Middle Eastern Civilization: Modern Period
- History 1500 World History to 1500
- History 1510 World History Since 1500
- History 3210 Age of Total War

International Requirement

- History 4271 European Exploration, Imperialism, and Decolonization 1750 to Present

- History 4780 The Korean War

The Department offers three advanced degrees (click on them to see their requirements in the Graduate Handbook): the M.S., M.A., and Ph.D. Students pursuing these degrees specialize in Asian History, Colonialism and Imperialism, Comparative Gender, European History, Latin American History, Middle East History, Religious History, US History, and World History.

The M.S. degree is designed for all those who "love history" including: students looking for a Masters level degree but not bound for the Ph.D., secondary educators, military service members, and those pursuing employment in government, archives, libraries and other sectors. The M.S. has *no thesis* and *no language requirement.* The M.S. is, in most cases, a terminal degree that is non-research focused and best suited for individuals not intent on pursuing a Ph.D.

The M.A. degree is primarily for those intent on pursuing Ph.D. work. The M.A. degree has both a language and thesis requirement and is considered training for individuals seriously considering the Ph.D. and a career in research, publication, and collegiate teaching.

The Ph.D. is the highest degree conferred and best suited for those planning on careers in the academy.

At Southern Utah University it is the Department of History and Sociology. The department offers **Bachelor Degrees in:**

- History
- Sociology
- Social Science Composite

- Professional Education Requirements for Secondary Licensure

The department also offers Minors in:

- History
- Sociology
- and is developing one in Anthropology

At Utah Valley University it is the Department of History and Political Science. In keeping with the University's mission, the History and Political Science department is dedicated to providing students with a broad range of opportunities and experiences in general-education

and discipline-specific courses in economics, geography, history, and political science. Classes are taught in ways that foster critical thinking and analysis of complex issues and materials through lecture, reading, class discussion, and the development of written- and oral-presentation skills. The History and Political Science department strives to provide a reflective, multicultural, and international perspective.

The department offers Associate Degrees in:

- AA/AS in History and Political Science

The department offers Bachelor's degrees in:

- BA in History
- BS in History Education
- BA in Political Science
- BS in Political Science
- BA/BS in Integrated Studies Emphasis in History
- BA/BS in Integrated Studies Emphasis in Social Sciences

The department offers Minors in:

- History
- Political Science

At Dixie State College there is no history department and there are no degrees in History offered.

At Salt Lake Community College it is the department of History and Anthropology. The history program is designed to expose students to a variety of history fields and to the methods used by historians. Students who complete the program will be well prepared to undertake upper division history courses or complete a four year degree.

Our faculty specializes in varied topics such as American West, intellectual history, politics, international relations, gender and women's history, immigration, religious history, urban and environmental history. History students can therefore explore and select history courses based on their interests, time periods, and regions.

The department lays stress on written, oral and analytical skills thereby preparing students for several careers in teaching, research, government and administration.

Program Description: The History Department provides a wide variety of courses that range from general surveys to specialized topics. The program goes far beyond an emphasis on

coverage and content; each course deals directly and indirectly with the historian's craft, i.e., the practice of interpretation and narration based on the systematic analysis of evidence. Additionally, all regular offerings carry the General Education designation. This means that this program is also a vehicle for students to broaden their perspectives and deepen their understandings of the world around them.

Academic Student Learning Outcomes	Program Objectives/Student Learning Outcomes	Program Assessments.
1	Students will: a) acquire substantive knowledge of the major social, political, and economic themes in a variety of history fields; b) understand the ways in which the study of the past informs the present; c) understand the methodologies historians utilize; d) be able to identify major schools of thought.	To gauge the program's effectiveness in increasing students' substantive knowledge in History, the History Department may employ any or all of the following: *A survey of majors who have completed the program. * A survey of graduates who have completed upper-level courses elsewhere. * Embedded writing assignment(s) across selected sections of American Civilization (History 1700) which will be scored using a departmentally agreed-upon rubric. *Embedded writing assignment(s) in selected sections of the 4 majors courses: 1100, 1110, 2700, and 2710 which will be scored using a departmentally agreed-upon rubric. * Other measures as designed by the History Department faculty.
2	Students will speak and write analytically, comparatively, and persuasively about historical themes, interpretations, arguments and ideas in a skilled and respectful manner.	To gauge the program's effectiveness in increasing students' oral and written communication skills, the History Department may employ any or all of the following: *A History conference or workshop where majors or graduates present their own research or portfolios of work. * Embedded writing assignment(s) across selected sections of American Civilization (1700), a sample of which will be scored using a departmentally approved rubric. * Embedded writing assignment(s) in selected sections of the 4 majors courses: 1100, 1110, 2700, 2710 which will be scored using a departmentally approved rubric. * Other measures designed by the History faculty.
4	Students will be able to: a) gather, identify, differentiate and analyze data from both primary and secondary historical sources; b) interrogate and contextualize sources; c) evaluate contested interpretations; d) use evidence to create narrative; e) revise narrative in the light of new	To gauge the program's effectiveness in teaching students to think critically, the History Department may employ any or all of the following: * A survey of our majors/graduates that will probe the students' sense of their own metacognitive growth and affective development in this area while in our program.

	findings.	* A History conference or workshop where majors/graduates present their own research or portfolios. * Embedded writing assignment(s) across selected sections of American Civilization (1700), a sample of which will be scored using a departmentally approved rubric. * Embedded writing assignment(s) in selected sections of the 4 majors courses: 1100, 1110, 2700, 2710 which will be scored using a departmentally approved rubric. * Other measures designed by the History faculty.

Utah System of Higher Education
Physics Degree Profiles

University of Utah Department of Physics & Astronomy Degree Profile

The Department of Physics & Astronomy was known before July 1, 2009 as the Department of Physics. New degree programs in Astronomy are forthcoming but will take some time to develop. This degree profile describes degree programs in physics only.

Undergraduate Degrees (4 year cycle)

- BS in Physics with pre-professional emphasis
- BS in Physics with pre-medical emphasis
- BS in Physics with applied emphasis
- BS in Physics Teaching
- BS in Astronomy (currently under development)

All of the above degrees are optionally offered as BA degrees. This distinction has no bearing on Physics course requirements. A BA requires 4 semesters (16 credits) of a foreign language. The BA in Physics is rarely if ever elected.

The University of Utah requires 122 semester credit hours for a bachelor's degree. For physics majors, 33-35 of these credit hours are devoted to mandatory general education that cannot otherwise be satisfied by the requirements for a BS in Physics.

Core requirements: All of the above degrees, except for the BS in Physics Teaching, require a common core of courses that consists of mathematics through ordinary differential equations and linear algebra; two semesters of general chemistry (and associated laboratories); two semesters of introductory physics (and associated laboratories) through mechanics, electromagnetism, and light & optics; and a semester

each of introductory quantum mechanics & relativity, thermal physics, and intermediate physics laboratory. (These last three are 3000-level courses.) At least 30 credits of upper division physics courses (3000-level and above) and some additional math courses are required for the non-teaching majors according to the particular emphasis (see below).

Pre-professional emphasis: This degree provides the highest level of rigor in the discipline of physics. Designed for students intending to go on to a doctoral program in physics or a closely related discipline (*e.g.*, astronomy, materials science, engineering). However, students who terminate their studies with this degree will have strong backgrounds in the fundamentals of physics used in research in industrial or national-laboratory research settings. Their problem-solving skills make them attractive as employees in a wide variety of technical and business endeavors. Additional courses include one semester of mathematics covering partial differential equations and complex variables; a semester of computational physics; a semester each of advanced theoretical mechanics, electricity & magnetism, quantum mechanics, and statistical mechanics; and additional elective courses selected in consultation with an advisor.

Applied emphasis: This degree provides a solid but streamlined foundation in theoretical physics and provides additional training in applied fields within physics and (guided by close consultation with an advisor) at the interface between physics and other disciplines. Designed for students intending to pursue technical careers in industrial research, it should also serve students interested in patent law, business, or marketing & sales. This degree could also lead to more advanced study in related fields (*e.g.*, biophysics, medical physics, or materials science). Additional courses include one semester of mathematics covering partial differential equations and complex variables; a two-semester sequence covering theoretical mechanics, electricity & magnetism, quantum mechanics, and statistical mechanics; at least one semester each of computational physics, applied optics, and electronics; and additional elective courses selected in consultation with an advisor.

Pre-medical emphasis: This degree provides a solid but streamlined foundation in theoretical physics with additional courses geared toward biomedical applications. It is designed for students who wish to major in physics and then apply to medical school, and it provides time and room in scheduling for the student to take all of the additional chemistry and biology courses required.

These students should be highly attractive to medical schools for their rigorous training in physics, an understanding of which is in ever greater demand in the clinical realm. The program should also be a solid preparation for dental school, veterinary school, or a career in a related medical field. It should provide students with an excellent background for pursuit of the MD/PhD combination degree. The broad training across all science disciplines should also be attractive to employers of technically skilled workers in biomedical and clinical settings. It should also serve students interested in patent law, business, or marketing & sales. Additional courses include one semester of an applied mathematical methods course for biology and medicine; a two-semester sequence covering theoretical mechanics, electricity & magnetism, quantum mechanics, and statistical mechanics; a two-semester sequence in "Physics of the Human Body"; and additional elective courses selected in consultation with an advisor.

BS in Physics Teaching: This degree is designed for those intending to become secondary school teachers with a primary assignment of teaching physics. It also provides additional courses in math and chemistry that should help in enabling students to teach within these disciplines, as well. Core requirements are the same as for non-teaching majors, except for the semester of thermal physics. Three additional upper division physics courses and a teaching methods course complete the major. Two additional courses in geology and atmospheric science allow the student to qualify for physical sciences teaching endorsement.

Graduate Degrees (6 year cycle)

- MS in Physics
- MA in Physics
- MS in Computational Physics
- MS in Instrumentation Physics

All degrees require a minimum of 30 credit hours in courses numbered 5000-level and above. A minimum of 20 credits must be non-thesis coursework. In the case of those degrees involving a thesis or final project, 6-10 credits are in research. Master's degree programs are generally intended for students wishing to enter the job market with a higher degree of qualification (and higher salary) than a bachelor's degree. In the case of a MS degree with thesis or final project, the student should be better equipped to function in an industrial research and development setting.

Supervisory Committees: The supervisory committee, consisting of three faculty members, is primarily responsible for approving the student's academic program, preparing and judging the qualifying examination, approving the thesis subject, reading and approving the thesis, and administering and judging the final oral examination. A satisfactory score on the Common Exam, a written exam given to all entering graduate students (including and especially PhD candidates) may count for the qualifying examination. The chair of the supervisory committee directs the student's research and writing of the thesis or dissertation. Decisions concerning program requirements, examinations, and the thesis or dissertation are made by majority vote of the supervisory committee.

MS in Physics (thesis option): A supervisory committee is appointed to guide the study and thesis research of acceptable candidates. The final oral examination is a defense of the thesis.

MS in Physics (non-thesis option): A supervisory committee is appointed to guide the study of acceptable candidates. A non-thesis Master's student must pass a specialized exam (written, oral, or both) administered by the supervisory committee.

MA in Physics: Either a thesis or non-thesis MA degree is indistinguishable from the MS degree, except that Candidates for the MA degree must be certified by the Department of Languages and Literature as having demonstrated "standard proficiency" in at least one foreign language.

MS in Instrumentation Physics: This program qualifies those with training in science and engineering fields to work with and develop modern instrumentation and control. Study includes numerical analysis by computer, electronics, microprocessor and minicomputer data acquisition and control techniques,

and the physical principles of the operation of various measurement transducers. The student takes part in developing an instrumentation project selected from a variety of research and industrial test areas. In many cases, the project occurs in disciplines other than physics. Courses include advanced computational physics, electronics, and instrumentation optics. The courses are scheduled to accommodate students with daytime employment. Students finishing this course of study are generally equipped to take on more demanding, technically intensive roles in industrial research and development. The typical student already has a job at an engineering or industrial firm and is looking to expand his/her qualifications and ability to be promoted.

MS in Computational Physics: This Physics Masters of Science program provides interdisciplinary training in the use of computers to solve problems in Physics, Computer Science, and Mathematics. With advice and assistance from a supervisory committee the student selects a computational project connected with ongoing campus research or with his or her employment. The project report and documentation constitutes the Master's thesis. Courses include computer interfacing, scientific visualization, and numerical methods. Students with this degree should be attractive to companies requiring expertise in computer modeling, non-analytical problem solving, and simulation. Applications range from industrial production to medical imaging and visualization, to the entertainment industry.

Utah State University Department of Physics Degree Profile

USU Physics Department Objectives

Degree programs in Physics are aligned with the Physics Department's overall goals and objectives, which are

- to communicate the beauty and utility of the fundamental principles of the physical universe and the power of describing nature in quantitative terms,
- to create new knowledge,
- to foster critical and creative thinking,
- to enhance the ability of citizens to participate in a technological democracy,
- to assist in the preparation of elementary and secondary school teachers,
- to provide opportunities for students to sharpen their communication and interpersonal skills, and
- to develop new tools and texts to improve physics pedagogy.

The degree programs of the department are constructed to be rigorous, yet flexible, and are intended to help students prepare for careers in academia, government and industrial laboratories, medicine, law, teaching, and business. Required course and laboratory work in these programs carefully balances theory and experiment. Because the department believes one must participate in discovery to understand science, undergraduates are encouraged to engage in departmental research early in their studies, and a formal research experience is integral to most departmental programs.

Undergraduate Degrees (4 year cycle)

Degrees offered:

The Physics Department offers the following undergraduate degree options: BS in Physics, BA in Physics, BS in Physics with Professional Emphasis, BS in Physics with Applied Emphasis, Double BS in Physics and Mathematics, BS in Physics Teaching, and BS in Composite Teaching—Physical Science.

Except for the two teaching degrees, all of the above minimally require a common core that consists of mathematics through differential equations and linear algebra, two semesters of introductory physics through electromagnetism and optics, a semester each of modern physics, classical mechanics, electromagnetism, and intermediate laboratory, and two credits each of computer methods in physics and research.

In addition to the above, the BS in Physics requires optics and thermal physics and eight additional elective credits in physics (55-57 total credits). The BA in Physics requires six additional elective credits in physics beyond the common core of courses, plus the philosophy of science, the history of scientific thought, and two years of a foreign language (72- 74 credits). The BS in Physics with Professional Emphasis requires one semester each of optics, thermal physics, wave phenomena, advanced classical mechanics, and advanced electromagnetism, two semesters of quantum mechanics, and two additional terms of laboratory (70-72 credits). The BS in Physics with Applied Emphasis requires a semester each of optics and thermal physics, an additional term of laboratory, and 12 credits in other technical departments, at the junior level or higher, with a coherent theme; the latter requires Department of Physics approval (64-66 credits). Finally, the Double BS with Mathematics is the BS in Physics plus 24 specified math credits (75-77 credits).

The two teaching degrees are quite different. The BS in Physics Teaching requires math through differential equations and linear algebra, a course in statistics, introductory astronomy, two semesters of introductory physics, one semester each of modern physics, classical mechanics, intermediate laboratory, and computer methods in physics, five additional elective credits in physics (that may include research), a two term sequence in another science (taken by the respective majors), and a capstone course, Science in Society. The BS in Composite Teaching requires two semesters of calculus, a course in statistics, two terms of astronomy, two terms of introductory physics, two terms of introductory chemistry, a semester of organic chemistry, one semester each of introductory biology, geology, and meteorology, Science and Society, and 5 additional credits in physics. Each teaching degree requires 35 credits in education. Both require a lot of credits (90-92 for Physics Teaching, 91 for Composite Teaching)—disproportionately, according to our bias, weighted to education.

Employment Profile

The BS in Physics is intended for students who are more than casually interested in physics but who have no intention of pursuing its study at a graduate level. This degree equips the recipient with potentially sufficient technical background to work as a lab technician or engineer aide. Supplemented with a few courses in business, perhaps, such a degree could be used to find employment in technical sales or management. With a stronger complement of business and economics courses, this degree might well provide entrée into a career in finance or marketing. Students interested in medicine and dentistry might find taking this degree (along with the usual courses in biology and chemistry) would distinguish them from other applicants competing for admission to professional schools. Such a degree would also be attractive for those wishing to practice patent law.

The BA in Physics is intended for students with a strong interest in the philosophical implications of physics, in its methodology and corpus of knowledge, but with no intention of pursuing the study of physics or a related discipline at the advanced level. With this degree, students might pursue advanced work in the philosophy, history, or sociology of science. They might embark on careers as writers of science for newspapers or popular magazines, as publicists or grant writers for technical firms, or as writers of educational texts. They might pursue careers in patent and corporate law. Some (with appropriate supplementary courses) might enter medicine, dentistry, or veterinary science. Others might use their knowledge in management positions or in other aspects of business.

The BS in Physics with Professional Emphasis is primarily designed to prepare students for continued study in physics, astronomy, materials science, and other related areas of physical science and engineering. Students terminating study with this degree, however, will have strong backgrounds in the fundamentals of physics used in industry or in research at national laboratories. Their strong problem solving skills should make them attractive as employees in a wide variety of technical and business endeavors.

The BS in Physics with Applied Emphasis provides a firm foundation in the macroscopic physics essential to industrial research and development, incorporates significant experience in one other area of engineering or science, and is sufficiently streamlined that students can actually complete the requirements in four years. By suitable choice of collateral courses (done in close consultation with Departmental advisors), students with this degree can create attractive credentials for employment in many areas of technological industry, business, sales, and marketing. Such students may also go on to advanced study in some fields of engineering, materials science, biophysics, medical physics, chemical physics, and geophysics.

The Double BS with Math combines the minimal BS degree requirements in Physics and Mathematics. The intent of the program is to allow students with unusually strong quantitative skills and interests to explore the close relationship of mathematics and theoretical physics. Though holders of this double degree will be well suited for careers in actuarial science and applied mathematics, many will probably wish to continue the study of one or other discipline at the advanced level. Such students are advised to supplement the minimal requirements listed above with appropriate courses to facilitate their admission to graduate work.

The BS in Physics Teaching is designed for secondary school teachers who will seek positions in which teaching physics is their primary assignment. The program provides enough background for the recipient of this degree to teach some other science and mathematics courses as well. The BS in Composite Teaching is designed for secondary school teachers who will teach physics as one component of their assignments, along with chemistry and perhaps mathematics.

Graduate Degrees (6 year cycle)

Students seeking the Master of Science degree can pursue a regular MS (Physics), an MS-Upper Atmospheric Physics option, or our Industrial Physics (IMS) option. The regular MS can take on Plan A, Plan B, or Plan C forms. In Plan A (30 credits), the student takes 6 to 15 credits of research, writes and defends a research thesis, and presents a departmental colloquium. In Plan B (30 credits), the student takes two or three credits of research, writes and defends a research paper (typically a literature review), and presents a departmental colloquium. In Plan C (33 credits), the student can take no research credits, but must present in writing and orally to his/her supervisory committee a paper on

some aspect of graduate physics education. The Upper Atmospheric degree is a Plan A masters only, and the IMS is Plan B only.

The Upper Atmospheric Option takes advantage of the Department's very strong research program in upper atmospheric physics. Originally designed specifically for students from the Air Force Institute of Technology (AFIT), the program is generally available to all students interested in this particular branch of applied physics.

The evolution of the IMS program has occurred with the assistance of industry and government representatives. One of the key features of the program is a requirement for the student to spend either the summer or one full semester in an internship. This program will be coupled with our BS with Applied Emphasis to create a BS-to-MS option.

All Master degrees are intended for students who wish to enter the workforce with higher qualifications than a BS or as additional preparation for further graduate studies.

Weber State University Department of Physics Degree Profile

COLLEGE OVERVIEW

Founded in 1889, Weber State University is an accredited, open-enrollment, multi-campus university serving the diverse needs of Ogden and Northern Utah. Weber State is a coeducational, publicly supported university offering professional, liberal arts and technical certificates, as well as associate, bachelor's and master's degrees in a broad variety of liberal arts, sciences, technical and professional fields. WSU offers more than 200 undergraduate degree programs—the largest and most comprehensive undergraduate offering in the state. In addition, the university offers eight graduate degree programs. The Ogden campus covers more than 500 acres and houses 37 academic buildings, as well as the Ott Planetarium, the Val A. Browning Center for the Performing Arts and the Kimball Visual Arts Center. More than 23,000 students study full and part time, and residence halls can accommodate 668 students. The university prides itself in its excellent teaching, extraordinary commitment to meeting the needs of students at every stage of life and ongoing service to the community. Online courses, distance learning, independent study and evening classes are offered at times and places to meet the complex needs of students balancing family and work responsibilities. To accomplish its mission, the university, in partnership with the broader community, engages in research, artistic expression, public service, economic development, and community-based learning experiences in an environment that encourages freedom of expression while valuing diversity.

PHYSICS DEPARTMENT

The Physics Department at WSU offers courses in physics and astronomy. The mission of the physics department is to provide high-quality instruction in physics at the undergraduate level. This includes providing courses in the general education area of physical science, pre-professional and pre-engineering courses in physics, and courses and programs for those who want to major or minor in physics. Further activities of the department include providing advising for the students served by the department, providing opportunities for research and other scholarly activities of both faculty and students, and serving as a resource for the campus and the state of Utah in the areas of physics and

astronomy. The department also has a very active outreach program. This year more than 16,000 people visited the department's Layton P. Ott Planetarium. Physics faculty, in collaboration with the Ott Planetarium and the Ogden City School District, created a summer science enrichment program in conjunction with Ogden's free lunch program for children in the city's parks. The department subscribes to the Discipline-Specific Competencies for Physics developed by the physics department chairs of the institutions in the Utah System of Higher Education.

The Physics Department fulfills its service role by offering the following introductory (general education) courses for diverse majors:

- Elementary Physics
- Elementary Astronomy
- College Physics
- Physics for Scientists and Engineers

The department awards four bachelor's degrees in

- Physics
- Applied Physics
- Physics Teaching
- Physical Science Composite Teaching

and offers minors in

- Physics
- Physics Teaching

The Physics Department graduates about 10 majors per year, with half going on to graduate school and the rest finding employment in physics or a related area. Graduates of the Physics Department report their successful transition to the next stage of their careers, and express appreciation for the education they have received at WSU and for the Physics Department's programs and faculty.

Southern Utah University Physics Program Profile

University Mission

Southern Utah University is a comprehensive, regional institution offering graduate, baccalaureate, associate, and technical programs. SUU is committed to providing an excellent education through a diverse, dynamic and personalized learning environment. The university educates students to be critical thinking, effective communicators, lifelong learners and individuals who demonstrate integrity and empathy as they pursue their lives' ambitions.

Physics at SUU

Physics is housed within the Department of Physical Science and offers the following programs:

- Minor in Physics
- Minor in Physics Teacher Education

In additional to offering General Education courses, physics courses are utilized as prerequisites for the following majors:

- Chemistry
- Geology
- Computer Science
- Elementary Education
- Integrated Engineering and Technology
- Pre-Health Professions

The physics faculty consists of 2 tenured/tenure track faculty and 1 full-time staff member. In addition to teaching the physics courses offered, they maintain the endowed Ashcroft Observatory – utilized for both student laboratories and weekly viewing nights for the public – as well as a darkroom for image processing. The mission of the physics faculty is to ensure academic excellence while demanding integrity and building self-esteem in our students. Our mission is met through the following:

The Learning Environment – to provide students with quality, current, comprehensive, rigorous courses of study; to prepare successful students by stimulating curiosity and instilling a lifelong love of learning; and to develop within the students communication skills and creative, analytic information gathering and processing skills.

The Faculty – to develop excellence in teaching by fostering the pedagogical development of our faculty, to maintain strong professional commitment and development, and to promote excellence within the faculty through involvement in scholarly activities, developments in our respective fields, and service to the university and the communities of southern Utah.

Snow College Physics Program Profile

Snow College, founded in 1888, is one of the oldest two-year colleges in the West. The main campus is located in Ephraim in rural central Utah. The enrollment is a few thousand students.

Physics is the study and application of the fundamental laws of nature. "Science is the systematic enterprise of gathering knowledge about the world and organizing and condensing that knowledge into testable laws and theories. (AAPT)"

The Snow College Physics Department has a solid reputation. Five faculty members (two with PhDs) teach some physics, but each also teaches in other departments. Most of the students who take physics are planning to major in engineering, math, or some other science; very few plan to become physics majors. Consequently, the physics department is largely a service department, teaching classes that students need for general education and other majors.

Students cannot officially major in physics at the two-year level; they get an associate's degree with the normal physics coursework required to transfer into a physics major program as a junior at a 4-yr college or university. Students who complete the recommended physics curriculum at Snow College will be expected to demonstrate that they

• know how to approach a problem and solve it;

• know how to apply physics to everyday situations;

• know about the basic laws that govern the universe and the world around us;

• understand that physics is useful in many areas of life;

• understand that physics is a fundamental science that underlies the other natural sciences;

• understand the methods scientists use to do science;

• can do elementary problems in mechanics, electricity & magnetism, gravitation, optics, waves, etc.;

• can set up an experiment to test an idea;

• can work with various kinds of physical and electrical equipment including computers comfortably;

• appreciate the pervasiveness of physics in the world;

• appreciate technological innovations that result from applied physics; and

• feel confident in their abilities to deal with the world.

Students who complete the recommended physics curriculum at Snow College will be well prepared to continue in a physics major program at a 4-yr college or university. Most Snow College physics students transfer to USU or BYU.

Dixie State College of Utah Physics Program Profile

Program Description

The physics program is part of the Physical Science Department in the Arts, Science, and Letters Division. It adheres to the institutional mission statement and goals as set forth by the administration.

Type of Program

The physics program at Dixie State College (DSC) does not offer degrees or certificates. The physics program helps students achieve their academic, career, and life goals by providing introductory physics courses required by a variety of baccalaureate degrees, both at DSC and at the transfer institutions, and by providing general education experiences.

Support Function

Physics is the most basic of all the sciences. Consequently, physics courses are required for a variety of baccalaureate degrees in physical science, life science, mathematics, and engineering. All of the sciences, health sciences, and engineering have their foundation in the fundamental principles of physics.

The physics program supports the Physical Science mission statement to provide students with knowledge and skills necessary to understand, assess, and utilize elements of the physical sciences they will encounter in the 21st century, and provide students with the skills and opportunities necessary to make independent, empirical inquiries about the natural world, apply scientific principles, develop critical decision-making abilities, and understand the roles physical sciences play in technological advancement.

The physics program supports the DSC mission statement to provide personalized and excellent teaching in a learning environment where all students can become passionate about their individual educational endeavors. The physics program is committed to offering quality general education courses and contributing to student success.

The physics program supports the students by providing courses designed to contribute to a well-rounded educational experience, expand understanding of the physical world, and help students develop problem solving skills that apply to all walks of life. These courses include a basic introduction to physics course, a basic astronomy course, a basic physical science course for elementary teachers, and a basic weather and climate course.

The physics program provides two semesters of College Physics to meet the requirements of a variety of majors, including pre-dental, pre-medical, pharmaceutical, biological, architectural, and computer science degrees.

The physics program also provides two semesters of Physics for Scientists and Engineers. This course meets the requirements for a variety of majors at the transfer institutions, including physics, chemistry, geology, mathematics, and engineering.

Physics Program Mission Statement

To teach physics and assist students in obtaining a conceptual and analytical understanding of the laws that govern the physical universe. To help students gain an appreciation of the physical world in which they live. To help students improve skills of critical thinking and problem solving which will carry over and apply to all learning and decision making in their everyday lives.

Physics Program Goals

1. Students will be empowered by gaining an understanding and a comprehension of the laws of physics and the application of these laws for the benefit of mankind including environmental concerns.

2. Students will understand their scientific heritage, ideas that shaped the past and will shape the future.
3. Students will improve skills of critical thinking and problem solving.
4. Students will understand and appreciate the historical and philosophical development of the basic scientific theories that are at the foundation of all disciplines of science.
5. Students will know (from many practical examples) the role of physics in other disciplines and in their everyday lives.

Physics Program Student Learning Outcomes

After completing a physics course at DSC, students can:

1. demonstrate the ability to use problem solving skills by solving a variety of conceptual and analytical problems.
2. demonstrate a conceptual understanding of the major concepts in physics through written assignments, and/or multiple choice or free response test questions.
3. demonstrate the ability to apply mathematical concepts to analyze physical problems and express the solutions in mathematical form through written assignments, and/or multiple choice or free response test questions.

Faculty:

	Tenure	**Contract**	**Adjunct**
Number of faculty with Doctoral degrees	0	0	2
Number of faculty with Master's degrees	1	0	3
Number of faculty with Bachelor's degrees	0	0	0
Other Faculty	0	0	0
Total	**1**	**0**	**5**

Students: Distinct Headcount by Academic Year of Students Enrolled in Physics Courses

		2004	**2005**	**2006**	**2007**	**2008**
PHYS 1010	Elementary Physics	150	168	155	147	175
PHYS 1020	Intro to Weather	28	17	28	17	12
PHYS 1040	Elementary Astronomy	93	86	63	29	54
PHYS 1360	Prin of Physical Science	0	0	0	0	21

PHYS 2010	College Physics I	34	33	28	26	35
PHYS 2020	College Physics II	22	19	17	18	21
PHYS 2210	Phys for Scientists/Engin. I	11	21	19	11	16
PHYS 2220	Phys for Scientists/Engin. II	10	19	19	6	10

College of Eastern Utah Physics Program Profile

The College of Eastern Utah is the youngest community college in Utah. Since 1937 it has grown from Carbon College, with an enrollment of 146, to College of Eastern Utah, with an enrollment of over 2500 students. In 1959, the college became a branch of the University of Utah. In 1965 it became College of Eastern Utah, and four years later its relationship with the University of Utah was terminated. In 1969, it became a full-fledged member of the Utah State System of Higher Education.

The College of Eastern Utah has 3 campuses. The main campus is in Price, UT. Price has a population of about 10,000 people and is located 2 hrs from Salt Lake City. This campus has 16 buildings as well as campus housing for students. The second campus, the San Juan Campus, is in Blanding. It was established in 1976. The San Juan Campus is located about 4 hrs south of the Price Campus. The third campus is at the Emery Center in Castle Dale, UT. It was established in 1997.

Students cannot get an associate's degree specifically in Physics at College of Eastern Utah. As such a recommended program of courses needed for transfer to a four year college or university has been developed. Most of students taking the physics courses required in this program are not actually physics majors but engineering, math, or other science majors. The physics department is a service department to the college, teaching general education and the required courses for other majors. The few students that have been physics majors have transferred to Utah State University.

The physics courses in the recommended program are currently only taught at the Price Campus. There is only one full time professor (with a Ph.D.) in the Physics Department at the Price Campus. Due to the small nature of the classes at the college, physics students are expected to complete 2 projects as part of the regular course work. The fall semester projects have included rocket launches and trebuchets, while the spring semester course has used speaker design and windmill construction as projects. The students give presentations on their projects to faculty, students and practicing engineers at the end of the semester.

Students who complete the coursework recommended for Physics majors are expected to demonstrate that they can:

Look at a solution and determine if it is a reasonable solution
Develop the ability to learn on their own

Present solutions in public, by problem solving on the board, laboratory reports, and student lectures on a topic
Apply basic physics principles to more complicated problems or novel situations
Apply physics to everyday situations
Use information stored in graphs
Determine the relationships between different quantities
Solve physics problems:
By describing and diagramming the situation
By determining what is known and unknown, relevant and irrelevant.
By determining where to find other relevant information
By applying the appropriate physics concepts
By making use of graphs
By checking the physical sense of the answer
Set up experiments to test an idea
Use a variety of test equipment, e.g. computers, oscilloscope

Students who have completed the recommend physics program at College of Eastern Utah have been well prepared to continue in a physics or engineering major program at 4 year colleges or universities.

Utah Valley University Physics Degree Profile

College Overview:
Utah Valley University is a teaching institution which provides opportunity, promotes student success, and meets regional educational needs. UVU builds on a foundation of substantive scholarly and creative works to foster engaged learning. The university prepares professionally competent people of integrity..." - UVU Mission Statement, 2009

UVU serves a student body of approximately 25,000. UVU is accredited by the Northwest Commission on Colleges and Universities. It is an open-enrollment university, facing the challenge of serving a traditionally prepared and adept student body while welcoming students that come to higher education under-prepared. UVU is committed to exacting a high level of performance from all its students. These challenges call for teachers with well developed and broad skills to reach and teach both the best and worst of students.

Physics department:

The UVU physics program began in 2001. It offers the following degrees:

- Bachelor of Science in Physics
- Bachelor of Science in Physics/Chemistry Secondary Education

Department makeup:

- 9 Tenured and tenure track faculty
- 3 Professional staff and lab managers
- 75 student majors
- 40 graduates in the last 6 years

Service courses:

- Introductory Astronomy, Physical Science, Conceptual Physics, for general education
- College Physics, for medical-related, and other professional majors
- University Physics, for science and engineering majors
- Introductory Acoustics, for multimedia students

Physics degree requirements:

- 26 general education credit hours
- 71 discipline core credit hours
- 23 elective emphasis credit hours in physics or physics-related courses.

The small size of our department means that a physics major will benefit by working closely with faculty and fellow students. The faculty often act as personal tutors and mentors, providing opportunities in research and problem solving that may be more difficult to obtain in a larger department. Access to all the requisite computing facilities is available, and many of our faculty work closely with students on a variety of undergraduate research projects.

Our program seeks to match our students' interests and meet the requirements of future employers. While the degree program is designed to provide a traditional physics student with all the skills required to promote their success in a graduate physics program, we have implemented an "emphasis" component that consists of a set of courses that would allow a physics major to direct their education toward a career path of their interest and choosing. For instance, a set of courses in geology might be incorporated into the degree program of someone wishing to pursue geophysics, or environmental science. A student in pursuit of biophysics or medical physics, could complete their degree with an appropriate set of courses from biochemistry or anatomy, and so on.

The skills learned by a physics student in our program, that would serve them well in any employment outcome include:

- Rational problem solving and logic,
- Computational skills,
- Computer programming,
- Numerical Analysis,
- Instrumentation, data collection and analysis,
- Electronics,
- Writing and presentation skills.

The department holds the following to describe the nature of its program and purpose:

The whole of the universe is a fair topic for study in physics. No facet is too small or too big to be considered. Physics is the investigation, assembly and application of the rational rules by which nature operates. Every action is played out according to its rules. Physicists seek to learn these rules and often apply them in solving problems in technology, the environment and society.

Physicists are valued for their ability to rationally approach complex problems and to construct practical solutions. They find fulfilling and satisfying employment not only in the academic world of teaching and research, but in engineering, business, industry, consulting and government. Those trained in physics have been extraordinarily successful in the development and invention of many of the technologies, both hard and soft, found in electronics, computation and communication. They are responsible for many of the key measurements that monitor and characterize our environment which have led to a greater awareness and appreciation of humanity and its relationship to our planet Earth.

Salt Lake Community College Physics Program Profile

COLLEGE OVERVIEW

Salt Lake Community College is an accredited, multi-campus college serving the diverse needs of the Salt Lake City community. With an open-door enrollment policy, the College serves more than 60,000 students through credit and non-credit courses and workshops each year, making it the largest institution of higher education in Utah. To accommodate student needs, SLCC has fourteen locations plus distance learning options that allow students to take classes virtually anywhere. Courses are offered in both traditional and accelerated semesters, during the day, at night and on weekends. Students receive personal attention from faculty as the College maintains an average student-to-faculty ratio of 19 to 1.

PHYSICS DEPARTMENT

The Physics Department at SLCC offers courses in physics and astronomy. The mission of the physics department is three-fold:

1. Provide elementary survey courses in physics and astronomy to satisfy the physical science general education requirement for either an Associates of Science Degree or transfer to another institution.
2. Provide a non-calculus, two-semester series required for students preparing for a professional or technical transfer program.
3. Provide a calculus based series which will prepare students with a strong foundation for their further education in a scientific field, particularly students wishing to pursue careers in physics and engineering.

The Physics Department serves primarily a service role at SLCC, teaching 200 to 300 students a semester. Only a few of these students desire to pursue physics as a major. Instead, the majority of students taking physics classes are pre-engineering or pre-professional students pursuing careers in other scientific fields. The rest of the students take the elementary survey courses required for their

Physical Science general education requirement. The Physics Department at SLCC is aggressively applying industry standard assessment practices to ensure that its educational practices adapt to national trends and remain competitive with 4-year institutions.

ASSOCIATE (AS) DEGREE

Students are able to receive an associate's degree with the normal physics coursework required to transfer to a physics major program as a junior at a 4-year college or university. Students who complete the recommended physics curriculum at SLCC will be expected to demonstrate that they

- Can identify physical laws and how they apply to the world around them.
- Can use the scientific method as a tool for understanding a wide and ongoing variety of physics concepts.
- Know how to apply appropriate mathematical techniques and problem solving strategies to solve a variety of physics problems.
- Can solve fundamental physics problems in mechanics, thermodynamics, electromagnetism, wave optics, and modern physics.
- Know how to organize, present, and explain – both orally and in writing – solutions to physics problems.
- Know how to collect, organize, and present data in a laboratory setting and connect the data to physics principles.

Students who complete the recommended physics curriculum at SLCC will be prepared to continue in a physics program at a 4-year college or university. Most SLCC students transfer to the University of Utah, Weber State University, Utah State University, and Brigham Young University. Reports from these universities tell us our students are competitive with other students in the program and are excelling in their work.

a. What lessons were drawn from this exercise?

We saw how much more information we can convey to our students, faculty and other audiences by focusing on learning outcomes rather than credit hours.

Comparison of degree or program profiles among institutions was interesting, both for revealing the healthy diversity of our institutions and for sharing ideas among institutions.

b. What challenges did this exercise present?

We continue to work on the challenge to express these profiles in terms of learning outcomes.

12. <u>Summary of the merit Utah sees in developing a national Qualifications Framework.</u>

The Utah Team discussed the idea of a national Qualifications Framework as well as Qualifications Frameworks in physics and history. The Physics Team felt that the benchmarks they were drafting would provide a foundation for a Physics Qualifications Framework, and they were willing to return to this topic after making more progress on the physics issues. Both teams had difficulty understanding the importance of a national QF, which primarily sets common language to describe levels of expectation for qualifications (degrees).

a. <u>What lessons were drawn from this exercise?</u>

It would help to see what positive impact qualifications frameworks have had in areas where they have been developed. The whole concept is nebulous for faculty in US higher education.

b. <u>What challenges did this exercise present?</u>

Clarifying the concept and its value is already a big hurdle and needs more background information for the groups considering it.

13. Appendices

A. Utah Team Meeting Agendas

Lumina Tuning Project Team
IP-Video, Monday, March 30, 3-4 pm
AGENDA

1. Stipends and Expenses for Team Members
2. What is Tuning?
3. The Process and Schedule
4. Goals of the Disciplinary Teams—sample template
5. Discipline Documents
6. Tuning Reference Information
7. Chicago Meeting

Utah Tuning Project
BoR Office, May 14, 2009
Agenda

1. Joint history and physics teams
   a. Surveys
   b. Plans and schedule
   c. Meeting time with video crew in October
   d. Other
2. Separate into discipline teams
3. Preliminary mapping of "employment" at various levels, remembering that "employment" will include moving into a bachelor's program from a 2-year program, graduate school, other professional schools, and anything else we are handing our students off to
4. Discipline-specific competencies for our degrees
5. Describe levels of expectation for 2-yr, BS, and MS
6. Refine discipline-specific competencies to measurable outcomes
7. Consider assignments for work outside the meetings
8. Overview of the project expectations and other issues

Utah Tuning Project
Board of Regents Office
September 18, 2009, 10 am – 3 pm
Agenda

1. Joint history and physics teams (10-12)

1. Review of expectations for final reports (Bill)
2. Reports on status of the project for each discipline (led by Kathryn & Bill)
3. Report on surveys of general and discipline-specific competencies (Bill)
4. Schedule for further work
5. Discussion of strengths and weaknesses of this project
6. Recommendations so far
7. Introductions to Degree Profiles and Qualifications Frameworks (Bill)
8. Questions from the group

2. <u>Lunch – 12-12:30</u>

Note: One or two team members will be interviewed on video during lunch. Our schedule will be flexible enough to accommodate these interviews, as necessary.

3. <u>Separate into discipline teams – about 12:30</u>

1. Review status of employment maps
   Note that "employment" includes moving into a bachelor's program from a 2-year program, graduate school, other professional schools, and anything else we are handing our students off to
2. Review status of disciplinary Reference Points (i.e. competences and learning outcomes / benchmarks at 2-yr, BS, and MS levels)
3. Discuss Degree Profiles of our academic programs "grounded in explicit learning outcomes"
4. Discuss feasibility of Qualifications Frameworks
5. Review status of student input to the process through our student team members and their investigations with student groups

B. Utah Team Meeting Notes

Utah Tuning Project

September 18, 2009 – Meeting Notes

1. **Introductions:** We welcomed Kevin Corcoran from the Lumina Foundation for Education and Mei Zhou from the Carnegie Foundation for the Advancement of Teaching. We also acknowledged the presence of a video team from Catalytica Corp. who were with us throughout the day.

2. **Review of Expectations for Final Reports:** Bill Evenson reviewed our status and what we still need to accomplish. Final report expectations include reviewing the process and its potential in the USA context, considering the feasibility of developing Qualifications Frameworks, carrying out and evaluating surveys of students, recent graduates, employers, and other stakeholders, mapping employability of graduates in each of our focus disciplines, agreeing upon reference points (learning outcomes), providing draft degree/program profiles for each institution, providing benchmarks at the two-year, bachelor's, and master's levels for assessing the learning outcomes, and proving an overview and assessment of the process and recommendations for future work.

3. **Reports on Status of the Work in the Discipline Teams:** Kathryn MacKay reported that the History team started from the American Historical Association outcomes for history majors. They have asked team members to carry out departmental conversations on these learning outcomes and expectations, both to achieve agreement on the competencies and to explore institution-specific issues that should be incorporated or included in the context for requiring these outcomes of history students in each institution. They have carried out some of the student surveys, but not all. (Bill will follow up as described below.) Employability is problematic since history majors go in so many different directions. Phil Matheson asked whether we should articulate a level of expectation for incoming students. No one knew how to do this in a meaningful way. (Norm Jones asked if there should be "remedial history" at the college level.) Dan McInerney explained what he and the Utah State History Department have done in the development of rubrics to evaluate the achievement of the learning outcomes. Thus far, they have agreed upon a rubric for their capstone course. They will develop rubrics course by course as they are able to in the future. Dan distributed their capstone course rubric and the learning outcomes for history.

4. Bill reported that the Physics team has had in depth discussions of physics competencies and has agreed upon a list that seems practical and useful. They are now working on benchmarks to define expected levels of achievement of the competencies. They have carried out student surveys. They have touched on the question of employability and have considerable information from the American Institute of Physics (AIP). They have contacted employer groups but have yet to address employer perceptions in detail.

5. **Surveys:** Bill suggested that he should work with staff to pursue the surveys that are still needed, consulting and informing the team as necessary. He has come to see that the disciplinary teams should think deeply about their disciplines and avoid getting bogged down in

the detail work of the surveys. The History team has proposed that departmental discussions could be more effective than faculty surveys at developing priorities for the discipline-specific competencies. These discussions will also lead to exploration of what experiences we must offer to achieve the outcomes, beginning the translation of competencies to pedagogy, which will be different for each campus. Dan reminded us to be very careful how we talk about competencies and learning outcomes so that a general audience will understand – see his framing of the student survey of general competencies.

6. **Schedule for Further Work:** We seem to be on track. We'll "keep on keeping on."

7. **Strengths and Weaknesses of the Project:**
   a. Phil noted that employer and alumni inputs through surveys or interviews are one of the most attractive aspects of the project, going beyond other efforts at improving our programs.
   b. Bill noted that the surveys diverted our focus from issues within our disciplines at the beginning and in some sense derailed us from starting with more central matters.
   c. Charlie Torre commented that surveys are a very blunt instrument, and discussions are much more useful.
   d. Jim Chisholm noted that we were slowed down (as will be our faculty colleagues) by unfamiliar language developed in Europe for this process.
   e. Norm asked why we should do our own surveys; could we not use the very professional employer surveys like those done by AAC&U?
   f. Team members noted that employability must be kept in perspective; discussions of how curriculum and policy affect the employability market give only one input to the academic decisions we make in our disciplines (an input that some disciplines have neglected more than others and that needs to be in the mix).
   g. Charlie suggested that we should be driven more by the analysis of our programs by alumni than by employers, who have a necessarily limited view of what is needed.
   h. Susan Neel suggested that we need to articulate our values more carefully and fully to help employers have a more complete picture of our disciplines.
   i. Jim Lehning noted that control over our academic programs is in the hands of the faculty, and it is the faculty responsibility to keep the proper balance.
   j. Jim Chisholm noted that we also need to take responsibility to educate employers, explaining what outcomes we provide (hard to do if we have not yet made those outcomes explicit and if we do not assess the achievement of the advertized outcomes).
   k. Brad Carroll noted that we have taken the project and made it our own. This is a very important strength of the process, which has reinforced both faculty ownership of and faculty responsibility for our disciplines.
   l. John Macfarlane noted that through our conversations we have given each other places to start in our own departments.
   m. Norm noted that a significant strength of the project has been to further the System-wide conversation.
   n. Larry Smith reminded us that our colleagues will ask how this work differs from what we are already doing. One response is that through tuning we provide more of a guarantee of student learning outcomes.
   o. Dan noted that this process brings us into participation with an international discussion, leading to much greater confidence in our results.

p. Phil suggested that a weakness of the process was the initial presentation to the participating faculty members: a huge amount of information that was difficult to contextualize. It is essential to articulate carefully what is truly unique about this process in the initial explanations.

8. **Recommendations:** In addition to the recommendations implicit in the comments listed above, the following specific recommendations were suggested:
   a. Dave Kardelis recommended that more tools be developed to help us guarantee outcomes.
   b. Phil recommended greater focus on unique aspects of this project.
   c. John recommended that exploring how to prepare diploma supplements that will be useful to employers.
   d. Jeff Hodges recommended making an inventory of what we are already doing well and what is not working in the current approaches.
   e. Phil recommended connecting educational resumés and e-portfolios more explicitly.
   f. Jim Lehning recommended more attention to workload issues. He noted very strong differences between USA and European higher education, so everyone involved in this process must be committed to making it our own, appropriate for the USA context.
   g. Norm recommended the development of an educational resumé for individual students. Students should build these by giving evidence that they have accomplished the learning outcomes.

9. **Introductions to Degree Profiles and Qualifications Frameworks:** Bill outlined the degree/program profiles we will need to prepare for each institution. He provided examples from the European work and will email copies of these to team members. Bill also reviewed the idea of Qualifications Frameworks, with emphasis on the ratchet principle – defining increased expectations and sophistication at each level of education. The discipline teams will discuss the feasibility of developing qualification frameworks in their separate groups and make recommendations.

10. Divided to Discipline Groups

C. <u>Physics Team Meeting Agendas</u>

Utah Tuning Project
IP-Video, June 22, 2009, 1-4pm
Agenda

1. Review Status
   a. Surveys
   b. Plans and schedule
   c. Meetings with video team, Sybille, other consultants
   d. Other
2. Discipline-specific competencies – review and complete
3. Student input
4. Describe levels of expectation for 2-yr, BS, and MS
5. Measurable outcomes
6. Assignments; Review of what we need to accomplish and schedule

Utah Tuning Project – Physics Team
IP-Video, July 17, 2009, 1-4pm
Agenda

1. Discipline-specific competencies
2. Student input – status, help needed?, SPS advisors & other contacts identified?
3. Report on status of employer survey list
4. Benchmarks and levels of expectation for 2-yr, BS, and MS
5. Assignments; Review of what we need to accomplish and schedule

Utah Tuning Project – Physics Team
IP-Video, August 25, 2009, 3-5 pm
Agenda

1. Review of where we are, what we still need to accomplish, and schedule
2. Discipline-specific competencies
3. Benchmarks and levels of expectation for 2-yr, BS, and MS
4. Student input – status, help needed
5. Report on surveys
6. Plans for September 18 meeting

Utah Tuning Project
Board of Regents Office
September 18, 2009, 10 am – 3 pm
Agenda

1. **Joint history and physics teams (10-12)**
2. **Lunch – 12-12:30**
3. **Separate into discipline teams – about 12:30**
   1. Review status of employment maps
      Note that "employment" includes moving into a bachelor's program from a 2-year program, graduate school, other professional schools, and anything else we are handing our students off to
   2. Review status of disciplinary Reference Points (i.e. competences and learning outcomes / benchmarks at 2-yr, BS, and MS levels)
   3. Discuss Degree Profiles of our academic programs "grounded in explicit learning outcomes"
   4. Discuss feasibility of Qualifications Frameworks
   5. Review status of student input to the process through our student team members and their investigations with student groups

Utah Tuning Project – Physics Team
IP-Video, October 19, 2009, 3-5 pm
Agenda

1. Review of Project Final Report Template
2. Benchmarks
3. Degree/Program Profiles
4. Feedback to Lumina Foundation; Use of the Project Results
5. Next Meeting

Utah Tuning Project – Physics Team
IP-Video, November 13, 2009, 3-5 pm
Agenda

1. Comments on Discipline-specific competencies, Benchmark reviews?
2. Degree/Program Profiles
3. Student input
4. Draft Final Report
5. Next?

D. Physics Team Meeting Notes

Utah Physics Tuning Project
June 22, 2009 – Meeting Notes

1. Need **input** on whom to include in employer surveys of general competencies.

2. Everyone should **go through the test surveys** on the web at the URL Marcus posted on the Ning under "Generic competences, history and physics competences" -- email Bill Evenson if you cannot find this. **Please respond** to the full Physics Tuning email list with comments and suggestions for making this work well for our audience.

3. Reminder: **meeting of both teams on September 18 at Board of Regents office, 10-3**. Helen Lowe will be here and do video recording and interviews. Some of you will be asked to come early or late for interviews. She will also do some video recording at nearby campuses (Orem to Ogden) on September 17.

4. Physics Discipline-Specific Competencies (raw notes for reference – see attached report with reorganized listing of discipline-specific competencies; note that some of the comments below are actually teaching or assessment suggestions).

Categories
Knowledge
Skills
Social Responsibility
Communication
Miscellaneous

Dublin Descriptors
A - Knowledge and understanding
B - Applying knowledge and understanding
C - Making judgments
D - Communications skills
E - Learning skills

Physics Discipline-Specific Competencies
<u>Nature of science, nature of physics</u>

- Role of evidence
- Understand cause vs. effect
- Understanding physics as an experimental science {Evaluate through analysis of student essays}
- Scientific ethics

<u>Modeling skills and problem solving</u>

- Organize problems: identify physical principles, relevant vs. irrelevant quantities, make appropriate diagrams

- Organize quantitative information: clearly step through the mathematics of the problem solution
- Estimation skills
- Modeling skills and limitations: build a model, be able to cast story problems into mathematical models, recognize the physics in a model, understand how much one can learn from simple models, recognize the differences between problem solving and modeling

Mathematical skills

- Identification of physical quantities with algebraic symbols
- Understanding the contexts for equations
- Mapping problems to new problems with related mathematics or physics
- Mathematical modeling skills
- Manipulation skills
- Computer algebra – secondary (first understand the algebra)
- Know what the math means, physical meaning of vector algebra
- Graphical skills and interpretation
- Numerical analysis

Physics concepts (see existing literature, e.g. Force Concept Inventory)

- Threads: conservation laws, forces (gravity, e&m), Newton's laws, work and energy, optics, thermodynamics
- Historical relevance: stories behind the physics
- What is **not** necessary to teach?
- Applications: acquired skills, come later in programs
- Contexts of applications: identify key elements in the functioning of an arbitrary physical system
- Layered development of concepts and applications

Laboratory skills

- Safety
- Error analysis, what errors mean
- Primacy of data
- How to evaluate data quality; why?
- How things get measured
- Connections between what you measure and how you infer physics
- How to collect and organize and present data and connect to physical principles
- Perhaps eliminate black box labs? Graphs by hand first half semester?

Scientific communication

- Written, oral, and visual communication
- Writing: complete, punctuated sentences, organization, good logic. Scientific writing -- be able to explain in words rather than equations
- Writing on homework problems, on exams, on papers
- Presentation skills: informal presentations to peers, formal presentations
- Teaching at 4-year and 6-year levels; how to impart their knowledge to others

Computer skills & literacy

- Using scientific packages intelligently
- Rudiments of scientific programming
- Excel or similar; Maple, MatLab or similar

Information literacy

- General education IL at 2-year level, more specific to physics at higher levels

Independent research

- Projects (survey what is being done in BS programs in the state), out of classroom
- Applying the physics competencies semi-independently, synthesis of physics principles and applications, require presentations, students begin to teach themselves

5. AP credit in physics: discipline faculty or departments must be responsible to assess appropriate credit for AP or other external exams.

6. Student input on Tuning: everyone **please send Bill Evenson and Jeff Hodges contact information** for someone on your campus whom Jeff can contact to get in touch with physics students at each school. An SPS advisor or officer would be helpful for this -- possibly in addition to a faculty member or advisor who can assist with the contacts. Please put Jeff in contact with all active SPS chapters. Possibility to arrange student discussion and response to Tuning in its status in October at the APS Four Corners Section meeting (October 23-24, Colorado School of Mines).

7. Levels, benchmarks for 2-year, 4-year, 6-year levels. We will need to define benchmarks at these levels for assessing the competencies.

8. Measurement, assessment of outcomes: to be defined.

9. Sybille Reichert: consensus of this group that it will be most profitable to arrange to meet or interact via Skype or other technology later in the project. E.g. late October, early November.

10. **Next meeting, Physics Tuning Team: Friday, July 17, 1-4, IP-Video**

Utah Physics Tuning Project
July 17, 2009 – Meeting Notes

1. Bill Evenson will be out of the country from July 21 to August 3. He will respond to email, but there may be some delay.

2. **Discipline-specific competencies:** We discussed priorities among our eight draft discipline-specific competency themes for the 2-year, BS, and MS levels. As an initial exercise, we polled the group on the top three priorities for each level. We noted that some of the ambivalence (e.g. between

themes 2 and 3 on the 6/22/09 competencies list) might be resolved by including more than three competency themes.

Our group consensus on the highest priorities was

Two-Year Level

4 – Physics Concepts

1 – Nature of Science/Physics

2 – Modeling Skills & Problem Solving

BS Level

4 – Physics Concepts

5 – Laboratory Skills

2 – Modeling Skills & Problem Solving

MS Level

6 – Scientific Communication

7 – Computer Skills & Literacy

4 – Physics Concepts

It was noted that at the MS (and PhD) students specialize in either experiment or theory. The priorities are somewhat different for these two groups of students.

It was also noted that themes 2 (Modeling Skills & Problem Solving) and 3 (Mathematical Skills) overlap appreciably, and theme 8 (Information Literacy) is hanging out on its own but might be included with theme 7 (Computer Skills & Literacy). We agreed to move themes 3 and 8 into other existing themes, bullet point (competency) by bullet point.

In discussion we agreed that, as the list stands now, theme 3 (Mathematical Skills) would be a likely fourth priority for BS, and perhaps for the other two levels as well.

3. **Benchmarks for Levels of Expectation:** We agreed to review individually the descriptions of levels of expectation. We circulated the document "Physics, astronomy and astrophysics 2008" from The Quality Assurance Agency for Higher Education for reference. At all three of our levels we will define "Threshold" and "Proficient" (instead of "Typical") benchmarks.

4. **Student Activities:** Jeff Hodges reviewed the contacts for each USHE institution. He will request student contacts and set up group discussions within types of institutions (two-year, BS, graduate programs). They will review our competencies, offer suggestions, and consider priorities. He will organize these student groups in August and set up meetings with them in September.

5. **Employer Survey of General Competencies:** Bill reported that he has requested that Utah Technology Council (UTC) work with us on a survey of their membership (copy of memo appended below). Brad will provide a list of physics department chairs in the APS 4Corners Section. Hill Air

Force Base should be added. Brian and Bill will check on the membership of UTC to avoid duplicate requests. Bill will consolidate the list of employers suggested so far and send around for comment.

6. **Next meeting:** Tuesday, August 25, 3-5 pm (IP-Video available)

Email to Rich Nelson, UTC (sent 7/14/2009)
Subject: Consulting potential employers -- USHE project

Dear Rich,

I am currently directing a project for the Utah State Board of Regents, funded by the Lumina Foundation for Education, about defining educational outcomes in specific disciplines in higher education. Utah has chosen to work on outcomes at the 2-year, BS, and MS levels for history and physics. Accordingly, we have two teams, one for each of these disciplines, with faculty representatives from the nine USHE institutions, students, and representatives of the System.

This project is an experiment initiated by Lumina to explore how a process begun in European and Latin American higher education might be adapted in the USA. One aspect of their process that we want to include in our exploration is a survey of what employers need when they hire students from these disciplines.

UTC seems an ideal group to interact with employers about their needs, especially with respect to physics majors. We have a survey instrument (about one page of questions ranking the importance of various competencies) to which we could point employers on the web. There would be no identifying information for the respondents. They would only be known to be included in the employer survey group.

I wonder if UTC would be willing to send an email (whose content we would agree upon together) to your membership requesting that they follow a link included in the email and respond to this survey? We would not ask for email addresses or other means of contacting the membership if you could send the message and web link to them directly.

At the end of this project (early 2010) we would be happy to share our report and the results of the employer survey with UTC members and others.

Thanks for considering this,
Bill

Utah Physics Tuning Project

August 25, 2009 – Meeting Notes

1. **Review:** Bill reviewed our status, what we have accomplished and what we still need to accomplish. He suggested that he should work with staff to pursue the surveys that are still needed, consulting and informing the team as necessary. This will allow the team to focus on the discipline – competencies, benchmarks, employability of graduates, and eventually Qualifications Frameworks. Our responsibilities to the Lumina Foundation for Education include surveying relevant stakeholders, mapping employability, providing a set of agreed-upon reference points for the discipline, drafting degree profiles of our academic programs that are grounded in explicit learning outcomes, and writing an overview and assessment of the project. [A summary, "Tuning Project: Responsibilities of State Teams," is attached to these notes.]

2. **Discipline-specific competencies:** We reviewed the Discipline-Specific Competencies from June 22, 2009, using Jim Chisholm's comments of August 24, 2009. Extensive and lively discussion led to revisions of the competencies as given on the attached list. Each team member is requested to review the attached revised set of Discipline-Specific Competencies and respond to the entire team by email by September 11.

3. **Benchmarks and levels of expectation for 2-yr, BS, and MS degrees:** We accepted Jim Chisholm's August 24, 2009 suggestion to clarify the levels of expectation using an easily understood specific example from the discipline for each category of Discipline-Specific Competencies. Bill will ask each team member to work on an example for a specific competency category. Bill will send the summary of Degree Descriptions provided by Lumina Foundation with these notes. These degree descriptions can suggest some general language we might use to broaden the application of our examples for levels of expectation. In addition, Phil Matheson suggested some possible ways to address levels of expectation: e.g. two-year level might be recognizing how to apply a textbook formula in a pre-defined problem; threshold four-year level might be recognizing constraints on validity and more general analysis of a problem or being able to apply a concept (like resonance) to a new area (like from e&m to mechanics); proficient four-year level and threshold MS level might involve applying general principles in novel situations. After the meeting Phil proposed a draft list of levels of sophistication through which students evolve during their study of physics (see attached).

4. **Student Input:** Jeff Hodges requested that each team member respond on the Ning to his request for information.

5. **Surveys:** Bill reported that the Utah Technology Council (UTC) has agreed to work with us on a survey of their membership. He will send the cover memo for the employer survey to this team for comment when it is ready. Bill will also send out an email report on the status of the other surveys we need to carry out.

6. **Next meeting:** Friday, September 18, 10-3, Board of Regents Office, Salt Lake City. We need everyone to arrange their schedules so they can be in Salt Lake City for this meeting. It will combine the Tuning Project and the annual Physics Major's Meeting – Bill will work with Larry Smith, the Major's Meeting Chair, to set up a time to address the Major's Meeting agenda. Bill will send out an email about travel arrangements. The video team working with Lumina Foundation will be with us on September 18, as will the History Team. Bill indicated that several members of this group will be asked for either interviews on Friday, September 18 or on-campus video shoots (for the four close-by campuses) on September 15-17. Participants will be contacted by email to make arrangements. Bill emphasized that Lumina Foundation wants candid responses, and we have been asked specifically to include skeptics as well as those who are enthusiastic about the project.

Utah Physics Tuning Project

September 18, 2009 – Meeting Notes

1. **Employment maps:** Bill will compile relevant data from the American Institute of Physics (AIP) and send it around for review. Phil will compile a common data pool showing where our graduates go. Each member should provide Phil with as much information as they can get from their departments about where recent graduates have gone for work or additional education. Alumni associations on our campuses should be good sources for this kind of information.

2. **Discipline-Specific Competencies and Benchmarks:** We accepted the latest version of the Discipline-Specific Competencies (dated August 25, 2009 – and, of course, subject to later revision as we work with these). We divided up assignments to write benchmark example statements using Jim Chisholm's comments of August 24, 2009 and Phil Matheson's suggested hierarchy of sophistication. Bill will email copies of the documents from Jim and Phil, along with a list of assignments. Each team member will respond with his or her draft benchmark statement as soon after September 25 as possible. These responses should be sent by email to the entire team. The assignments given were

    1. Nature of Science, etc. – Larry Smith
    2. Math, Modeling, Problem Solving – Bill Evenson, Steve Sullivan, Trina Van Ausdal
    3. Physics Concepts – Brad Carroll, Phil Matheson, Brian Saam
    4. Lab Skills – Dave Kardelis
    5. Scientific Communication – Jim Chisholm
    6. Computational and Information Skills – Jeff Hodges
    7. Research – Charlie Torre

3. **Draft Degree/Program Profiles:** We discussed the form of degree/program profiles we need to draft for each of our institutions. These need only be a page or two. Bill will email two examples of European physics degree profiles. Each team member is requested to respond with his or her draft degree/program profile by October 9. These responses should be sent by email to the entire team.

4. **Feasibility of Qualifications Frameworks:** The Qualifications Framework, as it applies to our work with physics, will be built upon the benchmarks we are working on. We will discuss the Qualifications Framework more when the benchmarks work is complete.

5. **Student Input:** Jeff reported on a successful discussion with students yesterday at U of U for the video team. He is also arranging a discussion of physics competencies with students from several institutions by IP-video. He will send a list of possible questions for these students to the physics team for comments and suggestions. Tentative date for the IP-video meeting is Thursday, October 8, 12-1pm.

6. **Next Meeting:** Monday, October 19, 3-5, IP-video or Board of Regents Office, Salt Lake City.

7. **Physics Major's Meeting:** Larry Smith conducted the Physics Major's Meeting, following the agenda provided by Teddi. He will report to Teddi on the issues raised and consensus reached.

Utah Physics Tuning Project

October 19, 2009 – Meeting Notes

1. **Review of Project Final Report Template:** Bill reviewed the Project Final Report Template. The report is due on November 20. Bill will draft the report and ask team members to review it before it is submitted.

2. **Benchmarks:** We discussed the draft benchmarks submitted by team members. We received draft benchmarks for each of the eight discipline-specific outcome themes. We discussed how specific out examples should be and agreed that the benchmarks should be introduced with a clear statement setting out that the benchmarks are provided as illustrations of levels of expectation and should not be taken as curricular prescriptions. The Matheson/Saam list of levels of sophistication provides the general statement of levels of outcomes, and the benchmark examples make these general statements more specific, but are not to be taken a prescriptive. We will refine the levels of sophistication so they can be taken to discussions in our individual departments as a framework for curricula. We are seeking to develop a mode of thought about our expectations of students. Phil suggested that we share the benchmarks among team members for individual critiques. Bill will send a request to each team member to review one benchmark other than the one they wrote.

3. **Draft Degree/Program Profiles:** We discussed the form of degree/program profiles we need to draft for each of our institutions. We agreed that the draft sent by Charlie Torre is a good model for these. Each team member is requested to provide a draft degree/program profile appropriate for their institution by Wednesday, October 28. These responses should be sent by email to the entire team.

4. **Feedback to Lumina; Use of the Project Results:** We each need to consider what recommendations should be sent to the Lumina Foundation in our final report. Please send your thoughts by email to the entire team. We also need to think through how we can each use the results of our discussions in our own departments to strengthen our degree programs and graduates.

5. **Next Meeting:** Friday, November 13, 3-5, IP-video or Board of Regents Office, Salt Lake City.

Utah Physics Tuning Project

November 13, 2009 – Meeting Notes

A. **Discipline-Specific Competencies and Benchmarks:** We discussed the benchmark reviews submitted by team members. Bill will send out a file containing all the benchmarks in the form he now has them. Many of these need some revision in light of reviewer comments. Bill asked that team

members edit and revise as necessary this weekend so he has a final version to include in the report for Lumina Foundation. Please email edited versions to Bill by early Monday.

B. **Degree/Program Profiles:** We discussed the variety in the degree/program profiles we have drafted and concluded that this is not problematic since it reflects the variety in our institutions. Bill indicated that he will draft an introduction to the set of profiles noting that they are couched in terms of credit hours and courses, the US higher education currency. Nevertheless, our goal will be to develop profiles in terms of our physics learning outcomes, as we continue our work in the coming semester. Bill will correct a few typos he has noticed and then insert these profiles into the report. Team members were invited to edit and revise their profiles as they desire and email any revised versions to Bill by early Monday.

C. **Student Input:** Jeff reported on his meetings with students from University of Utah, Weber State University, and Utah Valley University. He will provide a written report to Bill for the report to Lumina. Jeff met with about 15 students. All were quite happy with their physics major programs. Their primary concern was "not knowing what is expected." This had to do with priorities among topics in the course, not with expectations for particular exam questions or homework problems. Program level expectations seem to be clearer at some institutions than at others.

D. **Draft Report to Lumina Foundation:** We reviewed the report outline and the major sections dealing with the physics team's work in draft form. The team expressed continued skepticism about the Tuning *Process*, but not at all about the work we have done together in Utah. What was valuable was to take the goals of Tuning and pursue them according to our own needs and context. It was not so much following the European process that mattered. They suggested that a short summary of Tuning with emphasis on the goals would have alleviated anxiety at the beginning of the project and allowed us to move forward more efficiently, rather than so much detail about what the Europeans have done, the terminology, and procedural elements. In sum, the European *process* is not necessarily relevant to us because what we need to improve and correct in our system is not entirely the same as what motivated the Europeans (although there is overlap). So we have naturally done what we thought was best for us. We agreed that what we are doing, especially if we continue and complete this work, could help greatly with accreditation and assessment. Furthermore, we are very pleased to have had the opportunity and support to carry out this project. The ideas from Europe provided a useful impetus for discussions that have been very valuable. These discussions have been explicit and detailed about what we are each doing in our programs.

We noted that the relatively small size of the Utah System has contributed greatly to our ability to make as much progress as we have in 7.5 months. We agreed that the diversity of our institutions shows through appropriately in our degree / program profiles.

It was suggested that we add for future plans the possibility of considering the Ph.D. level. We are eager to work on the idea of Educational Resumés; these will be essential to demonstrating our learning outcomes. We want to emphasize that the project has developed a framework for faculty to work with in curriculum development.

There were several suggestions about specific editing of the draft sections we have reviewed so far. Bill will follow up on those.

We agreed to work with the final report early next semester to produce a summary version that will be useful for our individual departments. This will provide a document that can be used as a springboard for departmental discussions of learning outcomes, assessment, and curricular reform.

E. **Next Meeting:** We will plan another IP-video or Board of Regents Office meeting after January 18 (Martin Luther King Day). Each team member should email Bill during the coming week about his or her constraints for meeting times in January.

E. <u>Physics Student Report</u> (Submitted by Jeffery Hodges.)

The following is a report of student interviews regarding physics education in the state of Utah. While all universities tried to participate, the opinions expressed come mainly from students who have or are attending the University of Utah, Weber State University, and Utah Valley University. This report is rather informal, although I believe the information is useful.

When asked how pleased the students were with their physics programs, the overwhelming response was positive. The physics majors seem pleased with their programs, even though the programs differed in many ways.

When asked how the majors would change their programs, the response came in two general forms. First, students wished professors would be more clear as to what topics were important to know and which were less useful. I discussed this subject to some extent with the students and have come to believe the students are asking to know which topics are unnecessary for permanent retention versus topics which will be crucial to progress in the program, or in their future careers.

The second suggestion of changes in a general program was not so much regarding a program outline or process, but mostly concerns with specific professors. Not all students agreed on which professors were difficult to deal with.

When asked if professors were accessible, the answers differed directly with the size of program. For example, students in their first couple of years at the University of Utah seemed to deal more with TA's than directly with professors, while at Utah Valley University the professors handled the majority of student interactions directly.

When asked how physics majors expected to utilize their degrees, the majority of students at the BS/BA level did not expect to continue on into a graduate program in physics. Only ~20% of those nearing graduation expressed intent to proceed in physics. However, nearly 80% (which includes the above 20%) of all students expressed a desire to continue on into some form of graduate school education in a variety of fields. Medical, legal, computer science, and engineering were the most common. The remaining 20% or so expressed intent to enter the work force. Many expected to obtain jobs in computer science or engineering positions, but some believed they would be continuing in scientific capacities.

When asked if physics majors had a difficult time navigating the bureaucratic components of a college education, none claimed to have any difficulty. It is my opinion, for what it is worth, that the personality types drawn to a physics program are usually problem solvers, and the problems related to navigating a college bureaucracy are not difficult for such a person. Additionally, everyone I spoke with claimed the support of the departments in helping them through the process.

Physics majors in Utah do not appear to have any insurmountable problems in their programs. In general they are pleased with what they are doing. I am sure there are students who disagree, but they seem to be in the minority. All students I spoke with recognized the difficulty

of the task they are undertaking, and they vary in ability to achieve their goals, but they are remarkably loyal to their programs.

F. Utah State University History Department Elaboration of Learning Outcomes

BACHELORS PROGRAM

(1) Learning outcomes:

HISTORICAL KNOWLDEGE

1. (Range of historical information)

Pursue coursework that examines a broad range of historical experience through:

-surveys of pre-modern, modern, and U.S. history, as well as

-upper-division classes that provide greater focus and analytical rigor in specific subject areas,

-leading up to a capstone course focused on the construction of a senior thesis.

The coursework explores: how change occurs over time; the complex issue of historical causation; the influence of political ideologies, economic structures, social organization, cultural perceptions, and natural environments on historical events; and the ways in which factors such as race, gender, class, ethnicity, region, and religion create "histories" rather than a monolithic past.

HISTORICAL THINKING

2. (Recognize the past-ness of the past)

The ability to understand how people have existed, acted, and thought in the always-different context of the past. History often involves encountering and sensing the past's otherness and of learning to understand unfamiliar structures, cultures and belief systems. These forms of understanding also shed important light on the influence which the past has on the present.

3. (Emphasize the complex nature of past experience)

The appreciation of the complexity and diversity of situations, events and past mentalities. This emphasis is central to history's character as an anti-reductionist discipline fostering intellectual maturity.

4. (Emphasize the complex and problematic nature of the historical record)

The understanding of the problems inherent in the historical record itself: awareness of a range of viewpoints; appreciation of the range of problems involved in the interpretation of complex, ambiguous, conflicting and often incomplete material; a feeling for the limitations of knowledge and the dangers of simplistic explanations.

HISTORICAL SKILLS

5. (Develop skills in critical thinking and reading)

$ Critical thinking: a recognition that statements are not all of equal validity, that there are ways of testing them, and that historians operate by rules of evidence which, though themselves subject to critical evaluation, are also a component of intellectual integrity and maturity.
$ Critical reading: The ability to read and analyze texts and other primary sources, both critically and empathetically, while addressing questions of genre, content, perspective and purpose.
$ Primary sources include visual and material sources like topographical evidence, paintings, coins, medals, cartoons, photographs and films.

6. (Develop research skills)

Intellectual independence: a history program is not simply or even primarily a preparation for research in the subject, but it should incorporate the general skills of the researcher, namely the ability to set tasks and solve problems. This involves: bibliographic skills; the ability to gather, sift, select, organize and synthesize large quantities of evidence; the ability to formulate appropriate questions and to provide answers to them using valid and relevant evidence and argument. It should develop reflexivity, i.e. an understanding of the nature of the discipline including what questions are asked by historians, and why.

7. (Develop the ability to construct reasonable historical arguments)

In written and oral form, drawing on and presenting all the above skills. Such argument should have structure; it should be relevant and concise.

$ In the case of written argument it should be expressed in clear, lucid and coherent prose.
$ Orally, it should involve the capacity to sustain a reasoned line of argument in the face of others, to listen, to engage in sustained debate, and amend views as necessary in the light of evidence and argument.

(2) Achieving goals set out in "learning outcomes"

Larger curriculum reorganization:

The Department is currently in the process of revising its undergraduate program, creating changes that reflect both the "learning outcomes" model we have adopted *and* the changed circumstances at our institution (budgetary constraints + reduced personnel + increased student enrollment).

The changes proposed will, we anticipate, create a more structured, coherent, and incremental model of course organization, one in which students will:

$ -first, (in a new "pre-major" program) demonstrate their academic abilities in lower-division History surveys and a range of other Gen Ed courses in the humanities, arts, and social sciences;
$ -second, seek formal admission to the department – with new requirements for:
-higher GPA and

-mandatory, focused academic advising;

$ -third, follow a logical, sequential, and diversified set of upper-division course offerings;

$ -fourth, completing their work with a capstone course

-HIST 4990: a research-oriented class for History majors

-HIST 4850/60/70: a pedagogically-oriented class for the History Teaching Emphasis.

Individual course reorganization:

As the Department proceeds with its assessment program (inspired by the Tuning model), we will next move to individual classes where faculty will develop more specific "learning outcomes" for their particular courses and "rubrics" to measure student achievement.

MASTERS PROGRAM

(1) Learning outcomes

Source: Philip M. Katz, *Retrieving the Master's Degree from the Dustbin of History: A Report to the Members of the American Historical Association*, Washington D.C.: American Historical Association, 2005; http://www.historians.org/projects/cmd/2005/Report/index.cfm

Historical knowledge

1. A base of historical knowledge, combining both a breadth and depth of knowledge, a familiarity with more than one historiographic tradition, and the ability to synthesize different types of historical knowledge (such as might be required to construct a survey course). Master's programs should incorporate a comparative, if not a global, perspective on history. Program graduates should be "educated history generalists."

Historical thinking

2. Learning to think like a historian, which includes, among other attributes, "historical habits of mind" and "historiographic sensibilities" (i.e., a critical and self-conscious approach to the constructed nature of historical knowledge). Although it is very hard to specify the cognitive and intellectual maturation which indicates that a student is "thinking like a historian," most of the focus group participants agreed that it was a defining element of effective graduate education.

3. The foundations for a professional identity as a historian, including a familiarity with the historical development of the discipline, an introduction to ethical standards and practices, and

an awareness of the multiple contexts of professional practice. Master's programs should promote collaboration and provide a model for collaborative work among historians.

Historical skills

4. Research and presentation skills, evidenced by the completion of a substantial research project. This project does not have to take the form of a traditional thesis, as long as it demonstrates content mastery, a familiarity with primary research, and competent historical analysis. (A challenge for history departments is making sure that different projects are comparable in quality and rigor, and are seen to be comparable by other graduate students, other history departments, and potential employers.) Master's degree recipients should be familiar with the tools of bibliography, a foreign language, and the differences between academic and non-academic writing. They should also be conversant with new information technologies, as tools for both research and public presentation.

5. A solid introduction to historical pedagogy, in the broadest sense of the term: what are the cognitive processes involved in teaching and learning history, how do learners of all ages attain their understanding(s) of history, and how do historians present the past to different audiences. If possible, master's programs should include a teaching component—or, better yet, practical training in the "presentation of history to non-specialists," which encompasses classroom instruction at all levels as well as public history. This would require graduate programs "to take teaching seriously," which many do not seem to do at present.

(2) Achieving goals set out in “learning outcomes”

Four key elements distinguish the masters program from the bachelors program.

(a) The masters program cultivates a **“professional identity”** among students (an element that is not as clearly and continually emphasized in the undergraduate program)

- -identity with the discipline, not simply with course material
- -participation in the activities of professional societies
  - -strongly encourage conference presentations
  - -attend guest lectures
  - -dues-paying membership in organizations
- -consistent attention to details of evidence, argument

(b) The masters program emphasizes the **primacy of research**.

- -The student’s work in developing a focused project requires rigorous, sustained research, not simply partial, sporadic, course-connected research (that occurs in the undergraduate program)

-Students immerse themselves in both primary source material AND the secondary literature that defines the "state of the question" that they intend to explore.
-Far greater (and practical) attention to methodological questions also serves as a distinguishing mark of the masters program.

(c) The masters program, in its course requirements, emphasizes the **seminar model** of learning rather than the lecture model adopted in most undergraduate classes.
-The seminar provides for a forum to enhance collaborative learning, disciplined contributions to discussion, and oral communication.

(d) the masters program, while offering specific, graduate-level seminars for its students, moves closer to the **"tutorial" model** of education. -The program *does* contain required courses:
HIST 6000. Historical Methods and Research. Introduction to the historical profession, emphasizing research and writing skills, as well as the critical assessment of scholarly works. Should be taken at the beginning of a student's graduate program.
HIST 6010. History and Theory. Examination of major works that have influenced the theory and practice of historical writing. History master's students are required to complete HIST 6010, HIST 6020, or another theory-enriched course.
-However, much of the student's remaining "schedule" involves graduate research and continual consultation with faculty advisors.

G. Utah State University History Department Learning Outcomes Rubric Example

Learning Outcomes Rubric Example:
Implementing the Learning Outcomes in History Courses

HIST 4990: Senior Capstone
Learning Outcomes Rubric

Name_____
Date_____

LEARNING OUTCOME	Excellent mastery 5	Good mastery 4	Some mastery 3	Minimal mastery 2	No mastery 1-0
HISTORICAL KNOWLEDGE					
Student demonstrates an understanding of the key historical events related to the thesis 10%	The paper displays: clear chronological understanding of events; complex grasp of causation; analyzes a range of factors shaping the sequence and outcome of events; situates issues within larger contexts; reflects on larger themes informing specific events.	Sound chronological framework; good grasp of causation; omits some key informing factors shaping events; some effort at contextualizing the question; proposes a sufficient range of larger themes.	Some chronological confusion; weak causal analysis; narrow range of informing factors in the discussion; weak contextualization; little discussion of broader themes.	Many chronological errors; simplistic causal analysis; few informing factors tied to the discussion; little to no discussion of wider context of events; thin discussion of wider themes.	Paper explores its subject in a historical vacuum with little commentary on causation, context, and larger themes
HISTORICAL THINKING					
Student frames historical questions in a thoughtful, critical manner 10%	The paper addresses a clearly-stated and significant historical question. Focuses on critical analysis rather than mere description. Key terms defined. Student clarifies the significance of the question. The question is of manageable scope and logically formulated.	The paper addresses a significant historical question that is clearly stated. Focus rests largely on critical analysis. Key terms usually defined. Question is of manageable scope, posed with minimal logical flaws in framing of the question.	The paper addresses a historical question that can be identified with some difficulty. Focus shifts between critical analysis and mere description. Some key terms left undefined. Significance of question unclear; serious logical lapses in framing of the question.	Significance of question not demonstrated; commentary is largely descriptive rather than analytical; key terms often undefined; the central question in the paper is of inappropriate scope or illogically presented.	No identifiable historical question.
Student evaluates and analyzes primary sources 15%	Demonstrates thorough awareness of origins, authors, contexts of all primary sources; consciously employs verification strategies as needed	Demonstrates some awareness of contexts of primary sources; employs some verification strategies	Offers partial evaluation of primary sources; spotty verification	Offers little to no evaluation of primary sources; no verification.	Is not aware of need to evaluate or verify sources.
Student evaluates and analyzes secondary sources, demonstrating an awareness of interpretive differences	Demonstrates careful reading from all relevant historiographical traditions; offers thorough, fair-minded, and informed assessment of historiography, summarizing main ideas	Has read widely in several historiographical traditions; assesses and summarizes those read; places his/her own work within the historiography; at some points, critiques	Cites at least two different interpretations; makes an effort to place his/her own work in reference to these two interpretations; critiques often unfair, irrelevant, or	Minimal discussion of interpretation in secondary works. No effort to place his/her own work within historiography; critiques commonly unfair, irrelevant, or misinformed.	No awareness of interpretive differences.

10%	clearly and accurately; places his/her own work within the historiography; raises historically legitimate critiques concerning the strengths and weaknesses of the studies.	either inappropriate or unsubstantiated	misinformed		
LEARNING OUTCOME	**Excellent mastery 5**	**Good mastery 4**	**Some mastery 3**	**Minimal mastery 2**	**No mastery 1-0**

HISTORICAL SKILLS					
Student employs a range of primary sources appropriate to the informing thesis of the paper 15%	Makes thorough use of all relevant online and print databases to identify primary source literature; all available primary sources identified. All sources in bibliography used thoroughly in text.	Makes good use of relevant online and print databases; some gaps in primary source base. A few sources in bibliography not fully used.	Makes some use of online or print databases; significant gaps in source base; paper based on only a few of cited sources.	No evidence of using databases to establish source base; source base very limited. Major sources unknown or not employed. Little evidence that author has used works listed in bibliography.	No evidence of using databases; sources entirely insufficient and inappropriate to paper topic.
Student employs a range of secondary sources appropriate to the informing thesis of the paper 10%	Makes thorough use of all relevant online and print databases to identify secondary literature; uses classic and most recent secondary literature; no major secondary sources omitted. All sources in bibliography used thoroughly in text.	Makes good use of relevant online and print databases; some gaps in secondary source base. A few sources in bibliography not fully used.	Makes some use of online or print databases; significant gaps in source base; paper based on only a few of cited sources.	No evidence of using databases to establish source base; source base very limited. Major sources unknown or not employed. Little evidence that author has used works listed in bibliography.	No evidence of using databases; sources entirely insufficient and inappropriate to paper topic.
Organization of argument 10%	Thesis announced --and argument previewed for the reader -- at the start of the paper in a succinct and comprehensible manner; clear framework for analyzing the thesis; argument unfolds through a logical sequence of points	Statement of thesis --and preview of argument -- are clear, but do not appear in the opening of the paper. Structure of the argument is sound, understandable, and appropriate to the project.	Thesis stated, but not at the start of the paper. Argument previewed; but the paper moves in a different direction. Difficult to detect a logical sequence to the points raised in the paper.	Difficult to determine the meaning, appropriateness, or significance of the thesis. No clear preview of the argument's direction. Sequence of points raised in the argument remains confused and puzzling.	Thesis either severely flawed or simply not offered; organization of argument remains incomprehensible

Well-substantiated argument; proper citation of evidence 10%	The writer correctly and thoroughly cites sources using Chicago Manual of Style format in footnotes or endnotes; the paper includes a separate bibliography listing all sources consulted for the paper.	The writer cites sources using the Chicago Manual of Style format in footnotes or endnotes and provides a separate bibliography; however, the paper displays some gaps in citation, errors in their construction, and inaccuracies in the bibliography.	Offers partial evaluation of primary sources; spotty verification	Offers little to no evaluation of primary sources; no verification.	Is not aware of need to evaluate or verify sources.
Mechanics	Spelling, punctuation, grammar all correct; proper sentence and paragraph construction	Occasional errors in spelling, punctuation, grammar, sentence & paragraph construction; not	Weaknesses in spelling, punctuation, grammar, sentence & paragraph construction make	Problems in spelling, punctuation, grammar, sentence & paragraph construction make	Problems in spelling, punctuation, grammar, sentence & paragraph

10%		severe enough to hinder an understanding of the paper's main points.	sections of the paper unintelligible.	sections of the paper unintelligible.	construction so severe as to make the paper unintelligible.

TOTAL POINTS _____

500-450 "A" range

449-400 "B" range

399-350 "C" range

349-300 "D" range

299- 0 "F" range