Journal of Modern Education Review, ISSN 2155-7993, USA
September 2015, Volume 5, No. 9, pp. 821–826
Doi: 10.15341/jmer(2155-7993)/09.05.2015/001

http://www.academicstar.us

The Challenges of Designing Degree Plans for Noyce Teaching Candidates: The Value of Curriculum Mapping

Bradley E. Hoge[1], Jon Aoki[1], Ronald Beebe[2]

(1. Department of Natural Sciences, University of Houston-Downtown, USA;

2. Department of Urban Education, University of Houston-Downtown, USA)

Abstract: The University of Houston-Downtown (UHD) Noyce Teacher Scholarship Program was established in 2010 to provide teaching certification to science majors and encourage them to enter teaching careers at the secondary level. It quickly became obvious, through advising of these students and formative assessment of their progress, that it was very difficult to finish a science degree and teaching certification within the proscribed two years of the Noyce program, however. The Bachelor of Science in Biological and Physical Sciences degree plan provides the flexibility to include education courses as electives, but there was concern that if it was used for this purpose it might allow students to choose courses that would not meet all departmental learning objectives (LOs). Surveys were conducted with NS faculty to determine which courses delivered each LO, and at what level of Bloom's taxonomy. Curriculum maps were used to develop a new BPS with Teaching Certification degree plan which also meets State of Texas requirements that all degree plans fit within 120 hours. This degree plan has proven to be a better alternative for Noyce students, though there is some concern that this plan may limit student's potential applications to graduate school.

Key words: curriculum mapping, learning objectives, academic planning, high-impact learning experiences, Noyce teacher scholarship program

1. Introduction

There is a growing need for science teachers in Texas who have strong content backgrounds in specific areas. Texas recommends all high school students to complete four years of science courses, and now offers a STEM (science, technology, engineering, and mathematics) endorsement plan as an option (http://tea.texas.gov/graduation.aspx). This is creating a greater need for physics teachers, as well as for teachers qualified to teach advanced placement and dual credit courses. The Texas Business and Education Coalition (TBEC) commissioned a report that shows the majority of science teachers in the state of Texas are teaching with provisional certification and are not properly certified to teach science (Fuller et al., 2010). Numerous programs designed to increase the number of STEM teachers have been established in recent years in the attempt to fill this dire need. A report from The *Center for Research, Evaluation and Advancement of Teacher Education* (*CREATE*) report shows that most new science teachers in Texas are entering the field through alternative certification (Sid W.

Bradley E. Hoge, Ph.D., Associate Professor of Ecology and Paleoecology, Department of Natural Sciences, University of Houston-Downtown; research areas/interests: Wetland ecology/paleoecology, research-based learning. E-mail: HogeB@uhd.edu.

Richardson Found., 2009). This includes teachers with alternative certification who,though generally recognized as qualified, include many with deficiencies in science content and pedagogical knowledge. These teachers are placed in science classrooms due to the critical shortage of qualified teachers to meet growing demand, but they often leave teaching within five years. A report from The National Commission on Teaching and America's Future (NCTAF) states that "approximately one of every two teachers has left the classroom by the end of five years" (Fulton et al., 2005). This is particularly prevalent in urban districts, where the need for new teachers is greatest. These patterns are not unique to Texas. The National Center for Educational Statistics has reported a growing demand for teachers in STEM fields, especially in urban areas (NCES, 2009). Many new programs including the National Science Foundation (NSF) Noyce Teacher Scholarship Program, are aimed at producing more teachers with STEM degrees.

UHD has two NSF Noyce programs in the College of Sciences and Technology (CST). One is housed in the Department of Natural Sciences (NS), and the other in the Department of Mathematics and Statistics (MS). Both programs work closely together through the UHD Scholars Academy (SA) to recruit students. The SA is an academically competitive program in the CST that promotes scholarship and student success for UHD undergraduate students majoring in STEM fields. This paper highlights the NS program which was the first to be funded beginning with its first cohort of four students in 2010.

Noyce Scholars receive an $8,000 academic year scholarship which is supplemented with stipends for training during the academic year and summer. Only students with junior-level status are eligible for funding though this program, however students can enter into their science degree plan at any point. Post-baccalaureates can also receive stipends and are encouraged to apply. Students must have a 3.0 GPA overall in their science courses to be eligible for this scholarship. Accepted candidates for this program sign a contract that requires two years of service at an at-risk secondary school for every year of scholarship support after earning a baccalaureate degree in an area of science from UHD. The degree requirements are waived for post-baccalaureate participants.

UHD Noyce also offers a Pre-Noyce Program to encourage students to enter the Noyce program prepared to graduate in two years. Pre-Noyce Scholars must select the BPS with Teaching Certification (BPS + TC) degree plan and receive scholarship support in their Junior and Senior years. Students entering the UHD Noyce program as Juniors or Seniors under the BPS+TC degree plan are usually able to complete certification requirements in two years. Junior and Senior students in degree plans other than BPS+TC can enter the Noyce Program and complete certification requirements through post-baccalaureate or the Master of Arts in Teaching (MAT) programs These students graduate with their NS degrees before completing certification requirements and can use their Noyce Scholarship for any two years of their participation. Post-Baccalaureate students can use their Noyce Scholarship to complete both years of the MAT Program.

The NS department offers degrees in Biology, Chemistry, Geosciences, Biotechnology, and Biology and Physical Sciences (BPS). Concentrations are also offered within each program. The BPS degree allows students to earn a concentration in teaching certification. This concentration was developed for the UHD Noyce Science Teacher Scholarship Program (UHD Noyce) after advising and formative assessment found that students could not complete other concentrations within BPS, or other degree plans within the two years of scholarship support. The BPS + TC degree plan meets the Texas State Board for Educator Certification (SBEC) that specifies the standards that a beginning Texas educator should know and be able to do. The BPS+TC degree is also beneficial in terms of better preparing the student for the science composite exam. UHD Noyce encourages students to pursue composite science certification as opposed to a single discipline certification to maximize their marketability.

Noyce scholars can also minor in specific concentrations within the BPS+TC degree, such as geosciences or physics, and test for additional certifications beyond the composite certification.

It was a concern of the department, however, that students might be able to make their way through the BPS with teaching certification degree plan without taking all of the courses intended or being exposed to all learning outcomes identified by the NS department for program assessment. Curriculum mapping allows for the identification of student trajectories through degree plans, but also for discernment and refinement of learning objectives and improvement of LO assessment rubrics.

Learning objectives were mapped through the BPS+TC degree plan to ensure that all students are provided adequate content coverage and exposure to high-level learning experiences. These maps were utilized to identify proper progression for each LO, potential gaps in degree plans, appropriate pre-requisites for upper division courses, and to determine future needs for academic planning.

2. Methods

A curriculum mapping rubric was developed and completed by all faculty members for each course offered. A survey was presented to all faculty members of the NS department to provide information needed to construct curriculum maps for each degree plan. The NS department assesses seven learning objectives (LOs) for all degree plans offered. The LOs are:(1) Basic Knowledge — Graduates will have the basic knowledge of the discipline; (2) Scientific Reasoning — Graduates will be able to effectively use the scientific method and scientific reasoning both qualitatively and quantitatively; (3) Laboratory Skills — Graduates will have laboratory skills common to modern laboratories; (4) Written and Oral Communication — Graduates will be able to effectively communicate scientific information in writing and in oral presentations; (5) Research and Knowledge Application — Graduates will be able to carry out independent project-based activities; (6) Teamwork — Graduates will be able to work as part of a team; and (7) Ethics — Graduates will have demonstrated understanding of the ethical standards for the reasonable conduct of scientific research and its application.

The survey asked faculty to state whether the LO was introduced, reinforced, or emphasized; what percentage of time was spent on each LO; and what high-impact learning experiences were deployed for each course taught. Generally, only one faculty member was surveyed per course. Faculty members were chosen to assess courses they initially designed and/or taught exclusively. Results of the surveys were compiled and used to create maps for each of the degree programs in the department. Definitions used in the rubric are included in Table 1.

3. Results

Twenty NS faculty members completed the survey for 61 courses. 74 surveys were completed overall since some courses are taught by more than one faculty member. 44 course surveys were completed for Biology, 20 for Chemistry, and 9 for Physics and Geology. Results were compiled for each LO across course level.

The curriculum map for the BPS degree plan is too large to include in this paper, but can be obtained by contacting the corresponding author.

Overall, 96% of surveys reported covering basic knowledge (LO# 1) in their courses. 41% of courses introduce basic knowledge, 62% reinforce basic knowledge, and 49% emphasize basic knowledge. A summary of results showing how each LO was introduced, reinforced, and emphasized at each course level is shown in Table 2.

Table 1 Definitions Used in the Rubric Required Indicating Strategies in Three Categories, Level of Instruction, Method of Assessment, and Use of High Impact Learning Experiences

Level of Instruction	Assessment Method	High Impact Experiences
(**I**) Introduced — Instruction and learning activities focus on basic knowledge, skills, and/or competencies and entry-level complexity,	Student learning is assessed through (Ex) — Exams; (WA) — Written Assignments; (O) — Oral Presentations	(**HI**) High Impact — High impact strategies are utilized in this course:
(**R**) Reinforced — Students are expected to possess a basic level of knowledge and familiarity with content or skills. Instruction concentrates on enhancing and strengthening knowledge and skills, and expanding complexity.	Student learning is assessed through (Ex) — Exams; (WA) — Written Assignments; (O) — Oral Presentations	(**S**) — Seminar or Recitation; (**CI**) — Critical Inquiry; (**IW**) — Intensive Writing Assignments; (**LC**) — Learning Community Involvement; (**CP**) — Collaborative Projects; (RP) — Research Projects; (**GL**) — Global Learning Opportunities; (**SL**) — Service Learning;
(**E**) Emphasized — Students are expected to possess a strong foundation in knowledge, skills, and/or competency. Instruction builds upon previous competencies with increased complexity.	Student learning is assessed through (Ex) — Exams; (WA) — Written Assignments; (O) — Oral Presentations	(**C**) Capstone Course — This course was identified as a capstone course.

Table 2 Percentages (%) of Faculty Members Reporting Level of Coverage for Each LO at Each Course Level

LO	1000 level				3000 level				4000 level			
	I	R	E	Overall	I	R	E	Overall	I	R	E	Overall
1	100	71	29	100	18	46	91	97	15	62	62	96
2	43	57	29	81	9	64	64	87	0	67	75	96
3	100	50	0	62	0	75	50	61	20	60	80	30
4	33	67	0	48	9	73	36	74	0	75	83	100
5	0	14	0	19	0	67	33	43	25	75	100	33
6	0	9	0	29	0	100	25	65	20	60	80	52
7	57	9	0	38	33	67	33	48	22	89	44	74

89% of surveys said they cover scientific reasoning in their courses (LO# 2). 27% introduce scientific reasoning, 61% reinforce scientific reasoning, and 39% emphasize scientific reasoning. 50% of surveys said they cover lab skills in their courses (LO# 3). 15% introduce lab skills, 28% reinforce lab skills, and 23% emphasize lab skills. 77% of surveys said they cover communication skills in their courses (LO#4). 20% introduce communication skills, 47% reinforce communication skills, and 36% emphasize communication skills. 35% of surveys said they cover research skills in their courses LO#5). 12% introduce research skills, 16% reinforce research skills, and 15% emphasize research skills. 51% of surveys said they cover teamwork in their courses (LO# 6). 20% introduce teamwork, 28% reinforce teamwork, and 14% emphasize teamwork. 55% of surveys said they cover ethics in their courses (LO# 7). 31% introduce ethics, 19% reinforce ethics, and 18% emphasize ethics.

4. Discussion

Curriculum mapping allows for the identification of student trajectories through degree plans, but also for discernment and refinement of learning objectives and improvement of LO assessment rubrics. This first round of curriculum mapping identified numerous opportunities for refinement. Faculty interpreted terms used in the rubric differently, for instance, leading to an uneven distribution of responses. While results indicate that all learning

objectives are met in each degree plan, and that all LOs are introduced, reinforced, and emphasized in the proper sequence, different faculty members interpreted these terms differently, Improvements to the curriculum mapping rubric are needed to increase the resolution of the map and ensure that these results are robust.

The data did provide significant information for the purposes of academic planning, however. Prior to changes made to the degree plan resulting from academic planning informed by this curriculum mapping, all BPS students were required to take introductory course sequences in biology and chemistry and one of geology or physics. All introductory courses include labs. In addition, all students were required to take two writing skills courses and one world community course, though they did not have to be science courses.

Comparing reported coverage against required coursework, it can be shown that basic knowledge was introduced and reinforced in all course levels. Scientific reasoning was increasingly reinforced and emphasized as the student moved through the degree plan. Laboratory skills were introduced and reinforced early, but less emphasized in upper division courses. Emphasis on written and oral communication increased in upper division courses. Research was not required for the BPS degree plan as it is in other degree plans, though it is required for Noyce scholars. Teamwork was not required in introductory labs, though that is common practice. The need to increase the amount of teamwork was apparent in upper level courses. Ethics were emphasized in upper division Courses, but opportunities existed for introducing and reinforcing ethics earlier. BPS majors were required to take 44 hours of upper level courses, though they could easily avoid those designated as capstone courses.

As a result of academic planning, changes were made to the BPS degree plan. All BPS majors are now required to take at least one upper level course with a lab. Moreover, all students are required to complete at least one capstone course. Also, students are now required to take one course designated as an ethics and moral issues course, and two writing intensive courses from the science courses offered. Rubrics were developed to evaluate capstone, ethics, and writing courses for the purposes of these designations. The curriculum mapping informed all rubric development.

Additional rubrics for each LO were also developed to provide better guidelines for curriculum planning and assessment. Based on these results, the NS Academic Planning Committee established three categories for curriculum improvement: High-Impact Experiences **(HIE)**; Improving Student Access and Streamlining Operations/Service **(SA/SS)**; Resource Development and Student Success Initiatives to Improve Retention and Graduation **(RD/RG)**. The committee then developed specific goals for program improvement with benchmarks at Years 1, 3, and 5.

Changes were made to the UHD Noyce program to promote student success. Groups of UHD Noyce scholars are partnered with Aldine Independent School District mentor teachers, junior teachers, and UHD faculty mentors to form Noyce teams. Noyce teams meet face-to-face and use the NS department learning community HUNSTEM (Houston Urban Network for Science, Technology, Engineering, and Mathematics) to communicate and consider pedagogical issues and challenges. Further, UHD Noyce Scholars also have the benefit of interacting with faculty and peers of the UHD Scholars Academy. The SA provides peer-mentoring and tutoring as well as undergraduate research opportunities. UHD Noyce students are now required to pursue undergraduate research. Research teams are also comprised of Noyce Scholars, master teachers, junior teachers, and UHD NS faculty. UHD Noyce scholars are required to work with the teacher in their research teams to produce a lesson for the classroom based on their research experience. Noyce scholars then become mentors for teachers and high school students in Noyce Summer Research Camps.

Noyce scholars are especially appreciative of their research experiences and how it uniquely prepares them

for teaching. In an interview with one Noyce program graduate, she stated "I feel not only like a biology teacher, but a scientist that is also a biology teacher." Another stated that her teaching improved by knowing "…how to do research, plan out research, and transfer knowledge from experience to the classroom."

One drawback of the BPS + TC plan, however, is the lack of upper science course electives students can take. As one UHD Noyce graduate stated, the current BPS degree is the "…only logical teaching degree, but removes the opportunity for a science major to consider graduate school." Of the sixteen Noyce scholars who have participated to date, one left the Noyce program to pursue research, and two others have expressed a strong interest in returning to research careers once their teaching obligation is complete.

References

Fuller E., Springel M. and Fuller G. (2010). "Supporting college readiness: Preparing middle school students for high school success in Texas", Study funded with grants from the Hudson Foundation and State Farm Insurance for the Texas Business and Education Coalition (TBEC).

Fulton K., Yoon I. and Lee C. (2005). "Induction into learning communities", National Commission on Teaching and America's Future (NCTAF).

National Center for Educational Statistics (2009). "Digest of educational statistics: 2009", available online at: http://nces.ed.gov/programs/digest/d09/.

Sid W. Richardson Foundation Forum (2009). "Delivering a high-quality teacher workforce for Texas: Reconsidering university-based teacher preparation in Texas, renewing commitments, and improving practice in the twenty-first century", Center for Research, Evaluation and Advancement of Teacher Education.