

APPENDIX 6

Guidelines for the Development of Research-Based Curriculum

APPENDIX 6

Note: This appendix is not for quoting as it is being considered for publication

Considerations for Designing Instruction For Meaningful Understanding

Teaching → Learning

A. Design a Unit Framework

Organize your lessons into a meaningful framework that aims to build bigger ideas over time. Sequence of lessons and the connections between them are important. Before designing the individual lessons, plan a "storyline". Develop your "plot" so that the ideas unfold over time as the "story" develops. The ideas you develop should be aligned with clear, explicit learning goals. You may want to follow an instructional model such as the Learning Cycle or Conceptual Change Model.

B. Identify Prior Knowledge

Before designing a lesson, or even the unit, it is important to find out what your students already know about the topic. This can be done via whole class discussion, by eliciting ideas from students and organizing them. Solid starting points, gaps in knowledge, disagreements, and alternative conceptions can be identified in this way. Various diagnostic assessment strategies can also be used to identify individual ideas. You should also become familiar with what research says about how students think about and learn certain ideas in science. Many students, regardless of where they come from, hold similar ideas and this information helps you plan effective instruction. Chapter 15 in *Benchmarks*

C. Design Effective Lessons, Activities, and Tasks

Lessons, activities, and tasks are the "heart" of instruction. Each lesson, activity or task is selected to illustrate an important idea. This important idea should be aligned to a learning goal such as a performance indicator from the *Maine Learning Results* or a district or national benchmark, or lead to understanding of a learning goal. It should be developmentally appropriate for the targeted grade level. The purpose of the lesson, activity, or task should be very clear to your students. It helps to provide the learning goal to students. Purposeful repetition can be built into lessons by providing multiple experiences in different ways. Another consideration is to refrain from an emphasis on terms. Terms must be linked to ideas. Whenever possible, try to introduce ideas before bringing in terms.

is a useful resource

D. Frame the Lessons

Begin each lesson by asking students to reflect on and/or summarize what went on before and what was learned. Use their responses to draw links that lead students from the previous lesson(s) to the current one. If you can't draw links, this often means your unit is just a collection of activities. You should also be sure your students understand the purpose of every activity or task. If someone walked in to your classroom and asked your students "What are you doing and why?" they should be able to answer that.

E. Encourage Group Work

Working in small groups involves students in collaboration and dialogue. They **form** and express their ideas to one another, listen to one another, and come up with a common agreement on the ideas. They teach to and learn from each other in this process. They also learn the importance of real scientific talk/debate in coming to understand new ideas.

F. First Hand and Relevant Experiences with Ideas

Each lesson should involve students in a first hand, real experience whenever possible. Students should actively (as opposed to passive which usually involves watching a teacher demonstration) observe a phenomenon or event. Through real experiences, students have a concrete illustration of the scientific idea being studied. Real experiences also engage students and draw them into the problem, The phenomenon provides a context in which the scientific ideas make sense. Sometimes it is appropriate to design a "vicarious" experience such as using technology to simulate an event which could not be observable in the classroom. Be sure the experience is explicitly ties to the learning goals.

G. Design Embedded Assessments

Insert questions throughout a lesson to prompt students to focus on key ideas and think about deeper levels of interpretation. Questions can be for class discussion or individual prompts used for formative assessment. Questions should be designed to probe for student thinking and not just factual recall. You should use each phase of the lesson to assess students' progress, identify problems in understanding, and alter instruction as needed. Throughout instruction, you should monitor groups, listen in on conversations, review journal comments, use "snapshot" tasks, and ask probing questions. This formative assessment can be used to provide feedback to students as well as inform you of the effectiveness of the instruction.

H. Time for Sense-Making

At the end of a lesson or activity, discuss ideas and learning. This allows teacher and students to assess -and discuss the accuracy and meaning of their experiences. This is particularly important when students are doing inquiry-type investigations. When students' observations disagree with their expectations, they have a strong tendency to conclude that "I did the experiment wrong." That is, they hang onto their ideas and dismiss their observations. However, when students see that the whole class got similar results, they tend to be more willing to reconsider their ideas. Sometimes some groups of students do not obtain similar results. The class discussion helps them identify the reasons.

I. Make Links to Everyday Experiences.

Throughout the lesson and especially during sense-making discussions, students should be prompted to bring up examples from everyday life, as well as to apply their knowledge in interpreting everyday situations brought up by the teacher.

J. Reflection

One good rule of thumb is that students spend at least as much time making sense of a lesson as they do in performing the activity. Students should be asked to reflect back on the purpose of the lesson/activity, their initial ideas, and how their ideas have changed and why. Several strategies including journals, writing prompts, small group discussions, and concept maps can be used for reflection.

K. Post Knowledge/Interpretation

When you plan instruction around student ideas, lessons place a lot of emphasis on eliciting prior and present understanding. But, it is equally important to determine whether or not students understand the ideas after instruction and “synthesize” their learning experiences, applying them in a new way. What have students learned from the entire unit or sequence of lessons? The conclusion may seem obvious to the teacher, but do the students see it? How many still believe their “misconceptions”? Carefully designed summative assessments will help you to determine whether students have achieved the learning outcomes of the unit. At the end of a sequence of lessons and/or unit, devise assessments that reflect the kinds of activities and skills used in the lesson, and that focus on deep understanding of the “big idea” (learning goals such as a performance indicator) rather than small details. Students should also have an opportunity at the end of a unit to reflect on their progress- comparing their initial understanding with their current level of understanding.

L. Creating a Conducive Learning Environment

Throughout your instruction, remember that when students are treated with respect, as thoughtful young adults, that is how they behave. Creating an environment conducive to thoughtful discussions and active learning is often challenging for teachers who have learned the art of ‘controlling’ their classes. Among the strategies of successful teachers are: talking softly, talking in an authentic and thoughtful way, listening carefully to students’ ideas and responding with interest, encouraging students to respect one another’s ideas, getting to the same physical level as the students talk to them, and giving interesting and challenging tasks. Whenever you can, show your students that you are using their ideas to design their learning experiences. When students see that the instruction is centered on them and not a textbook or some other model, they are more willing to contribute their ideas. They also appreciate and benefit from a class reflection at the end of a unit to see how they progressed through the learning which helps them to recognize the value of your excellent instruction!

Instructional Design Rubrics
Considerations for Designing Instruction for Meaningful Understanding

Qtr Qtr Qtr **Part A: Designing a Unit Framework**

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Storyline	There is no evident storyline. Unit is mostly a collection of activities	Most Lessons are organized into a meaningful framework. Lessons are designed with a sequence in mind and connections are made between most lessons. There is an attempt to tie ideas together at the end.	Lessons are organized into a meaningful framework that builds bigger ideas over time. Careful attention is paid to scaffolding and there is a clear sequence of lessons or clusters of lessons with connections between them clearly evident. More advanced or peripheral ideas do not interrupt the flow of the unit. There is a clear attempt to tie ideas together in the end.
Learning Goals	Learning goals are unclear or missing for the unit or unit clusters. It is not evident that <i>Learning Results</i> or national standards were used to guide development of the unit. There is weak or no alignment between learning goals and the purpose of the unit or unit clusters.	The learning goals are clear and explicitly stated for the unit or unit clusters. Learning goals are derived from <i>Learning Results</i> and may also include national standards. There is alignment between the learning goals and the purpose of the unit or unit clusters	The learning goals are clear, specific, and explicitly stated for the unit or unit clusters. They reflect a thoughtful and deliberate study of the standards (<i>Learning Results</i> and national standards). Prerequisite ideas are considered as well as ideas at the next level of sophistication. There is a high degree of alignment between the learning goals and <u>the purpose of</u> the unit or unit clusters.
Use of Instructional Model	No instructional model was used	An instructional model was used appropriately in designing the framework	A research validated instructional model was used appropriately and consistently in designing the framework's conceptual flow of ideas.
Content and Process	unit emphasizes content over process or vice versa.	Unit targets both process and content learning goals with a balance throughout most of the unit.	Unit clearly targets both process and content learning goals, with an appropriate balance between the two. Process is not taught independent of content.

Part B: Identifying Prior Knowledge

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Use of the Research Base (Note: This consideration does not apply in areas where there is no research)	The research base was not considered in unit development.	Some research was used to identify common alternative conceptions and difficulties and this information was used in designing parts of the unit.	The research base (<i>Benchmarks</i> Chapter 15, Rosalind Driver books, publications, etc) was studied to identify common alternative conceptions and difficulties and this information was used extensively in designing the unit to address student ideas.
Diagnostic Assessment	Few or no diagnostic assessment strategies are used to find out what students know about the topic.	Various diagnostic assessment strategies are used to find out what students know about the unit topic(s). This information is used to inform, alter, or refine the design of the unit.	Various individual and class diagnostic assessment strategies are used to find out what students know both before the unit is designed and during its implementation. This information is used to inform, alter, and refine the design of the unit.

Part C: Effective Lessons, Activities, and Tasks

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Accuracy	The scientific accuracy of the content of the lessons, activities, and tasks has not been reviewed and checked. The developer assumes, based on his/her knowledge, that the content is correct	The scientific accuracy of the content of the lessons, activities, and tasks has been carefully reviewed and checked, including the potential to perpetuate misconceptions.	The scientific accuracy of the content of the lessons, activities, and tasks has been thoroughly reviewed and checked, by the developer and outside reviewers, including the potential to perpetuate misconceptions
Alignment	There is little or no indication of alignment of learning goals to central ideas in most lessons, activities, and tasks.	Central ideas or skills in most lessons, activities, or tasks are identified and aligned to a learning goal. The lesson, activity, or task addresses the substance of the <i>Learning Result</i> or national standard.	Central ideas or skills in the lessons, activities, or tasks are identified and highly aligned to a specific learning goal. The lesson, activity, or task clearly addresses the substance of the <i>Learning Result</i> or national standard and treats the ideas or skills explicitly.

Part C (Continued): Effective Lessons, Activities, and Tasks

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Developmental Appropriateness	Some lessons are not developmentally appropriate and the level of sophistication often exceeds or is below the targeted grade level.	Most lessons, activities, and tasks -are developmentally appropriate for the intended grade level. Sophistication level is generally not too high or not too low for most lessons, activities, and tasks.	All lessons, activities, and tasks are developmentally appropriate for the intended grade level. Careful and deliberate attention was given to the sophistication of the ideas.
Purpose	Most lessons, activities, and tasks do not have an identified, explicit purpose	The purpose of most lessons, activities, and tasks is identified and made explicit to students.	The purpose of each lesson, activity, and task is identified and made explicit to students
Promote Student Thinking	Most lessons, activities, and tasks do not--- encourage students to think and/or reason. Tasks and/or questions are not always tied to the experiences in the lessons or activities.	Throughout most lessons, activities, and tasks students are encouraged to think/reason. Relevant, specific, framed, and scaffolded tasks/questions are tied to the experiences in the lessons and activities	Throughout the lessons, activities, and tasks students are explicitly encouraged to think/reason (examples: express, clarify, justify, and/or represent ideas). Tasks and questions are highly specific, relevant, well- framed, carefully scaffolded, and explicitly tied to the experiences in the lessons and activities.
Developing and Using Scientific Ideas	Where applicable, most lessons, activities, and tasks do not encourage students to use evidence to support their ideas. Representations of ideas may be inaccurate or confusing. Where appropriate, the lessons, activities, and tasks fail to make connections among ideas.	Where applicable, lessons, activities, and tasks encourage students to use evidence to support their ideas. Representations of ideas are accurate and comprehensible. Where appropriate, connections are made among ideas.	Where applicable, lessons, activities, and tasks strongly encourage students to use evidence to support their ideas. Representations of ideas are highly accurate and easily comprehensible to students. Where appropriate, strong connections are made among ideas.
Multiple and Varied Resources	Few or no additional resources are used to supplement and enhance the lessons, activities, and tasks.	A variety of resources such as internet sites, trade books and supplementary readings, software, posters and graphics, hands-on materials and objects, videos, field trips, guest speakers, etc. are used to supplement and enhance the lessons, activities, and tasks.	A rich collection of multiple and varied resources such as Internet sites, trade books and supplementary readings, software, posters and graphics, hands-on materials and objects, videos, field trips, guest speakers, etc. are used to supplement and enhance the lessons, activities, and tasks
Use of Scientific Terms	Terms are often introduced before ideas. Unit is "terminology dense" and many terms used are not needed to understand ideas.	Ideas are usually introduced or experienced before terms. Terms are only used when necessary and are linked to ideas.	Ideas are introduced or experienced before terms. Terms are only used when necessary and are explicitly linked to ideas.

Part D: Framing Lessons

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Drawing Linkages	There is no or little reflection or summation at the beginning of lessons. Links can not be drawn which indicate that lessons are mostly collections of activities.	Some lessons begin by having students reflect on or summarize what went on before and what was learned. Responses are sometimes used to draw links to lead students from the previous lesson to the current one.	Lessons begin by having students reflect on or summarize what went on before and what was learned. Responses are used to draw links to lead students from the previous lesson to the current one.
Understanding Purposes	No or little attempt is made to ensure students <u>understand</u> the purpose of each activity or task. If someone walked into your classroom and asked students what they were doing and why, many students would not be able to answer the question with the intended purpose.	Some attempt is made to ensure that students <u>understand</u> the purpose of each activity or task. If someone walked into your classroom and asked students what they were doing and why, all students would be able to answer the question with the intended purpose.	An obvious attempt is made to ensure that students <u>understand</u> the purpose of each activity or task. . If someone walked into your classroom and asked students what they were doing and why, all students would be able to answer the question with the intended purpose.

Part E: Encouraging Group Work

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Small Groups	There are few or no opportunities for small group work. In instances where there is small group work individuals have specific roles but the group does not encourage collaboration and dialogue	Opportunities exist for small group work involving collaboration and dialogue. Students are encouraged to form their own ideas first and express their ideas to one another and come up with common agreement.	Multiple opportunities exist for small group work involving collaboration and dialogue. Students are encouraged to form their own ideas first and express their ideas to one another and come up with common agreement. The importance of real scientific talk/debate in coming to understand new ideas is emphasized explicitly.

Part F: First Hand and Relevant Experiences with Ideas

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
First Hand and Vicarious Experiences	Very few or no first hand experiences are provided. In some cases, vicarious experiences are provided when it is feasible and practical to experience a phenomenon firsthand. Some firsthand and /or experiences lack any connection to a learning goal.	When appropriate and practical, there are meaningful and engaging firsthand opportunities to experience the phenomenon or skill. These experiences are tied to a learning goal. Opportunities that are not firsthand (such as vicariously experiencing a phenomenon through a video or software simulation) are relevant, engaging, and tied to a learning goal.	When appropriate and practical, there are several rich, varied, meaningful, and engaging firsthand opportunities to experience the phenomenon or skill. These experiences are explicitly tied to a learning goal. Opportunities that are not firsthand (such as vicariously experiencing a phenomenon through a video or software simulation) are relevant highly engaging, tied explicitly to a learning goal, and are used when a real firsthand opportunity is not practical or for reinforcement.

Demonstrations	Demonstrations, when use , may not be appropriate or are used passively	Demonstrations, when appropriately used, are relevant and include some interactivity	Demonstrations, when appropriately used, are relevant and highly interactive.
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Part G: Embedded Formative Assessments

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Strategies	Few or no strategies are used throughout the unit to elicit ideas, check for understanding, provide feedback to students on their learning and inform instruction. Emphasis may be on one purpose.	Several strategies are used throughout the unit to elicit ideas, check for understanding, Provide feedback to students on their learning, and information instruction.	Multiple and diverse strategies are used continuously throughout the unit to elicit ideas, check for understanding, provide. feedback to students on their learning, and inform instruction.
Questioning	Few or no questions are inserted in lessons. Questions that are inserted may be designed primarily for factual recall or low level interpretation.	Questions are inserted in a lesson to prompt -students to focus on key ideas. Questions are used for class discussion as well as individual prompts used for formative assessment. Questions are designed to probe for student thinking.	Questions are routinely inserted throughout a lesson to prompt students to focus on key ideas and think about deeper levels of interpretation. Questions are used for class discussion as well as individual prompts used for formative assessment. Questions are designed to probe deeply for student thinking.

Part G (Continued): Embedded Formative Assessments

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Continuous Monitoring	Continuous assessment is seldom or not used for monitoring purposes.	Several times during the unit or lesson, assessments are used to gauge students' progress in meeting learning goals and identify problems in understanding. Assessment is frequent for monitoring purposes. Instruction is altered as needed based on this information.	Each phase of the unit and/or lesson is used to assess students' progress in meeting and learning goals and identify problems in understanding. Assessment is continuous for monitoring purposes. Instruction altered as needed based on this information.
Feedback	Feedback is seldom or not given. Feedback may be vague, non-specific, and not very useful to students in terms of helping them to progress toward meeting learning goals.	Useful feedback is given frequently to students regarding their progress in meeting learning goals.	Useful feedback is given continuously to students regarding their progress in meeting learning goals.

Part H: Time for Sense-Making

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Making Sense of Experiences	Time is seldom or not included at the end of a lesson or activity to discuss ideas and learnings.	Time is usually included at the end if a lesson or activity to discuss ideas and learnings.	Time is included at the end if a lesson or activity to discuss ideas and learnings. Teacher and students discuss the accuracy and meaning of their experiences and revise ideas as needed.

Part I: Making Links to Everyday Experiences

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Everyday Linkages	Few or no real life examples that demonstrate the application of an idea or skill have been identified and used.	Several real life examples that demonstrate the application of an idea or skill have been identified and used.	Deliberate consideration is given to identifying and using real life examples that demonstrate the application of an idea or skill. Students are prompted to bring up examples as well as to apply their knowledge in interpreting everyday situations brought up by their teacher.

Part J: Reflection

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Time for Reflection	There is insufficient or no time built in for students to reflect on the lessons or activities.	Most lessons and activities leave time built in for reflection.	Students spend almost as much time making sense of an activity as they do in performing the activity. Every lesson includes time for students to reflect back on the purpose of the lesson/activity, their initial ideas, how their ideas have changed, and why.
Strategies for Reflection	Reflection is either missing or consists of primarily one strategy used throughout the unit.	More than one strategy is used for reflection.	Multiple and varied strategies are used for reflection such as journals, writing prompts, small group discussions, self-assessments, "L" in KWL, last word, concept maps, etc.

Part K: Post Knowledge/ Interpretation

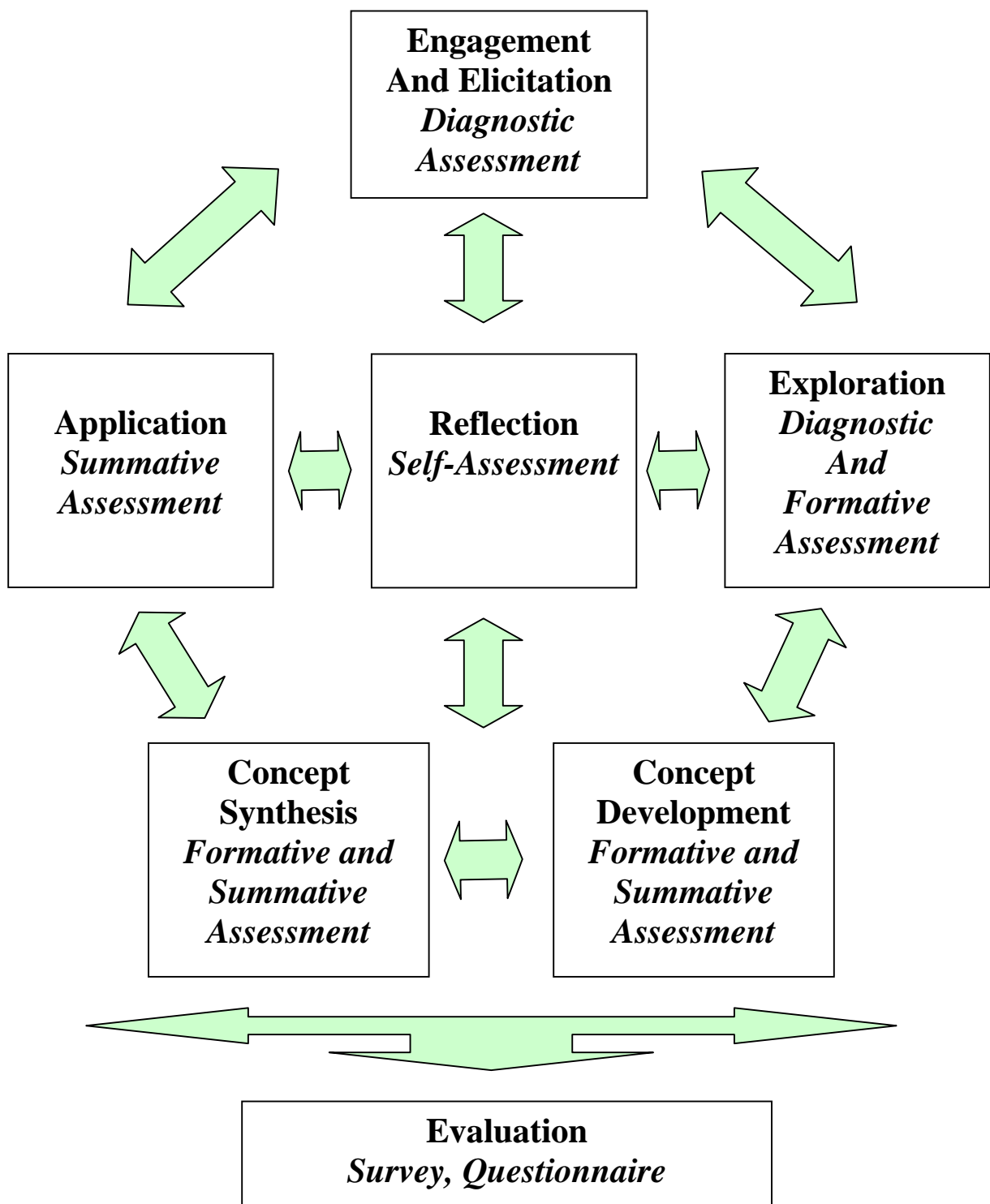
Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Summative Assessment	Assessment items and tasks, when used, may not be aligned and/or are not effective in assessing understanding of the learning goals. Assessments may be a repeat of previous tasks or items experienced in the lessons and activities. Assessments may not reflect the kinds of thinking and skills provided in the learning opportunities and may focus more on small details, facts, and/or recall. Assessments may not validly and/or reliably indicate the level of proficiency achieved by the student.	A variety of aligned and comprehensible assessment items and tasks are used to determine whether or not students achieve learning goals after instruction in both clusters of lessons and the end of the unit. Assessments include opportunities to synthesize ideas and apply understanding in a new context. Assessments reflect the kinds of thinking and skills used in the lessons/activities and focus on understanding rather than on small details, facts, and recall. Assessments validly and reliably indicate the level of proficiency achieved by the student	Multiple and varied well-aligned, comprehensible, and carefully designed assessment items and tasks are used to determine whether or not students achieve learning goals after instruction in both clusters of lessons and the end of the unit. Assessments include rich opportunities to synthesize ideas and apply understanding in a real life, new, and/or novel context. Assessments clearly reflect the kinds of thinking and skills used in the lessons/activities and focus on deep understanding of the central ideas rather than on small details, facts, and recall. Assessments validly and reliably indicate the level of proficiency achieved by the student
Self Assessment	Students have little or no	Students have opportunities at the	Students have

	opportunity to reflect on their progress in achieving learning goals/	end of a cluster of lessons or the end of a unit to reflect on their progress in achieving learning goals.	opportunities at both the end of a cluster of lessons and the end of unit to reflect in their progress in achieving learning goals- comparing their initial knowledge and understandings with their current knowledge and understanding.
Evaluation	Students have little or no opportunity to participate in the evaluation of instruction	Students participate in the evaluation if instruction and provide feedback through questionnaires, surveys, or evaluation forms on the effectiveness of activities, lessons or unit as a whole. Teacher uses this feedback for unit modification	Students participate actively in the evaluation if instruction and provide feedback through questionnaires, surveys, or evaluation forms on the effectiveness of activities, lessons or unit as a whole. Teacher uses this feedback for unit modification

Part L: Creating a Conducive Learning Environment

Consideration	Inadequate Design- Needs Significant Improvement	Adequate Design- May Need Some Modification	Exemplary Design
Respect for Students and Their Ideas	Certain students are treated respectfully. Not everyone feels valued and challenged.	All students are treated respectfully at all times. The classroom environment is one where everyone feels valued and challenged	All students are treated respectfully at all times using successful strategies such as talking softly, talking in authentic and thoughtful ways, listening carefully to their ideas and responding with interest, and encouraging students to respect each others' ideas. An attempt is made to have personal contact with each student in every class. The classroom environment is one where everyone feels valued and challenged.
Student Centered Instruction	Students ideas are seldom or never used to design learning experiences	Students ideas are used to design several f the learning experiences.	Students ideas are frequently solicited and used to design learning experiences and this is made evident to students. Instruction is not centered on the textbook or set in stone lesson plan

A Learning Cycle of Integrated Instruction and Assessment



APPENDIX 7

STUDENT MISCONCEPTIONS RELATED TO ENERGY CONCEPTS
(AS DESCRIBED IN THE AAAS DOCUMENT, *BENCHMARKS FOR SCIENCE LITERACY*)

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STUDENT MISCONCEPTIONS RELATED TO ENERGY CONCEPTS (AS DESCRIBED IN THE AAAS DOCUMENT, *BENCHMARKS FOR SCIENCE LITERACY*)

STUDENT MISCONCEPTIONS RELATED TO ENERGY CONCEPTS (AS DESCRIBED IN THE AAAS DOCUMENT, *BENCHMARKS FOR SCIENCE LITERACY*)

Conceptions of What Energy Is:

- Energy is associated primarily with humans or other living things. Living things need energy to live and be active and non-living things don't need energy.
- Energy is associated only with activities like growing, fitness, exercise, and food.
- Energy is thought of as a causal agent stored in certain objects.
- Objects only have energy if they are moving. An object that does not move has no energy. Potential energy is sometimes confused with the potential to have energy.
- The terms energy and force are used synonymously by some students.
- Energy is synonymous with fuel rather than fuel is a source of energy.
- Energy is thought of as a fluid that flows out of one thing into another
- Energy is thought of as an 'ingredient' that lies dormant in an object until something triggers it, rather than being thought of as continuous.
- Energy is not measurable or quantifiable.

Conservation of Energy Related Ideas:

- Energy is thought of as short-lived by-product or waste product that is generated, active, then disappears.
- Energy is something that gets used up.

Heat and Temperature Related Ideas:

- Heat is a substance that flows from place to place.
- Heat is associated only with hot things.
- Heat is manufactured.
- Temperature is a measure of the amount of heat in an object.

Energy Transfer Related Ideas:

- Transformations involve only one type of energy at a time.
- During conduction heat accumulates in one spot and then overflows to the rest of an object.
- Objects can absorb coldness. Coldness is transferred to a warm object rather than heat being transferred away.
- Heat and cold are transferred at the same time.
- Objects cool down or release heat spontaneously- without being in contact with another object.
- Particulate ideas are not used in explaining heat transfer by conduction or convection.
- Different materials at the same room temperature can be different temperatures- Metals are colder substances than plastic at room temperature.
- Energy changes focus only on forms that have perceivable effects.
- Transformation to heat only happens when the heat can be felt.
- Living processes do not involve heat energy transfer.