SYNESIS
A JOURNAL OF SCIENCE, TECHNOLOGY, ETHICS, AND POLICY

Strengthening Student Learning Through "Tuning"

William E. Evenson, PhD[1]

1. Consultant, Utah System of Higher Education and Professor of Physics emeritus, Utah Valley University and Brigham Young University, 711 E 3100 N, Provo, UT 84604, USA. Email: bill@evenson.ch.

Abstract
Physics faculty in the Utah System of Higher Education have engaged in "Tuning" physics in the state institutions of higher education since 2009. This paper explains Tuning, describes how it can strengthen student learning, and reports some of the experience of Tuning physics in Utah. It argues that this process is directed toward a culture change in academic departments, giving primary focus to what students learn rather than to what faculty teach or to other faculty and institutional inputs.

Key words: Tuning, Bologna Process, physics, learning outcomes

Introduction

Beginning in the fall of 2008, the Utah System of Higher Education began work with Lumina Foundation to implement a US version of "Tuning," a process of quality improvement for academic disciplines that had been developed in Europe (1-5). Tuning was a faculty initiative in Europe, what some have called "the antidote to Bologna" (6) because it was developed to maintain faculty control of the disciplines in the face of the centralized direction established by European education ministers through the Bologna Declaration and related agreements. In this article, I emphasize the ongoing work in Utah to Tune physics.

Lumina Foundation sought to understand how some Bologna participating countries were able to increase their production of post-secondary degrees, while US degree production was stagnant near 40%. The Foundation believed that, of the many initiatives tied to Bologna, Tuning contained the most promising ideas for improving student learning in the context of US higher education. As processes to improve higher education quality, Tuning and Degree Qualifications Profiles (7) are faculty and institution driven. They respect institutional autonomy. They respond to the differences of institutional contexts. They give attention to all stakeholders: faculty, students, alumni, employers, K-12 teachers who prepare students for college, institutional administrators, advisors, librarians, policy makers, and any others, while leaving faculty in charge of their discipline, clearly recognizing the faculty as the experts on what students need to know, understand, and be able to do to develop professionally in the discipline. Other Bologna initiatives that involve structural changes in higher education, such as the European Credit Transfer and Accumulation System (ECTS), the diploma supplement, and the realignment of degrees, would be much more difficult to adapt to the US context.

Tuning USA

Utah undertook a pilot project in Tuning, beginning with the disciplines of physics and history. In parallel with Utah's work, Indiana Tuned history, and Indiana and Minnesota Tuned other disciplines in the exploratory work in 2009-2010. There are now projects in several other states as well as multi-state projects and a US-wide effort in history that is led by the American Historical Association.

Tuning is faculty devised, driven, scoped, managed, developed and owned. This has been fully true in the Utah Tuning projects. Tuning appears to have global appeal. There are now fairly mature Tuning projects in Latin America, Australia, Russia, India, and China, with exploratory projects elsewhere. Standardization is inconsistent with Tuning; Tuning brings faculty together to build clear common reference points in a discipline, but every institution brings its students to accomplish the learning outcomes in its own way. Neither curriculum nor pedagogy nor assessment is prescribed by Tuning, only outcomes. I think of Tuning as learning to sing in the same key but not in unison, discipline by discipline.

The focus in Tuning is on student learning: what does a student need to know, understand, and be able to do to qualify for a bachelor's degree in the discipline? Furthermore, what does a student need to know, understand, and be able to do at the transfer point from community colleges to a bachelor's program, whether or not they are actually moving to a new institution? What does a student need to know, understand, and be able to do to qualify for a master's degree? How do the competencies and learning outcomes ratchet up from entry to midpoint (or associate's degree) to bachelor's degree to master's degree? (Taking these questions to the doctoral level seems less meaningful, at least in physics, since doctoral degrees are essentially research degrees.) Tuning is "making the implicit explicit" (8) as regards the knowledge, understanding and skills required for a degree in the discipline.

Closely connected to Tuning is the "ratchet principle" (1). Not only do the faculty define competencies and learning outcomes for degrees in the discipline, but also they define expectations for accomplishment that are ratcheted up from the associate's to the bachelor's to the master's levels. In this process, faculty develop a shared language for competencies and learning outcomes, making degree expectations transparent. They extend that transparency to students and eventually to all higher education stakeholders.

Part of the object of Tuning is to shift the focus of faculty, departments, institutions, systems, professional associations, and accrediting organizations from what is taught to what students learn. There is conscious attention to a needed culture shift within higher education. Furthermore, Tuning aims to make student learning expectations transparent to other stakeholders, as mentioned above. Finally, Tuning emphasizes the need to assess student accomplishment of the degree-level learning outcomes before granting a degree in the discipline.

With these goals for student learning, quality assurance, accountability, and transparency, it should be clear that Tuning is an on-going process, not a discrete project. We can only speak of a Tuning project in the sense of an initiative to set the process in motion. We cannot think of a discipline as "having been Tuned," because the competencies and learning outcomes, as well as the other elements discussed below, like degree profiles and employment maps, will be revisited again and again in an ongoing focus on student learning tied to evolution of the discipline.

Utah's preparation for Tuning

The process of Tuning must be collaborative among the faculty on the team. In Utah, we included representatives from each Tuning discipline from all nine (now eight) state institutions: two research universities, four comprehensive state or regional universities, and three community colleges. Since the pilot project, we have also included representatives from private institutions in the state. The work of these discipline teams was greatly facilitated by more than a decade of serious collaborative faculty work in Utah that was facilitated by the Office of the Commissioner of Higher Education under the leadership of Assistant Commissioner for Academic Affairs, Phyllis 'Teddi' Safman, PhD.

As far back as 1997 Safman began faculty-driven meetings on transfer articulation which evolved into annual "Majors' Meetings" that now include faculty representatives of 38 academic disciplines. These groups coordinate transfer articulation policies and have considered learning outcomes for general education requirements in the areas of mathematics, writing, life sciences, social sciences, humanities, and fine arts. They have brought faculty groups from different institutions and educational sectors (community colleges to research universities) together to address common concerns, thereby opening lines of communication between institutions and sectors, establishing trust, and developing respect. These faculty groups in the Tuning disciplines formed the basis for our Tuning teams, so they started their work knowing and respecting one another. In 1993 Utah formed a faculty general education task force, now recognized by the System as the Regents' General Education Task Force. The relationships developed in the work of the Task Force also contributed significantly to the ability of the Tuning Teams to move quickly into meaningful discussion of the disciplines being Tuned. Finally, since 1999 the Task Force has held an annual conference on "What Is an Educated Person?" that is open to faculty, administrators, and interested policy makers or members of the public. This conference introduced Utah participants to European reforms connected with the Bologna Process and to the work of the Association of American Colleges and Universities (AAC&U) in producing Essential Learning Outcomes (ELOs) for higher education (9). The ELOs provided a natural springboard to the Tuning process.

Tuning physics in Utah

As should be clear from above, Tuning is carried out primarily by the faculty in the discipline. In addition, we have included student representatives on the Tuning teams. Students who have sufficient confidence to be heard at a table of engaged faculty members make an invaluable contribution to reforms aimed at strengthening student learning because they provide a reality check about what the students' actual experience in the degree program is and can be. While faculty may have an idealized view of what actually happens in classrooms and laboratories, students can express what the developing learner of the discipline experiences in practice.

The work of the Tuning teams began with in-depth discussion of their discipline by the teams of faculty and students: How do we define what it is that students need to qualify for a degree in the central discipline? What competencies are essential that are taught in other departments (general competencies)? What discipline-specific competencies are essential? Several sessions of discussion were required before teams took ownership of the process. They needed to understand the process and how their work related to prior efforts to define learning outcomes and establish requirements. They needed to understand that Tuning is not standardization! They needed to understand that administrators who may have facilitated the establishment of the Tuning teams did not have preconceived outcomes, but that the outcomes of this work were the responsibility of the faculty/student teams themselves. Once the teams reached that understanding of the process, they agreed rather quickly on common sets of general and discipline-specific competencies that are central to the discipline. Physics faculty clearly understand what it means to be a physicist, even though that understanding may typically not be explicit or available beyond the faculty.

Table 1. Categories of Physics

Understanding the nature of science and the nature of physics
Mathematical and problem-solving skills
Physics concepts
Laboratory skills
Scientific communication skills
Computational and information access skills
Research skills

Discipline-specific competencies for physics degrees.

Examples of general competencies that were deemed important for physics degrees include oral and written communication, abstract thinking, analysis and synthesis, reasoned decision-making, and the capacity to learn and update learning. Discipline-specific competencies were defined in seven categories, as shown in Table 1. (For more detail see Utah's reports to Lumina Foundation (10).) With these competencies, the team defined learning outcomes at the associate's, bachelor's, and master's levels. Even though there is not an associate's degree in physics, this common transfer point from two-year to four-year institutions is important to define carefully, both for coordination among institutions and for clear and transparent communication of expectations to students.

We note again that agreement among the institutions on competencies and learning outcomes does not prescribe how different institutions bring their students to achieve the learning outcomes. Every institution has its own strengths and weaknesses, context, and demographics, all of which play into specific emphases of curriculum, pedagogy, and assessment practices. Team members from different institutions eagerly exchanged ideas with their colleagues, adapting and taking back to their own departments those ideas that fit their own situations.

It was difficult to understand how to communicate levels of expectation that ratchet up from the associate's level to bachelor's to master's. Therefore, the physics team developed a hierarchy of sophistication describing progress in learning and understanding physics (10). This hierarchy ranged in 11 steps from "ability to identify physical laws by name and to provide definitions of important terms related to the physical laws" to "ability to teach effectively and see where common pitfalls in understanding occur."

Table 2. Example Physics Benchmarks

Associate's degree level	• Identify the physical principles that underlie a problem from the introductory physics curriculum • Identify the relevant physical laws and know their names, e.g., Coulomb's law or Gauss's law • Know the definitions of important terms or symbols in the relevant physical laws • Express the meaning of the relevant physical laws or principles in words • Draw appropriate schematic diagrams showing relationships among the elements of the problem • etc.
Bachelors's degree level	• Do everything on the associate's degree list, but for more sophisticated problems in the bachelor's curriculum. In addition, the bachelor'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 • Specialize general formulas for specific problems • 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 • etc.
Master's degree level	• Do everything on the bachelor's-level student list, but for the still more sophisticated problems in the master's curriculum. In addition, the master's-level student should be able to: • Set up problems combining several subfields of physics, e.g., mechanics and electricity and magnetism • Teach problem organization and solving effectively to associate's- and bachelor's-level students • Incorporate advanced mathemstics (e.g., complex analysis, group theory) into problem solving • etc.

Benchmarks using examples to define the level of expectation for a student's ability to organize a physical problem.

Table 3. Survey of Technical Employers

Top Five Priorities of Technical Emloyers	Bottom Four Priorities
Able to work in a team	Shows awareness of equal opportunites and gender issues
Oral and written communication	Appreciation of and respect for ethnic, cultural and other diversity
Able to identify, pose and resolve problems	Social responsibility and civic awareness
Determination and perseverance in tasks and responsibilities	Commitment to environmental conservation
Able to plan and manage time	

Top five and bottom four priorities of technical employers surveyed about what they look for when considering hiring a physics graduate.

Table 4. Employer Focus Group Responses

Top Five Skills Desired by Physics Emplyoyer Focus Group	Other Recommendations of This Focus Group
able to solve problems and open to new ideas and learning	Physics majors should have an applied statistics course that prepares them to work with data in the industry.
have a foundation of physics fundamentals and know how the physical world works	Physics graduates need to be better at knowing how to work with other disciplines and they need to have better technical writing skills.
have the ability to work with others	More internships are needed as part of physics education, providing more practical skills. Senior projects and/or capstone courses that provide services for real firms were strongly recommended, and could substitute when internship opportunities are limited.
keep excellent records and use practical instrumentation	
salesmanship (the ability to sell their ideas to others in the firm)	

Responses of physics employers in a focus group about expectations of physics graduates.

Then the physics team prepared examples to serve as benchmarks at each level for each of the discipline-specific learning outcomes. Table 2 exhibits the benchmark example for showing the ability to organize a physical problem.

Other important elements of the process include consultations with a wide range of stakeholders, including other faculty members not on the Tuning team, students, alumni, employers, academic advisors, librarians, K-12 teachers, college administrators, and policy makers. These consultations do not dictate the programs defined by the faculty, but they give insight and keep the team grounded in the realities of their larger context. We surveyed some stakeholder groups about priorities for and quality of preparation in general competencies. The survey results were, unfortunately, not particularly rich in insight because the pre-conceived questions turned out not to line up well with the respondents' main concerns, concerns that often became explicit only with the kind of discussion one engages in a focus group. In contrast to surveys, focus groups with students and employers and group or individual discussions with faculty colleagues not on the team were very productive consultations. See Tables 3 and 4 for examples of the results of consultations with physics employers.

Each team also mapped the employability of their graduates, often with the help of alumni surveys and surveys from professional organizations. They drafted "degree profiles," making use of the learning outcomes and describing what each institution does to help students achieve those outcomes, emphasizing institution-specific strengths of the programs. All of these elements of Tuning give snapshots in time, emphasizing the need to work through from competencies to learning outcomes, consultations, employment maps, and degree profiles repeatedly in an ongoing process of strengthening and updating the program. Perhaps the most important outcome of the process has been the shift of focus from teaching and classroom time to student learning. This, too, is an ongoing process, amounting to a culture change in most departments.

Faculty response to Physics Tuning

The faculty who have been involved in Tuning physics have progressed from skepticism to interest to enthusiasm. Initially, they were skeptical because of unfamiliar terminology, an unfamiliar process, doubts about faculty autonomy since they knew the Bologna Process was a project of the European Ministries of Education, and doubts about whether Tuning would lead to standardization. However, as they understood the process, accepted that Tuning is not standardization, and appreciated that the Utah System of Higher Education organizers and Lumina Foundation actually empowered the faculty team to define their own discipline and find a productive path through the process, faculty team members generated greater interest in the process and were eager to learn how Tuning could help strengthen student learning. This enthusiasm grew out of seeing the work of the Tuning team shift focus from faculty inputs to student learning. Both faculty members and the Utah System leaders were enthusiastic about the growth of discussions about student learning across different institutions and education sectors and the development of meaningful relationships among faculty members from various institutions and sectors who were now sharing experiences and ideas. They also saw great value in giving greater attention through Tuning to general competencies required by our students, even though these are taught in other departments.

What Tuning adds

What does Tuning add to the quality equation for higher education, or, what is missed if we do not Tune our disciplines? First, the process itself is valuable by facilitating, or even requiring, discussions about student learning across institutions and sectors and by establishing meaningful relationships among faculty members across those boundaries. Tuning creates space for innovation by reducing the importance of credit hours and acknowledging that learning is about outcomes, not courses. It adds transparency and accountability to our disciplines by making implicit expectations explicit, and by giving clear outcomes to be assessed before granting degrees. This work is led by the faculty and provides a defense against accountability imposed from outside the institution. Tuning enlarges the focus of the faculty by giving attention to general competencies as well as discipline-specific competencies. Tuning consultations involve employers, alumni, and academic advisors as well as faculty and students in thinking about what student learning is represented by discipline degrees. It also facilitates the transfer of credit and degrees through the added transparency that is introduced and thereby aligns expectations across education sectors. In principle, it could help in the validation of non-traditional learning for credit toward a degree. Through consultations with employers and policy makers, Tuning supports a better match between the needs of the labor market and higher education.

Challenges

While Tuning has been generally well accepted and achieved relative success in Utah, serious challenges remain. First, it is not simple to scale up the Tuning process either geographically or to a broader set of disciplines. This is because of the need for a whole system of related activities that work together to produce learning outcomes, expected levels of student performance, consultations with faculty outside the Tuning team and with other stakeholders, employment maps, and discipline degree profiles for each institution. Tuning requires a commitment to frequent faculty meetings and a change in faculty culture to focus on student learning first, so that all resources are directed to that primary goal. In Utah, physics team members are still working to encourage their departmental colleagues in this process; some departments have accepted Tuning outcomes and insights more fully than others. To be sure, the process of cultural change associated with implementing the Tuning process will require considerable time.

Tuning and US higher education

US higher education is built around faculty and institutional autonomy, values that the Tuning process respects. Tuning involves general education, transfer articulation, and continually greater accountability through regional and professional accreditation. Tuning supports general education through inclusion of general competencies within the discipline expectations, and facilitates transfer articulation by connections made between institutions in different education sectors. It supports accountability by making expectations explicit and by requiring assessment of degree-level learning outcomes. Therefore, Tuning has potential both to strengthen student learning in US higher education and to fortify social support for US higher education through increased transparency and accountability. The way Tuning prompts and induces faculty to make their expectations explicit, while reexamining these expectations, can benefit any discipline, just as it has been shown to effectively strengthen physics programs in Utah.

Acknowledgments

Thanks to my co-workers in the Utah System of Higher Education for their many contributions to the work described here: Phyllis ‘Teddi’ Safman, Janice Gygi, Norman Jones, Daniel McInerney and the faculty participants on the Utah Physics Tuning Team.

This work was supported by a grant from Lumina Foundation to the Utah System of Higher Education.

Disclaimer

This paper is the work of the author and all claims and representations are his alone.

No commercial support was received for this work.

Competing interests

The author declares that he has no competing interests.

References

1. Adelman C. The Bologna club: what US higher education can learn from a decade of European reconstruction [Internet]. Washington, DC: Institute for Higher Education Policy; 2008. www.ihep.org/assets/files/TheBolognaClub.pdf [cited 2012 July 30].
2. Adelman C. Learning accountability from Bologna: a higher education policy primer [Internet]. Washington, DC: Institute for Higher Education Policy; 2008. www.ihep.org/Publications/publications-detail.cfm?id=112 [cited July 30, 2012].
3. Adelman C. The Bologna process for US eyes: relearning higher education in the age of convergence [Internet]. Washington, DC: Institute for Higher Education Policy; 2009. www.ihep.org/assets/files/EYESFINAL.pdf [cited 2012 July 30].
4. González J, Wagenaar R, editors. Universities' contribution to the Bologna Process: an introduction, 2nd ed. [Internet]. Bilbao, Spain: Publicaciones de la Universidad de Deusto; 2008. www.unideusto.org/tuningeu/images/stories/Publications/ENGLISH_BROCHURE_FOR_WEBSITE.pdf [cited 2012 July 30]. (See also additional publications at this website.)
5. Gaston P. The challenge of Bologna: what United States higher education has to learn from Europe, and why it matters that we learn it. Sterling, Virginia: Stylus Publishing; 2010.
6. Birtwistle T. In a presentation to American Association of University Professors, Washington, DC, June 2011.
7. Adelman C, Ewell P, Gaston P, Schneider CG. The degree qualifications profile [Internet]. Indianapolis: Lumina Foundation for Education; 2011. www.luminafoundation.org/publications/The_Degree_Qualifications_Profile.pdf [cited 2012 July 30].
8. McKiernan HH, Birtwistle T. Making the implicit explicit: demonstrating the value added of higher education by a qualifications framework. J. College & University Law. 2010;36(2):511-64. www.nd.edu/~jcul/files/Birtwistle_McKiernan.pdf [cited 2012 July 30].
9. Association of American Colleges and Universities. The essential learning outcomes. www.aacu.org/leap/documents/EssentialOutcomes_Chart.pdf [cited 2012 July 30].
10. Utah System of Higher Education. Tuning USA reports to Lumina Foundation; 2009, 2010, 2011, 2012. Available by email from the author.