Curriculum Materials Module for Secondary Science Methods

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Overview of the Module

Many student-teachers think that a teacher's job is to cover the material presented in a textbook. Hopefully, after this module is enacted, they will have realized that teachers should not "teach" a textbook; they should craft their own enacted curriculum by adapting and modifying existing material from numerous sources so that they support their students needs in achieving pre-specified learning goals that are based on district, state and national standards.

This module is intended to assist instructors of secondary science methods courses in introducing student-teachers to:

A. The importance of curriculum materials in shaping classroom activities and supporting student learning.
B. The Project 2061 criteria as measures of curriculum quality.
C. Considerations in selecting, adapting, and enacting curriculum materials.

The module provides student-teachers opportunities to use the Project 2061 criteria in evaluating and modifying existing materials.

The module addresses 6 of the 22 criteria developed by Project 2061. The 6 criteria addressed in this unit are:

Category I, Criterion B	- Conveying Lesson/Activity Purpose
Category II, Criterion D	- Addressing Students' Ideas
Category III, Criteria A	- Providing a Variety of Relevant Phenomena
Category IV, Criterion C	- Representing Ideas Effectively
Category V, Criterion A	- Encouraging Students to Explain their Ideas
Category VI, Criterion B	- Probing Student Understanding

The module is intended to be used by the course instructor as a supplement to existing course material.

The design of the module assumes that the student-teachers are in field placements and have access to:

A. *Chemistry That Applies* by Michigan Science Education Resources Project. A PDF of Cluster 3 from the unit can be downloaded if the full unit is not available.
B. Teacher journals such as *The Science Teacher*, *Science Scope*, and *The Physics Teacher*.
C. Science units taught in the field placement classrooms.

It also assumes that the student-teachers have already learned about the importance of naive conceptions, formative assessment, representations, contextualization, and cooperative group work in learning.

The module includes approximately 3 hours of instruction and 12-15 hours of homework.

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Driving Question

The following question is intended to frame the activities in this module for pre-service teachers: “What do I need to know in order to provide my pupils with curriculum materials that support the construction of deep scientific understanding?” It may help the student-teachers understand the importance of the concepts and skills that will be learned during the module’s enactment.

Model response to the driving question:

I need to know three main things:

A. How to identify which are the central learning goals that need to be addressed.

B. How to analyze curriculum materials in order to determine their strengths and weaknesses in supporting pupils as they construct an understanding of pre-specified learning goals.

C. How to modify and enhance existing curriculum materials in order to improve the support they provide in learning pre-specified learning goals.

Learning Goals & Performances

1. Pre-specified learning goals are an important factor to consider when selecting, modifying, and designing the enacted curriculum.
    a. Student-teachers will identify and analyze the central learning goals for specific science topics and grade levels.

2. Selecting, modifying, and designing the enacted curriculum are an important part of teaching.
    a. Student-teachers will analyze existing curriculum materials using Project 2061's curriculum analysis criteria.
    b. Student-teachers will modify and combine existing curricular materials in order to enhance the support they provide in meeting pre-specified learning goals.

Pre-assessments

There are 2 pre-assessments that can be done at any stage during a methods course before the module is enacted. They are described in further detail in the Activity Sequence and Description section. Their purpose is not to inform implementation of the module but to allow the instructor and the student-teachers to identify and assess changes to their thinking about science teaching that may follow the enactment of this module. They are:

1. A concept map of science teaching that describes the various activities in which science teachers engage and the ways in which these various activities are related to each other and to the ultimate purpose of learning science in schools.
2. A list of the things teachers need to consider as they prepare for a series of lessons on topic X.

Activity Sequence and Description

Activities 1-8 should be carried out one after the other without any breaks in between.

Activity 1 is homework (a pre-assessment task and introductory reading) and should be done by the student-teachers immediately before the first lesson in the methods course that will be dedicated to the module.

Activities 2-4 take about 60 minutes of classroom time. They look at the importance of curriculum materials, learning goals, and backwards design.

Activity 5 is homework that should be done after activity 4 but before activity 6. It looks at some of the problems plaguing the typical textbooks found on the market. If each session of the methods course lasts more than 60 minutes, you will be able to do more than just activities 2-4 in the first session dedicated to the module; this extra time should be used at your discretion for other activities not specified by the module, not for activity 6 since it should enacted only after activity 5 is completed at home.

Activities 6-7 should be carried out in the second session dedicated to the module. The present Project 2061's method for analyzing curriculum materials and provide the student-teachers with opportunities to gain experience applying the method. No more than 2 hours should be spent on these activities.

Activity 8 is homework and should be completed immediately after activity 7. In it the student-teachers finish whatever remains undone from activity 7.

Activity 9 is an optional activity in which the student-teachers analyze, modify, and enact an activity from a professional journal. It combines homework and classroom presentation by the student-teachers. This assignment can be

presented to the student-teachers immediately after giving back graded assignment 8 to them. The presentations can be spread over the remaining sessions of the methods course, spending on them about 15 minutes per session.

Activities 10-11 can be done immediately after returning graded activity 8, after or during activity 9. They are both homework assignments and do not require any classroom time. They require the student-teachers to analyze and modify a unit from the textbook used in their placement classrooms. Activity 11 can be combined with other requirements, such as crafting lesson plans, or enacting a lesson, videotaping it and analyzing the recording, to become a final project.

1. **Homework: Introductory Reading and Pre-assessment**

Give the student-teachers a written description of this homework assignment:

a. The student-teachers read at home *Curriculum Materials, Teacher Talk and Student Learning*, an article by K.J. Roth, C.W. Anderson, and E.L. Smith. They should prepare for a discussion of the paper at the following lesson.

b. The student-teachers prepare two documents and submit them at the following lesson. Both are briefly described in the pre-assessment section. These two documents should not be scored; you should make only general comments, such as: "I see little reference to the selection and adaptation of curriculum materials. Was this forgotten or left out on purpose?" "Just about everything in your map is about teaching. Where does learning come in?" "How do you choose which topics to emphasize and which to gloss over or skip altogether?" "Every type of assessment you mention is summative. Do you think formative assessment can be beneficial?" Do you think it is important to consider what children typically think about a given topic before you teach it?" Besides helping you know what your student-teachers think about teaching, these documents will be useful at the module's end when the student-teachers prepare the same two documents again and compare them with the original ones to see where their thinking has changed.

2. **Discussion: Why are Curriculum Materials Important? (**20 min)

The reading in Activity 1 looks at the relevance of conceptual change to science learning, how classroom talk can foster or ignore conceptual change, and how different curriculum materials can support or neglect classroom talk that can lead to conceptual change. The discussion with the student-teachers should focus on the relation between the curriculum materials that were used, types of classroom talk that they fostered, and the type of learning that was supported by the different types of classroom talk. At the end of the discussion the student-teachers should realize that good materials are requisite components of

establishing effective contexts for learning and that materials can potentially guide and structure class discussions that promote opportunities for students to learn; therefore, teachers' choices of curriculum materials may have an acute impact on their students' learning.

3. **Discussion: Backwards Design** (20 min)

The goal of this discussion is for the student-teachers to recognize that planned activities are usually much more efficient and effective if their desired outcome is known and explicitly articulated in advance. Thus, if we know in advance exactly what we want pupils to learn in a lesson or string of lessons, there is greater chance that what we will plan to do in these lessons will actually lead to this learning than if we did not have pre-specified learning goals.

To emphasize the importance of design goals and the planning that leads to them, present two analogies:

a. You get in your car in Washington DC and start driving. What is the chance that you will get to 200 Canal St. in New Orleans if you don't plan your route in advance? How much of a chance is there that you will be able to plan an efficient driving route if you didn't know in advance that you wanted to arrive at 200 Canal St. in New Orleans?

b. An auto designer is given the task of designing a water pump for a new car. What are the things the designer needs to know before going to the drawing board? (For example - how much water does the pump have to supply?) Without this knowledge the designer has no way of knowing if what s/he designs will be useful.

4. **Analysis: Learning Goals and Learning Performances** (20 min)

Analyze what the NSES and the BENCHMARKS have to say about a specific topic, for instance, about what middle school students need to know about the structure of matter. Compare the two documents to find where they are similar and where they differ.

Present an example of breaking down a BENCHMARK into learning goals; emphasize what are some of the kinds of issues that may arise while trying to articulate the learning goals. Give the student-teachers a copy of the presentation. Use the BENCHMARK "All matter is made up of atoms, which are far too small to see directly through a microscope. The atoms of any element are alike but are different from atoms of other elements. Atoms may stick together in well-defined molecules or may be packed together in large arrays. Different arrangements of atoms into groups compose all substances."

The result of analyzing the benchmark and constructing a series of learning goals from it is not unique – there are many possible end results. Different people will deconstruct the benchmark differently. What is important is not the end result but

the process; the fine-grain analysis helps identify many of the issues that will need to be attended to while teaching.

Explain that learning goals are statements of abstract ideas on which there is widespread agreement in the scientific community.

How are we to know that someone knows and understands the implications of a learning goal? For knowledge to be recognized by others it needs to be externalized. This means that pupils must apply their knowledge of learning goals in ways that will allow us to recognize whether they understand the learning goals or not. There are many ways to apply knowledge: one can explain, describe, analyze, predict, synthesize, critique, etc. Any combination of one of these actions with a learning goal is called a "learning performance." Thus, for every learning goal there are multiple learning performances. It is important to clarify this distinction.

5. **Homework: What's Wrong with Existing Curriculum Materials?**

Give the student-teachers a copy of this homework assignment and either a full copy of *Chemistry That Applies* or just a copy of Cluster 3 from the unit:

a. The student-teachers read at home a number of pages from Project 2061's website:

   http://www.project2061.org/about/press/pr990928.htm

   http://www.project2061.org/tools/textbook/mgsci/about.htm

   http://www.project2061.org/tools/textbook/mgsci/analysis.htm

   http://www.project2061.org/tools/textbook/mgsci/mgbooks.htm

   They should consider how they as teachers would act following this critique, and how they thought the textbook being used in their placement classrooms (if not on the list of evaluated textbooks) would measure up.

b. The student-teachers read Cluster 3 from *Chemistry That Applies* in preparation for its analysis in the following lesson. Remind them to bring the unit to the following lesson.

6. **Presentation: Project 2061's Curriculum Analysis Method**

Explain that the purpose of today's lesson is to learn about and gain experience in applying the curriculum analysis method employed by Project 2061 in the article read at home. This knowledge and skill will be needed by the student-teachers for the completion of activities 8-11 in the module, and in order to make reasonable decision regarding the curriculum materials they will use in their practice. The curriculum to be analyzed is Cluster 3 from *Chemistry That Applies*, a middle-school unit on the structure of matter. This Cluster was to have been read by the student-teachers at home before this lesson.

a. Pass out the following documents: Presentation handout, Overview of Curriculum Analysis Method, Curriculum Analysis Criteria, Student Reader, List of Sightings, and Criteria Worksheets.

b. This activity is structured by using a Powerpoint presentation. Start by having everyone look at the Curriculum Analysis Criteria. There are altogether 7 categories and 22 criteria; we will focus on 6 criteria, each one belonging to a different category. With the class, read the descriptions of any two criteria. Emphasize that each criterion looks at a different aspect of learning that needs to be considered by the curriculum materials. Ideally, a textbook with its teacher guide and accompanying materials should meet the requirements of all the criteria. In practice none do, so it becomes the teacher's job to decide what is missing and how modify or enhance the materials so nothing will be missing. We have seen in the first assignment what may happen when curriculum materials do not consider certain aspects of learning. Analysis and modification of curriculum materials should help the teacher make sure that the pupils will get the best support possible from the curriculum materials.

c. Explain that the Overview of Curriculum Analysis Method is just that. Read through the first 3 sections of the overview. Explain that you are going to demonstrate the method by using criterion IIIA to see whether Cluster 3 provides the pupils sufficient support to construct an understanding of one Learning Goal. Introduce the LG (remind the student-teachers that it was derived from a Benchmark analyzed earlier in the course) and read through Criterion IIIA and its indicators in the Student Reader. Discuss what is meant by "relevant phenomena" and why they are important to consider. Continue through the presentation, discussing each sighting and the indicators it meets.

7. **Practice: Analyze Cluster 3 of *Chemistry That Applies* in Small Groups**

Working in groups of four, have the student-teachers continue the analysis of Cluster 3 using the remaining 5 selected criteria. Walk around the classroom as they work, listening in on their discussions, answering their questions and probing them where necessary.

There should not be enough time to complete going over all 5 remaining criteria. The student-teachers should finish whatever remains undone at home and submit a written summary the following lesson.

8. **Homework: Finish Analysis of Cluster 3 from *Chemistry That Applies***

Give the student-teachers a copy of this homework assignment and let them take home either a full copy of *Chemistry That Applies* or just a copy of Cluster 3 from the unit:

Working in pairs, the student-teachers complete whatever remains unfinished from the classroom analysis of Cluster 3 from *Chemistry That Applies*. Each pair should prepare a summary of their analysis and submit it the following lesson together with the details of the analysis. They should note who their classroom partners were and what part of the analysis they completed as a pair at home.

Remind them to return the unit at the following lesson.

Grade the submitted assignments with a rubric and return them to the pre-service teachers. The purpose of grading this assignment is not to see whether or not the student-teachers made the "right" analysis, but to see how thoughtful and thorough they were in making their analyses. Remember that the rubric and this assignment consider the support Cluster 3 gives to the learning of a particular learning goal. The same Cluster may fair completely differently when analyzed through the perspective of a different learning goal.

You may decide to give the student-teachers a copy of the rubric when returning this assignment and request them to compare their analysis with that described in the rubric.

9. **(Optional) - Homework: Analyze and Modify an Activity from a Professional Journal; Classroom: Peer-Teach the Modified Activity**

Give the student-teachers a copy of this homework assignment.

Working in pairs and using the Project 2061 curriculum analysis method, the student-teachers select, analyze, and make improvements to an activity from a professional journal. They then prepare a lesson plan based on the improved activity. Possible journals to use are *The Science Teacher*, *Science Scope*, *The Biology Teacher*, *Chemical Education*, and *The Physics Teacher*. Each pair should select an article that interests them and that describes an activity that could be used in their placement classrooms.

After submitting their analysis and lesson plan, each pair gets 10 minutes to present a concise version of the improved activity to their peers (peer-teach). On the lesson before each peer-teaching session student-teacher pairs should give each member of the class a copy of the original, unmodified teacher journal article to read. Thus the class will be expecting one thing but will see something different. After the presentation another 5-10 minutes should be spent having the class give their feedback to the presenters. The feedback should focus on the changes made between the original version of the activity and the enacted version.

The first part of this assignment (activity analysis, modification, and preparation of a lesson plan) can be done without doing the second part of the assignment (peer-teaching).

This activity can be spread over the remaining course time.

10. **Homework: Analysis of a Textbook Section**

Give the student-teachers a copy of this homework assignment.

Using the Project 2061 curriculum analysis method and the same forms used earlier in the module (List of Sightings, and Criteria Worksheets), the student-teachers select and analyze a section from the textbook used in their placements classrooms. This assignment should be done in pairs if there are 2 student-teachers to each placement classroom; if not it should be done individually. The section should cover up to 10 days of instructional time. If the student-teachers are scheduled to teach a few lessons, they should preferably analyze the section that includes these lessons.

This assignment should be a precursor to the final assignment which should include the preparation of lesson plans based on a modified and improved version of the analyzed section from the textbook.

11. **Homework: Modification and Improvement of a Textbook Section**

Give the student-teachers a copy of this homework assignment.

Based on the finding of their analysis, the student-teachers should modify and improve a section from the textbook used in their placements classrooms. This assignment should be done in pairs if there are 2 student-teachers to each placement classroom; if not it should be done individually.

This assignment should be part of the final assignment which should include the preparation of lesson plans based on this improved version of the analyzed section from the textbook.

12. **Post-Instructional Assessment**

Give the student-teachers a copy of this homework assignment.

a. The student-teachers prepare and submit two documents, identical to those submitted as a pre-assessment. These two documents should not be scored; you should make only general comments similar to those mentioned in assignment #1.

b. The student-teachers should complete a questionnaire during the final lesson. This questionnaire should inform you what the

student-teachers thought of the module; it may also help you revise and improve the module.