Understanding Our Secondary Content in the Sciences Standard

The program ensures that teacher candidates have the content preparation necessary to successfully teach the sciences to increasingly rigorous state standards for college and career readiness.

WHY THIS STANDARD?

High school teacher candidates must develop a sophisticated level of knowledge in the sciences they will be certified to teach if they are to help their students succeed in increasingly rigorous classrooms and graduate from high school college and career ready.

WHAT IS THE FOCUS OF THE STANDARD?

If a state does not have regulations that require that all high school science teacher candidates pass adequate subject-matter licensing tests, the program's subject preparation requirements are examined. At the undergraduate level, if candidates will be licensed to teach one subject, they should earn a major in that subject; if they are going to teach under a composite certification (i.e., general science), they should earn two minors in related subjects or complete at least 50 semester credit hours across the sciences. At the graduate level, the transcript review process is examined to check that programs are verifying that their incoming candidates have sufficient content knowledge in the area they will be certified to teach.

Standard applies to: Secondary programs.

Standard and Indicators

Standard 7: Secondary Content in the Sciences

The program ensures that teacher candidates have the content preparation necessary to successfully teach the sciences to increasingly rigorous state standards for college and career readiness.

Standard applies to: Secondary programs.

The former Standard 7, Middle School Content, has been removed because the standard primarily gave information about state policies, rather than providing information about the quality of individual preparation programs. For more information, see here. Standard 8, previously High School Content, has been replaced by two new standards: Standard 7, Secondary Content in the Sciences and Standard 8: Secondary Content in the Social Sciences. Because the depth and breadth of content requirements for secondary candidates seeking certification in English and math are generally adequate, but adequacy varies in the sciences and social sciences, a standard dedicated to each of the latter two areas provides more nuanced and actionable information. For more information, see here.

Indicator relating to outcomes that the program meets the standard at the undergraduate or graduate level:

Institutions of higher education have traditionally articulated their vision of teacher preparedness in a subject area by defining a prescribed course of study through a major or minor. For high school teachers charged with teaching several different subjects subsumed under one science certification, pursuing multiple majors is impractical. Because it is particularly challenging for a program to craft adequate coursework requirements for multiple-subject science certification (especially for candidates entering graduate programs of study), states should ensure that licensing tests are sufficiently rigorous to ensure content mastery in every subject a candidate will be certified to teach.

7.1 Using an outcomes-based approach, secondary certification in the sciences requires passing either:

- a rigorous standalone test in every subject a teacher will be certified to teach,
  OR
- all sections of a multiple-subject test offering section-specific cut-scores that pertain to the subjects a teacher will be certified to teach.

Absent such licensing tests used to verify competency, we look for programs to require or verify courses of study.

Indicator relating to courses of study that the program meets the standard at the undergraduate level:

7.2 A secondary teacher candidate seeking science certification in a state that requires single-subject certification must have a major (consisting of 30 or more semester credit hours, which may include some credit hours in ancillary supporting subjects) in the single teachable science discipline for which certification will be awarded. A secondary teacher candidate seeking science certification in a state that offers general science certification must have coursework preparation that consists of either (1) at least two minors (15 or more semester credit hours each) in two teachable science disciplines (biology, chemistry, physics, or earth science), or (2) at least 50 semester credit hours across the sciences.

Indicator relating to courses of study that the program meets the standard at the graduate level:

7.3 The burden posed by a stringent credit count does not relieve the program of its responsibility to ensure that secondary teacher candidates in the sciences meet requirements for content knowledge preparation. If candidates have significant weaknesses in content knowledge, the program works with the candidate to remedy those weaknesses. When the program's application forms, catalogs, or other public documents do not describe such a process and its requirements, the presumption will be made that no content preparation requirements are imposed on graduate teacher candidates.

Rationale

Standard 7: Secondary Content in the Sciences

The program ensures that teacher candidates have the content preparation necessary to successfully teach the sciences to increasingly rigorous state standards for college and career readiness.

Standard applies to: Secondary programs.

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RATIONALE

Research base for this standard

"Strong research"[1] conducted in the United Kingdom demonstrates the importance of teachers' intensive study of a specific subject in order to develop content knowledge adequate to teach that subject. Researchers examined the content knowledge of pre-service teachers enrolled in a post-baccalaureate certificate program who had majored in disciplines closely associated with chemistry, biology, or physics. Only those teacher candidates in the chemistry cohort demonstrated the requisite content knowledge in chemistry.[2]

Additional research studies[3] have demonstrated the positive impact of teacher content knowledge on student achievement. Teacher content preparation in math and science has a positive effect on how much math and science high school

1 NCTQ has created "research inventories" that describe research conducted within the last decade or so that has general relevance to aspects of teacher preparation also addressed by one or more of its standards (with the exceptions of the Outcomes, Evidence of Effectiveness, and Rigor standards). These inventories categorize research along two dimensions: design methodology and use of student performance data. Research that satisfies our standards on both is designated as "strong research" and will be identified as such. That research is cited here if it is directly relevant to the standard; strong research is distinguished from other research that is not included in the inventory or is not designated as "strong" in the inventory. Refer to the introduction to the research inventories for more discussion of our approach to categorizing research. If a research inventory has been developed to describe research that generally relates to the same aspect of teacher prep as addressed by a standard, the inventory can be found in the back of this standard book.

2 For the purposes of this study, requisite knowledge for teaching secondary chemistry includes an understanding of particle theory and changes of state, mass conservation, chemical bonding, mole calculations, and combustion reactions. Kind, V. (2014). A degree is not enough: A quantitative study of aspects of pre-service science teachers' chemistry content knowledge. *International Journal of Science Education, 36*(8), 1313-1345.

3 "Additional research" is research that is not designated as "strong" because it is not as recent and/or does not meet the highest standards for design methodology and/or use of student performance data.

students learn.[4] One study found that high school teachers' content coursework had a higher payoff for less experienced teachers,[5] and another found that when hiring novice teachers, selecting those who excelled academically can make up for their lack of teaching experience.[6]

Several studies have found that while teachers' pedagogical knowledge may play a larger role in students' success than content knowledge, content knowledge is still essential.[7] For example, Monk (1994) emphasizes the importance of both content and pedagogy, indicating that the former is necessary but not sufficient.[8]

OTHER SUPPORT FOR THIS STANDARD

For decades, teacher preparation and higher education reformers attempted to improve the rigor of undergraduate teacher preparation programs by promoting the requirement of full academic majors for prospective teachers. For example, the Holmes Group of the mid-1980s, a group of education school deans, advocated for programs in which teachers complete a traditional bachelor program with a content-area major and then devote an additional year to teacher preparation, such as through a postbaccalaureate program. While this type of program has not always been executed effectively, the concept shows the ongoing emphasis on teachers' content knowledge.

The structure of the standard acknowledges that most states offer certification in the sciences such that teachers with specialization in any one subject area may also teach other subject areas.[9] Based on their high school science licensure requirements, many states seem to presume that a teacher with a background in one science area is equally capable of teaching anatomy, photochemical reactions, and Newtonian physics. Most states allow teachers to obtain general science or combination licenses across multiple science disciplines, and, in most cases, these teachers need only pass a general knowledge science exam that does not ensure subject-specific content knowledge.[10] This means that a teacher with a background in biology could be fully certified to teach chemistry or physics having passed only a general science test — and perhaps answering most of the chemistry or physics questions incorrectly.

Districts undoubtedly appreciate the flexibility that these broad field licenses offer, especially given the very real shortage of teachers in many science disciplines. But the all-purpose science teacher not only masks but also perpetuates the shortage of STEM teachers with strong STEM backgrounds, which leads to fewer students with a strong foundation in STEM who can pursue STEM professions. This cycle of inadequate preparation merely prolongs the STEM crisis.

Given the prevalence of these pathways into high school teaching, requiring a major (30 semester hours) in each of the subjects in which a teacher is certified (e.g., biology and chemistry for a teacher with a general science certification) would be unrealistic. On the other hand, requiring anything less than at least two minors (15 semester hours each) or 50 credit hours across the sciences for general science certifications would clearly be inadequate.

This standard garners support from school district superintendents.

4 Monk, D. (1994). Subject-area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review, 13*(2), 125-145; Goldhaber, D. D., & Brewer, D. J. (1997). Why don't schools and teachers seem to matter? Assessing the impact of unobservables or eduational productivity. *Journal of Human Research, 32*(3), 505-523.

5 Monk, D. (1994).

6 White, B. R., Presly, J. B., & DeAngelis, K. J. (2008). Leveling up: Narrowing the teacher academic capital gap in Illinois. *Illinois Education Research Council*, 1-44.

7 Baumert, J. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal, 47*(1), 133-180.

8 Monk, D. (1994).

9 National Council on Teacher Quality. (2010). *The all-purpose science teacher: An analysis of loopholes in state requirements for high school science teachers*. Retrieved from http://www.nctq.org/p/publications/docs/NCTQ_All_Purpose_Science_Teacher.pdf

10 National Council on Teacher Quality. *Handy Dandy Guide to NCTQ's Secondary Content Analysis*. Retrieved from http://www.nctq.org/dmsView/NCTQ_-_Standard_7,8_Groundwork_-_Infographic_on_Secondary_Certification

Methodology

How NCTQ scores the Secondary Content in the Sciences Standard

Standards and Indicators

DATA USED TO SCORE THIS STANDARD

Evaluation of secondary teacher preparation programs under Standard 7: Secondary Content in the Sciences uses the following sources of data:

- State regulations that specify the available secondary teacher certifications
- State documents that outline possible teaching assignments and required licensing tests for each secondary certification
- Course requirements and descriptions found in institution of higher education (IHE) catalogs
- Degree plans provided by IHEs
- Relevant IHE web pages, including web pages for the college of education and the registrar, and those relevant to graduate school admission
- Admissions-related documents, including transcript review forms

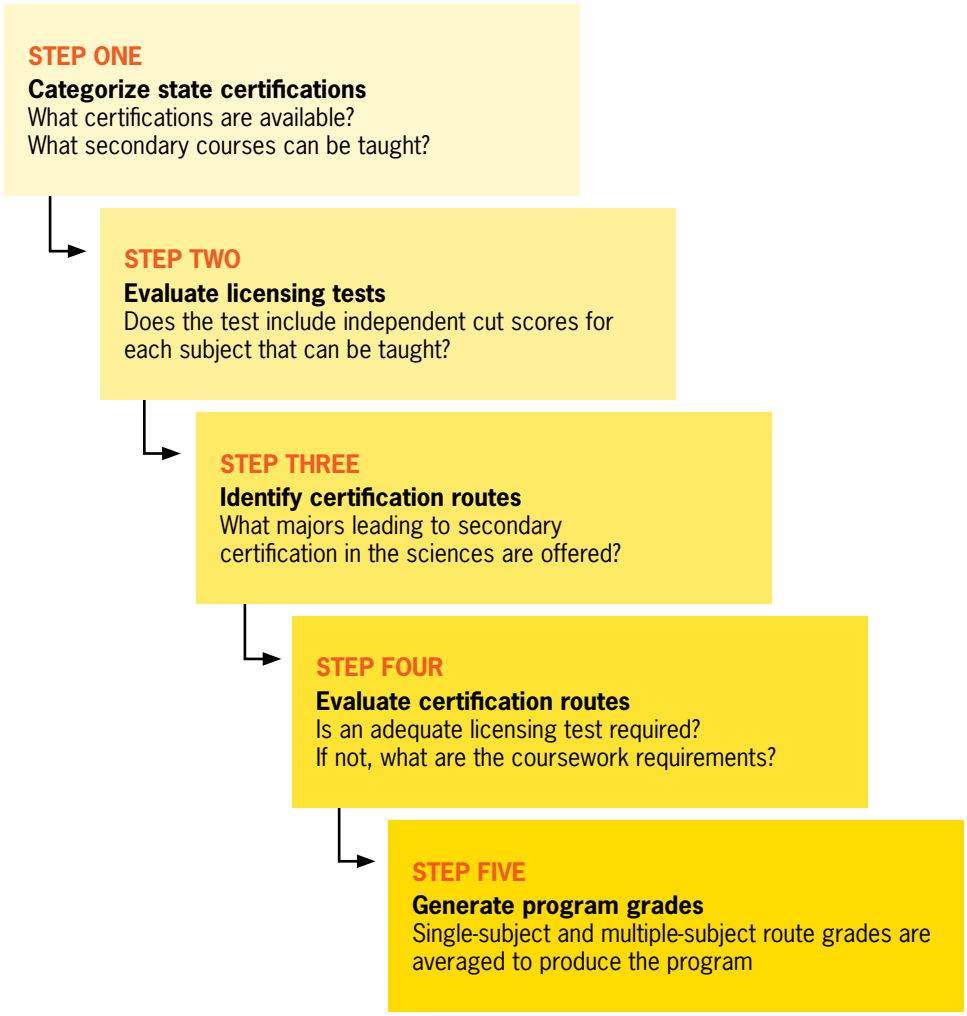
WHO ANALYZES THE DATA

A general analyst evaluates each program using a detailed scoring protocol from which this scoring methodology is abstracted. Twenty percent of programs are randomly selected for analysis by a second general analyst. For information on the process by which scoring discrepancies are resolved, see the "scoring processes" section of the General Methodology.

SCOPE OF ANALYSIS

There are four major steps in analysis. First, the science certifications in each state are identified and categorized as either single-subject or multiple-subject based on the possible teaching assignments. Next, the adequacy of licensing test requirements is determined based on whether the test has an independent cut score for each subject that can be taught under the certification. Once the state context for each certification is established, the majors leading to certification are identified for each secondary teacher prep program. Finally, if the licensing test is not adequate for a specific certification, analysts examine the coursework requirements for the major(s) leading to that certification. Where adequate licensing tests are found, content preparation is deemed satisfactory without a review of coursework requirements.

Steps of Secondary Content in the Sciences Analysis



More detail about each step in this process follows below, including an explanation of how program ratings are calculated under this standard. Information about coursework satisfying Indicators 7.2 and 7.3 can be found at the end of this document.

STEP ONE: CATEGORIZE STATE CERTIFICATIONS

As illustrated in this Handy Dandy Guide to NCTQ's Secondary Content Analysis, each state has its own organization for secondary certification, making it necessary to evaluate this standard within a state context. The evaluation process begins by using state regulations to identify all science certifications that allow high school level instruction.

Certifications within the sciences are categorized as either single-subject or multiple-subject. Single-subject certifications allow an individual to teach only the subject specified on the certification. A biology certification that only allows a teacher to teach high school biology courses is an example of single-subject certification. Multiple-subject certification allows an individual to teach two or more subjects. General science certification, which permits instruction in all high school science courses, is one example of a multiple-subject certification. In most instances, science certifications are categorized as follows:

Single-Subject Certifications	Multiple-Subject Certifications
Biology Chemistry Earth Science Physics	Physical Science (physics and chemistry) General Science (all of the sciences)

After categorizing the science certifications in each state, analysts review information on which high school-level courses teachers can teach with each certification. Not all states follow typical designations. As an example, Illinois and Oregon offer what appears to be single-subject certification in biology; however, under these certifications, both states permit instruction in chemistry and physics courses. Consequently, in those two states, the biology certification is categorized as multiple-subject. There are also cases where the inverse is found. Five states[11] limit teaching assignments under what appears to be a multiple-subject general science certification to foundational science courses.[12] Because teachers with these certifications cannot teach biology, chemistry, or physics, each certification is treated as single subject.

STEP TWO: EVALUATE LICENSING TESTS

With the certifications in each state categorized, analysis under this standard continues with a review of the licensing test(s) required for each certification.[13] Individual states set licensing requirements at the state level as a condition of certification. Most states require licensing tests for all certifications; however, there are instances where individual certifications are untested. Licensing tests for single-subject certifications are deemed adequate if the majority of the questions are focused on content relevant to the certification. In almost all cases where a licensing test is required for single-subject certification, the test is found to be adequate.[14]

For a multiple-subject test or series of tests to be deemed adequate, independent cut scores must be required for each subject covered under the certification. To provide an example, a licensing test for a "teach everything" general science certification would be deemed adequate only if it required candidates to independently pass sections covering biology, chemistry, and physics. Without separate cut scores for each subject, it is possible for a candidate to incorrectly answer almost all the questions focused on physics, for example, but score well enough on the remaining questions to pass the test.

11 Arizona, California, Missouri, Rhode Island, and West Virginia.

12 In California, for example, the Foundational-Level General Science certification allows instruction in "introductory and general science, introductory life science, and introductory physical science" courses. Teachers with this certification are not permitted to teach standard or AP biology, chemistry, earth science, or physics courses.

13 Some states do not require teachers to pass a licensing test until after their first year as the teacher of record. North Carolina, for example, allows teachers to fulfill the testing requirement in their second year of teaching, provided they attempt to pass the assessments during their first year.

14 Wisconsin provides one counterexample. The state's single-subject certification in biology, which limits instruction to biology courses, requires candidates to earn a passing score on a general science content knowledge licensing test. Only 20 percent of the questions on that test are focused on biology; the remaining 80 percent covers chemistry, earth science, physics, and general science concepts. The passing score reflects overall performance on the test, with no specific information provided about the candidate's performance on the biology questions. This same test is also used for Wisconsin's single-subject certifications in chemistry, earth and space science, life and environmental science, and physics. In each case, the use of this test for single-subject certification is deemed inadequate because of insufficient coverage of the subject for which certification is being sought.

Missouri's approach to science certification

Unlike every other state offering a "teach everything" general science certification, Missouri requires a series of licensing tests that ensure teacher candidates possess content knowledge in each subject they will be certified to teach. Missouri achieves this through four Unified Science certifications (one each for biology, chemistry, earth science, and physics). These are essentially general science certifications with a concentration.

For each Unified Science certification, a teacher candidate must pass the licensing test in the named concentration area. For example, a candidate pursuing Unified Science: Biology certification would have to pass the same licensing test as a candidate pursuing biology certification alone. In addition to passing that test, candidates seeking Unified Science certification also need to pass licensing tests in each of the other three sciences. For these additional areas, the state created unique licensing tests that are half the length of the assessment administered in the concentration area. For example, Unified Science: Chemistry certification requires passing scores on the following assessments:

- Chemistry (80 questions)
- Unified Science: Biology (40 questions)
- Unified Science: Earth Science (40 questions)
- Unified Science: Physics (40 questions)

This is the only licensing test structure that requires teacher candidates to pass an independent licensing test in each of the four sciences in order to teach every subject.

Missouri also offers single-subject certification in each of the sciences and a general science certification that is limited to foundational science courses, all of which require adequate licensing tests.

There is considerable variety in the certifications and licensing test requirements of each state. In addition to listing the available certifications in each state, this Handy Dandy Guide to NCTQ's Secondary Content Analysis also catalogs the adequacy of licensing test(s) for every certification.

STEP THREE: IDENTIFY CERTIFICATION ROUTES

Using course catalogs, analysts identify the certification routes — the majors, minors, or other defined sequences of courses that each IHE mandates to satisfy state requirements for a specific secondary teacher certification in the sciences. In many instances, more than one route at an IHE leads to a given certification. Because this is the most complicated aspect of program analysis, two analysts independently complete this work to ensure the accuracy of certification route identification.

Analysts identify all certification routes offered at each IHE and evaluate up to three single-subject and three multiple-subject certification routes for each program.[15] In cases where there are more than three single-subject or multiple-subject certification routes, those *without* adequate licensing tests are given priority over those with adequate licensing tests. Where all else is equal, the following order of preference is observed:

15 This standard evaluates no more than three single-subject and multiple-subject routes in order to eliminate two sources of redundancy in the analysis. First, when reviewing routes leading to physics certification, there is typically just one path offered by the program. However, when the program allows candidates to select any physics major, for example, and the institution offers five or more physics degrees, analysis of all five options, especially in instances where an adequate licensing test is required by the state, provides little to no additional insight. The second level of redundancy exists due to the nature in which programs are graded. Because the lowest single-subject and/or multiple-subject certification route grade determines the program grade and because the certification routes that have the highest probability of not satisfying the standard are evaluated first, analysis of a fourth single-subject or multiple-subject route is unlikely to alter the program's grade. Previous editions of the *Teacher Prep Review* evaluated up to five certification routes without independent consideration of single-subject and multiple-subject routes. That analysis would conclude if any certification route failed to meet the standard. In this edition of the *Teacher Prep Review*, analysis continues for up to three routes regardless of the grade for each individual route.

Single-Subject Certifications	Multiple-Subject Certifications
1. Physics 2. Chemistry 3. Biology 4. Earth science 5. Other single-subject routes	1. General science 2. Physical science 3. Other multiple-subject routes

The end product of the first three steps is an extensive database identifying the available certifications in each state, the adequacy of licensing test requirements, the certification routes offered at each IHE, and the number of majors leading to each certification route. The table below provides a snapshot of this database for a hypothetical IHE in Alabama.

Database snapshot for hypothetical institution

Certification	State Licensure		IHE Offerings		Analysis Priority
	Number of subjects covered	Requires adequate licensing test?	Offered by IHE?	Number of routes leading to certification	
General Science	Multiple	No	Yes	2	Both multiple-subject routes analyzed
Physical Science	Multiple	No	No	0	—
Physics	Single	Yes	No	0	—
Chemistry	Single	Yes	Yes	1	1st single-subject route analyzed
Biology	Single	Yes	Yes	1	2nd single-subject route analyzed
Earth and Space Science	Single	Yes	No	0	—

In the case of this hypothetical IHE, the two majors leading to general science certification would both be evaluated as multiple-subject certification routes without adequate licensing tests. The majors leading to chemistry and biology certification would be evaluated as single-subject certification routes with adequate licensing tests.

STEP FOUR: EVALUATE CERTIFICATION ROUTES

All certification routes administered in states with adequate testing requirements satisfy analysis under Indicator 7.1 without a review of coursework. Under Indicator 7.2, all other **undergraduate** single-subject and multiple-subject certifications are evaluated on the basis of coursework requirements found in course catalogs and degree plans.

The criteria used to evaluate coursework depend on the type of certification being considered. Multiple-subject certifications are analyzed using either the physical science or general science protocol based on the number of subjects that can be taught under the certification. The physical science protocol detailed in the table below is used in all instances where the

certification permits a teacher to teach two subjects.[16] Where a certification permits instruction in three or more subjects, the general science protocol is applied. Both protocols look at the number of required credit hours in relevant subject areas.

Analysis under this standard considers only *required* content coursework. Recommended courses and those primarily focused on pedagogy are excluded from analysis. Also excluded are science courses that explicitly endorse religion or pseudo-scientific principles such as creationism or intelligent design.

Undergraduate Analysis under Indicator 7.2

Certification Type	Scoring Criteria
Single-Subject (Biology, Chemistry, Earth Science, or Physics)	Indicator 7.2 is satisfied with either 30 semester credit hours (SCH) of certification-specific coursework[17] or at least 26 credits of certification-specific coursework and at least 12 credits of supporting coursework. Supporting coursework covers courses that benefit instruction, but fall outside of what is directly taught under a given single-subject certification.[18] The indicator is partly satisfied with at least 26 SCH of certification-specific coursework and at least 8 SCH of supporting coursework.
Physical Science (Two subjects)	Indicator 7.2 is satisfied with 15 SCH of certification-specific coursework in both chemistry and physics (for a total of 30 SCH). The indicator is nearly satisfied with at least 24 SCH of certification-specific coursework in either chemistry or physics and at least 10 SCH of certification-specific coursework in the other subject. The indicator is partly satisfied with at least 15 SCH of certification-specific coursework in either chemistry or physics and at least 10 SCH of certification-specific coursework in the other subject. A small part of the indicator is satisfied with at least 15 SCH of certification-specific coursework in either chemistry or physics and at least 6 SCH of certification-specific coursework in the other subject.
General Science (Three or more subjects)	Indicator 7.2 is satisfied with either 15 SCH of certification-specific coursework in two subject areas or 50 SCH across the sciences.[19] The indicator is nearly satisfied with at least 15 SCH of certification-specific coursework in one of the sciences with at least 24 SCH of coursework in the sciences in the other sciences. The indicator is partly satisfied with at least 15 SCH of certification-specific coursework in one of the sciences with at least 18 SCH of coursework in the sciences in the other sciences. A small part of the indicator is satisfied with at least 12 SCH of certification-specific coursework in one of the sciences with at least 18 SCH of coursework in the sciences in the other sciences.

Graduate programs without adequate licensing tests are evaluated under Indicator 7.3. Graduate programs must demonstrate a clear commitment to ensuring secondary teacher candidates complete the same requirements outlined for undergraduates. Graduate programs may also meet this indicator by requiring candidates to complete 15 SCHs (the equivalent of a minor) of graduate-level content coursework, which ensures candidates have an understanding of higher-level concepts relevant to the

16 Physical science certification, which permits instruction in chemistry and physics, is the most common two-subject science certification; however, in instances where two other subjects are paired, the physical science logic detailed in the table still applies, with the two subjects under review adjusted accordingly.

17 Coursework that directly relates to and can be taught with the certification. For example, when evaluating a major leading to certification in chemistry, the certification-specific coursework count includes only chemistry courses.

18 As an example, calculus courses are counted as supporting coursework when reviewing physics certification routes.

19 Additional criteria apply to the 50 SCH threshold. To fully satisfy Indicator 7.2 with at least 50 SCH of coursework in the sciences, at least 18 SCH of science coursework must be found outside of the most credit-heavy subject area. The indicator is partly satisfied where at least 15 SCH of coursework is in the sciences is found outside the most credit-heavy subject area. Where fewer than 15 SCH of science coursework is found outside the most credit-heavy subject area, the indicator is not satisfied. In all instances, if a certification route scores higher under separate criteria in the table above, that analysis will be applied.

area of certification.[20] This provision relies on the assumption that a graduate-level chemistry course, for example, requires the requisite knowledge that can only be acquired from undergraduate coursework in chemistry. In addition to course catalogs and degree plans, analysis also relies on admissions documents (such as applications and transcript review forms) and other publicly available material which outline the course expectations for candidates entering into the program.

Graduate Analysis under Indicator 7.3

Certification Type	Scoring Criteria
Single-Subject (Biology, Chemistry, Earth Science, or Physics)	Indicator 7.3 is satisfied with an undergraduate major in the subject area, 30 SCH of certification-specific coursework at the undergraduate level, or 15 SCH of certification-specific coursework at the graduate level. The indicator is partly satisfied with at least 26 SCH of certification-specific coursework at the undergraduate level or 9 SCH of certification-specific coursework at the graduate level.
Physical Science (Two subjects)	Indicator 7.3 is satisfied with undergraduate minors in chemistry and physics, 15 SCH of certification-specific coursework at the undergraduate level in chemistry and physics, or 15 SCH of certification-specific coursework at the graduate level in chemistry and physics.[21] The indicator is nearly satisfied with an undergraduate major in chemistry or physics, 30 SCH of certification-specific coursework at the undergraduate level in chemistry or physics, or 15 SCH of certification-specific coursework at the graduate level in chemistry or physics.
General Science (Three or more subjects)	Indicator 7.3 is satisfied with undergraduate minors in two subject areas, 15 SCH of certification-specific coursework at the undergraduate level in two subject areas, 50 SCH of certification-specific coursework in the sciences, or 15 SCH of certification-specific coursework at the graduate level. The indicator is nearly satisfied with either 42 SCH of certification-specific coursework in the sciences, or 15 SCH of certification-specific coursework at the graduate level.

Coursework included in analysis

Not all science courses are included in the credit count. The following table provides examples of coursework that counts toward this standard and the subjects for which they would apply; the table also provides examples of courses that do not count and the reasons for their exclusion.

20 This provision does not consider undergraduate coursework, even if it is completed during the graduate program. The content courses must be intended for graduate students and are typically at the 500-level or higher for programs using a traditional course number system.

21 Program must require at least one course in chemistry and one course in physics.

22 All courses can be completed in either chemistry or physics.

23 Programs must require at least one course in two subject areas (selected from biology, chemistry, earth science, or physics).

24 All courses can be completed in one of the science subjects.

Examples of courses that count toward Indicators 7.2 and 7.3

✓ Included in coursework count	X Excluded from coursework count
BIO 300 – Ecology and Population Biology Nutrient cycling and energy flow, populations, population genetics, use and construction of phylogenies, communities and biodiversity. (Counted as a certification-specific course for biology)	**ED 542 – Science Pedagogy in Secondary Schools** Through school-based experiences, students will learn how to engage young people in science and how to make decisions about planning instruction and developing assessment based on a sound knowledge base for applying content, materials, and methods appropriate for high school students. (Excluded due to focus on pedagogy and not content)
GEOL 211 – Historical Geology This course covers the diversity of life, catastrophic extinctions and the effect of biologic change on the environment. The basic principles of stratigraphy, use of stable isotopes to interpret sedimentary environments and the stratigraphic and tectonic history of the earth are also explored. (Counted as a certification-specific course for earth science)	**BSC 390 – Creation Biology** An in-depth study of the biblical and scientific views of the origin of the universe, life and man. Evidence and arguments for creation and evolution will be discussed. This course is designed for students with a strong science background or a very strong interest in the origins controversy. (Excluded due to focus on non-scientific religious topics)
BIOC 372 – Biochemistry Survey of basic principles of biochemistry and molecular biology, emphasizing broad understanding of chemical events in living systems in terms of metabolism and structure-function relationships of biologically important molecules. (Counted as a certification-specific course for either biology or chemistry)	**BIOL 440 – Methods of Teaching Science** Methods, philosophy and structure of science; application in teaching middle and secondary school science courses. (Excluded due to focus on pedagogy and not content)

STEP 5: GENERATE PROGRAM GRADES

After completing analysis of up to three single-subject and three multiple-subject certification routes under Indicators 7.1 and 7.2 for undergraduate programs or Indicators 7.1 and 7.3 for graduate programs, the program rating is produced in the following manner:

Program grade calculation

Programs with *only* single-subject certification routes
Program rating reflects the lowest-rated single-subject certification route

Example #1
- Certification route in biology earns an A
- Certification route in chemistry earns an A
- Certification route in physics earns an A

Program receives a grade of A

Example #2
- Certification route in biology earns an A
- Certification route in chemistry earns an A
- Certification route in physics earns a C

Program receives a grade of C

Programs with *only* multiple-subject certification routes
Program rating reflects the lowest-rated multiple-subject certification route

Example #1
- First certification route in general science earns a B
- Second certification route in general science earns a C
- Certification route in physical science earns an A

Program receives a grade of C

Example #2
- Certification route in general science earns an F
- Certification route in physical science earns an A

Program receives a grade of F

Programs with both single-subject and multiple-subject certification routes
Program rating reflects the average of the lowest-rated single-subject certification route and the lowest rated multiple-subject certification route

Example

Single-subject certifications
- Certification route in biology earns an A
- Certification route in chemistry earns an A
- Certification route in physics earns an A

Single-subject routes earn an A

Multiple-subject certifications
- First certification route in general science earns a B
- Second certification route in general science earns a C
- Certification route in physical science earns an A

Multiple-subject routes earn a C

Program receives a grade of B

Research Inventory

Researching Teacher Preparation: Studies investigating the preparation of secondary teacher candidates in the sciences and social sciences

These studies address issues most relevant to Standards 7–8: Secondary Content in the Sciences and Secondary Content in the Social Sciences

Area of research	Total number of studies	Studies with stronger design		Studies with weaker design	
		Measures student outcomes	Does not measure student outcomes	Measures student outcomes	Does not measure student outcomes
Std. 7	8	3	2	0	3
		Citations: 2, 3, 4	Citations: 5, 9		Citations: 1, 6, 7
Std. 8	4	2	1	1	0
		Citations: 2, 3	Citations: 8	Citations: 10	

Citations for articles categorized in the table are listed below.

Databases: Education Research Complete and Education Resource Information Center (peer-reviewed listings of reports on research including United States populations).

Publication dates: Jan 2000 – March 2017

See Research Inventories: Rationale and Methods for more information on the development of this inventory of research.

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