Developed for Physically Active Youth

Professional Development Resource Guide

How to Design Curriculum Development and Do Research

John Benoit, Elizabeth DiRuzza, Andrew Fisher, and Daniel Marsh
# Table of Contents

## Introduction

## Curriculum Development
- Backward Design  
  Additional Resources  
- Successive Approximation Model  
  Additional Resources  
- Design Thinking Method  
  Additional Resources  

## Lesson Planning and Curriculum Development Templates
- Backwards Design  
  Template 1  
  Template 1 With Descriptions  
  Template 2  
  Template 2 Example  
  Template 3  
- Successive Approximation Model  
- Design Thinking Method

## General Pedagogy Resources

## Research Methods
- How to Begin Researching  
- Investigating Sources

## Concept Mapping for Skills and Lessons
- Why map out skills to teach?  
- How to use the tool:

## Conclusion
Introduction

Through this guide, instructors will have access to a consolidated set of resources to develop their own lessons to make the robotics program more sustainable. In the case that they want to expand past previously created curricula, they will now have the framework and structure to create these lessons. Furthermore, we also detailed the best practices for researching materials for new curricula and methods to assess it.

The curriculum development methods that we detailed in this document are backward design, successive approximation model, and the design thinking method. Backward design has the instructor think ahead to what objectives they want the students to learn from the lesson, and use that understanding to develop the intermediary steps. The successive approximation model is a model that promotes iterative design of curricula, meaning that material should be constantly revised and adapted even through the delivery of the lesson. The final method detailed is the design thinking method which brings the instructor through the design process of a lesson and is very applicable to STEM lessons. These methods are assessed and ultimately we provide recommendations and templates for each method.

Later, we assigned a list of pedagogy resources that defined a list of teacher recommendations from accredited universities and we described the overall research process an instructor could use to construct new material. We utilized resources from the Worcester Polytechnic Institute library department to give recommendations on how to assess material. Finally, we detailed concept mapping, a technique that instructors can use to connect interrelated topics in a visual way that anyone can interpret. On the website for Physically Active Youth, the concept map was live and interactive, however for the case of the document the topics are shown in a single picture.
DEVELOPED FOR
PHYSICALLY ACTIVE YOUTH

CURRICULUM DEVELOPMENT

Professional Development
Resource Guide
Curriculum Development

Curriculum development is critical to having a successful educational program, ensuring that the goals of the program are transferred to the students. There are many different methods of curriculum development each with their own approach to converting learning objectives into course material. Each of the methods have different strengths and weaknesses.

Through our research we determined that using a combination of two different models allows for the most complete curriculum. The combination of methods that we recommend is Backwards Design and the Successive Approximation Model (SAM). These two methods work very well together as they are able to offset many of each other’s weaknesses and allow the strengths of each method to shine through.

To use them together, backwards design should be used as the framework, giving the curriculum and lessons structure, while SAM acts as the supplemental method used to add a more iterative nature to the process. If instructors feel that SAM is not a model that adds to backwards design in a way that is beneficial to them, we also found that the design thinking method is another strong iterative model.

However, our research indicated that SAM is a stronger method as it is a slightly more iterative and has more potential. The following sections will detail each of the methods, show how they can be integrated into curriculum development and lesson planning, and contain additional resources for additional information on the method.
Backward Design

Backward Design is a model of curriculum development that focuses on in-depth understanding of learning goals.¹ Also known as understanding by design (UbD), it is comprised of three stages (Figure 1): identify desired results, determine acceptable evidence, and plan learning experiences and instruction.² Backward design is set up to promote long term information retention and skill development by determining how students will display mastery of a topic before creating the instructional material.³

![UbD: Stages of Backward Design](image)

*Figure 1: The steps of backwards design⁴*

In the first stage, curriculum designers determine learning goals based on what information is the most important to have a lasting understanding of.⁵ Information should be broken down into three categories, knowledge, skills, and enduring understandings. Knowledge is defined as information students should be familiar with, skills being what students should be able to do, and enduring understanding being the big ideas that students should retain after

---

³ “The Fundamentals of Backward Planning.”  
⁵ Ibib.
completing the curriculum. The second stage is when curriculum developers “determine how [they will] know if students have achieved [the] desired learning results.” Assessments are broken into two types: performance tasks and other evidence. Performance tasks are “...larger assessments that coalesce various concepts and understandings like large projects or papers.” Other evidence includes traditional homework, quizzes, and tests as well as self-assessments. As the curriculum is developed around performance tasks that encompass multiple topics, students are required to use older information to inform new assignments in a way that traditional assessments would not require. The final stage is when lessons and learning activities are planned to address the goals initially identified. This stage is not as structured as it is up to the curriculum developers and educators to determine what instruction and learning activities are required to achieve the initial goals. This stage is where iterative design takes place, allowing curriculum developers to experiment with different techniques.

Every curriculum development method has strengths and weaknesses, and backwards design is not an exception. Some of the strengths of backwards design are:

- It focuses on student learning,
- It tends to lead to more explicit and transparent instruction and objectives,
- Material tends to be more focused and related, and
- It allows for other styles of curriculum development to be used alongside it to accommodate students.

These strengths are some of the driving forces behind why backwards design has been so successful in education. Having materials that are directed towards encouraging learning and understanding is something that many educators and administrators are looking for in a curriculum. Backwards design facilitates this type of material due to its goal-oriented approach. It is a very overarching method with space within each of its stages to work with different

---

6 “The Fundamentals of Backward Planning.”
7 Ibid.
8 Bowen, “Understanding by Design.”
9 Ibid.
10 “The Fundamentals of Backward Planning.”
11 Burnham, “5 Instructional Design Models You Should Know.”
12 Bowen, “Understanding by Design.”
14 Bowen, “Understanding by Design.”
15 Ibid.
methods. This gives educators the ability to combat many of its weaknesses by using methods that are stronger in those areas. While backwards design has a great number of strengths, it is also limited in some ways:

- It is a rather rigid structure without much flexibility for adjustments,\(^1\)
- It is time consuming for educators,\(^2\) and
- It may be impersonal at times.\(^3\)

The biggest drawback of backwards design is how rigid its structure is. However, because we are recommending that it be combined with another more flexible method much of this drawback is mitigated. In places where flexibility is needed, another method can be used instead. The rigidity of backwards design is what makes the method feel impersonal at times, as the design process is focused on how to best teach the goals rather than how to teach each individual student. To counteract this shortcoming, educators may set individual learning objectives for different groups of students within the program. However, this can lead to the third limitation of backwards design, as identifying more learning objectives and deciding how to teach them adds extra material that needs to be planned and edited. This, however, is an issue with many different methods of curriculum design and is more of a result of education's focus on outcomes.

Integrating backwards design into an educator’s curriculum development repertoire will require practice as the method has many nuances. Applying backwards design to a pre-existing curriculum is one way that an educator could practice using the method. From here, the results of the backwards design process could be compared to the results from previous designs to see how it improved the curriculum and what still needs to be worked on in the backwards design process. Additionally, the use of a template for planning both curriculum and lessons may aid in increasing how quickly backwards design is understood, while also guiding instructors through the steps of the process. Templates for both curriculum design and lesson planning are attached to this guide as well as completed examples of each. Additional resources to further the understanding of the methods are linked below and complete offline versions will be attached to the end of the guide.

\(^2\) Ibib.
\(^3\) Heick, Terry. “I’m Not Sure What to Think about Backward Design.” teachthought.com, February 21, 2019.
Additional Resources

This section contains a list of resources on backwards design. These resources were gathered from trusted sources to further explain backwards design and provide additional help while implementing it in the classroom.

1. https://www.cultofpedagogy.com/backward-design-basics/
   One educator experiences with backwards design and how backwards design thinking improved their classroom.

2. https://cft.vanderbilt.edu/guides-sub-pages/understanding-by-design/
   Vanderbilt University’s backwards design page details the history, methods, and implementation of backwards design including a template for using backwards design.

   This is an article about using the backwards design process.

   A short article explaining the backwards design model.

5. https://fctl.ucf.edu/teaching-resources/course-design/backward-design/
   A video detailing backwards design.
Successive Approximation Model

The successive approximation model, SAM, is a curriculum design method that was adopted from technical fields such as computer science. SAM consists of three iterative phases each consisting of several stages. The three phases are preparation, iterative design, and iterative development as seen in Figure 2.

The preparation phase gives stakeholders the opportunity to decide on the goals of the curriculum and how it will be delivered. In this preparation phase the first outlines of the curriculum may even take shape. The next phase is the iterative design phase which is made up of designing, prototyping, and evaluating stages that are repeated in an iterative manner. The designing stage is where concepts from the preparation phase are given more substance and become concrete ideas. In the prototyping stage, the designs are created and tested in a rough unfinished state so that they can be evaluated. This evaluation informs the curriculum designers as to which parts of the design work and which need to be redesigned. Once the design has been evaluated, the designers will begin to do any redesigns that they see necessary, and this process is iterated until the curriculum is ready to go into development.

![Figure 2: The phases of the successive approximations model](image)

The final phase of SAM, the development phase, is a “constant loop of developing, implementing, and evaluating” the curriculum. During this phase it is important that there is

---

21 Allen, “The SAM Model.”
22 Herrholtz, “Rapid Instructional Design With SAM.”
23 Allen, “The SAM Model.”
24 Herrholtz, “Rapid Instructional Design With SAM.”
always a usable section of the curriculum so that instructors and learners can interact with it and give feedback. As SAM was adopted from technical fields, there are additional release stages that come at the end of the development phase. The release stages are in place to give the curriculum developers an opportunity to make final changes to the curriculum if minor issues arise.\(^{25}\) By this point in the model there should not be any major flaws in the curriculum but the feedback in the release phase ensures that the developers did their jobs well.

SAM is another method that has more strengths than weaknesses and its strengths are very effective at covering for the weaknesses of backwards design. Some of the strengths of SAM are:

- It is very flexible and iterative allowing for all options to be explored,\(^{26}\)
- It avoids major reworks after development is completed,\(^{27}\) and
- It leads to clearly defined and well put together course materials.\(^{28}\)

The biggest weakness of backwards design is that it is not flexible and SAM is extremely flexible allowing it to pick up the slack for backwards design in the curriculum development process. Additionally, as backwards design is a less iterative model major reworks are more common, by integrating SAM principles with those of backwards design these major reworks can be avoided. SAM is not perfect however and it does have some limitations:

- It lacks of structure,\(^{29}\)
- It may be rushed at times,\(^{30}\) and
- It is repetitive in nature.\(^{31}\)

SAM does sometimes lack structure as it is a very free flowing method that focuses on generating ideas and testing them. When partnered with backwards design this actually becomes a strength as backwards design provides the structure that allows for flexible idea generation to flourish as it has the defined steps that help curriculum designers stay on topic and focused on

\(^{25}\) Allen, “The SAM Model.”
\(^{27}\) Ibid.
\(^{28}\) Ibid.
\(^{29}\) “The SAM (Successive Approximation Model) Approach to ELearning.”
the learning objectives. Seeing as SAM relies on rapid prototyping it can move very quickly at times. This allows for ideas to be tested quickly, but may lead to team members becoming confused. As a method on its own, SAM has many merits and its strengths far outweigh its limitations; when used with backwards design the strengths of the two methods support one another and allow for both methods to be more effective.

Integrating SAM into an instructor’s curriculum development arsenal is arguably the easiest of any of the methods discussed in this guide. This is because it can be the most easily applied to pre-existing curriculum. As SAM is an iterative process, any curriculum can be reviewed and updated using SAM. By taking an existing curriculum and beginning with either the evaluate or review stages of the process, the SAM process can be applied. SAM is full of tables and guides on how to plan and develop content for courses and these resources are also important to understanding and integrating SAM into the classroom.
Additional Resources

This section contains a list of resources on SAM. These resources were gathered from trusted sources to further explain backwards design and provide additional help while implementing it in the classroom.

   Allen interactions is a website run by the creators of the successive approximation model. This page contains a breakdown of the steps of SAM. For more information on SAM explore the site further.

2. [https://dli.kennesaw.edu/resources/idmodels/sam.php](https://dli.kennesaw.edu/resources/idmodels/sam.php)
   Kennesaw State University’s guide to the successive approximation model.

   A blog post about implementing SAM to create usable training materials.

4. [https://www.findcourses.com/prof-dev/l-d-articles/addie-vs-sam-which-is-better-11516](https://www.findcourses.com/prof-dev/l-d-articles/addie-vs-sam-which-is-better-11516)
   A short post comparing SAM to another curriculum development technique highlighting SAM’s strengths.

   A blog post about using SAM to address the weaknesses of older curriculum development methods.

   An article about how to implement SAM in the classroom.

   A breakdown of the steps of SAM.
Design Thinking Method

The design thinking model of curriculum design focuses on understanding a learner’s needs and developing specific solutions to address those needs. This model is comprised of five stages: empathize, define, ideate, prototype, and test as seen in Figure 3. The first stage, empathize, requires the curriculum developer to “gain an empathic understanding of the problem [they] are trying to solve.” The empathize stage is a research phase when as much information on the problem should be gathered. The second stage, define, is where the core problems are identified to be solved. Throughout this method, it is important to frame information in a human-centric manner as to make the students the most important people in the curriculum.

![Design Thinking: A 5 Stage Process](image)

*Figure 3: The stages of the design thinking model*

The third stage, ideate, is when solutions should be brainstormed using a variety of techniques. This gives many possible ways to address the problem and students will have access to the best methods. Prototyping is when specific solutions are designed and tested, this is a stage where the teaching materials for the curriculum would be made. This is also when feedback would be received from stakeholders as to whether or not the materials being created

---

32 Burnham, “5 Instructional Design Models You Should Know.”
33 Ibid.
35 Ibid.
36 Ibid.
37 Burnham, “5 Instructional Design Models You Should Know.”
successfully teach the curriculum. The final stage is to test, this is where the curriculum is implemented in the classroom and feedback is received from students.

While the design thinking method is a strong method of curriculum design, it has more weaknesses than the previous methods discussed. That being said, design thinking still has many strengths including:

- It is flexible and iterative,
- It encourages taking multiple approaches to the same problem, and
- It is student-focused.

Like SAM, design thinking is created to be an iterative process giving designers the ability to try different things. This gives designers a chance to approach an issue from multiple angles, trying to understand different ways the students may understand concepts. The other upside to design thinking is that it focuses on the students throughout the planning process.

Design thinking is a strong secondary choice because of its flexibility, student-centered focus, and focus on different perspectives. However, design thinking also has additional drawbacks that SAM and design thinking do not. Some of the more glaring drawbacks are:

- It is more complicated to understand,
- There are often challenges integrating it into pre-existing curricula,
- It often becomes limited over time, and
- It can become a lengthy process.

Design thinking is based on more complex psychology than other curriculum development techniques and is harder to grasp. Because of its more complex nature, it is harder to use to update existing curricula, as it is more likely to clash with proven methods that designers are too stubborn to change. Its complexity also often leads to it being more constrained as it is used more as designers attempt to simplify making it a much less iterative and effective

---

39 Burnham, “5 Instructional Design Models You Should Know.”
40 Friis Dam and Siang, “5 Stages in the Design Thinking Process.”
42 Friis Dam and Siang, “5 Stages in the Design Thinking Process.”
44 “Innovate with Design Thinking: Pros and Cons.”
45 Hobcraft, “The Limitations, Criticisms, and New Pathways for Design Thinking- Part One.”
46 “Innovate with Design Thinking: Pros and Cons.”
method. As a result, it can also become a long drawn out process without the same amount of effectiveness as other longer curriculum design methods.

Additional Resources

This section contains a list of resources on the design thinking method. These resources were gathered from trusted sources to further explain backwards design and provide additional help while implementing it in the classroom.

   This is a journal article discussing how to use the design thinking method including extensive research on the methodology, implementation, and outcomes. It includes a “curriculum innovation canvas” to help instructors plan curriculum using design thinking.

2. [https://drawbackwards.com/blog/drawbackwards-design-thinking-process](https://drawbackwards.com/blog/drawbackwards-design-thinking-process)
   A guide to one organization’s approach to using design thinking.

   A two part investigation on design thinking and how it must progress to stay relevant in the ever changing environment of curriculum design.

4. [https://www.interaction-design.org/literature/topics/design-thinking](https://www.interaction-design.org/literature/topics/design-thinking)
   An article about what design thinking is and how to use it.
Lesson Planning and Curriculum Development Templates

Using a new curriculum development technique without a template for the first time can be overwhelming. As such, we collected well developed curriculum and lesson planning templates for each of the curriculum development methods discussed in this guide. Each template is accompanied by either a completed example of the template or a version of the template with descriptions in each step.

Backwards Design

The following templates have been reformatted to fit within this guide. Template one originated from Vanderbilt University’s Center for Teaching’s page on Understanding by Design and template two originated from modelteaching.com in their article titled Backwards Design in Lesson Planning.
**Stage 1 – Desired Results**

<table>
<thead>
<tr>
<th>ESTABLISHED GOALS</th>
<th>Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to independently use their learning to...</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDERSTANDINGS</td>
</tr>
<tr>
<td>Students will understand that...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ESSENTIAL QUESTIONS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will know...</td>
</tr>
</tbody>
</table>

| Students will be skilled at... |

**Stage 2 – Evidence and Assessment**

<table>
<thead>
<tr>
<th>Evaluative Criteria</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE TASK(S):</td>
<td></td>
</tr>
</tbody>
</table>

| OTHER EVIDENCE: |

**Stage 3 – Learning Plan**

*Summary of Key Learning Events and Instruction*
<table>
<thead>
<tr>
<th>ESTABLISHED GOALS</th>
<th>Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The enduring understandings and learning goals of the lesson, unit, or course.</td>
<td>Students will be able to independently use their learning to…</td>
</tr>
<tr>
<td></td>
<td>Refers to how students will transfer the knowledge gained from the lesson, unit, or course and apply it outside of the context of the course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDERSTANDINGS</td>
</tr>
<tr>
<td>Students will understand that…</td>
</tr>
<tr>
<td>Refers to the big ideas and specific understandings students will have when the complete the lesson, unit, or course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will know...</td>
</tr>
<tr>
<td>Refers to the key knowledge students will acquire from the lesson, unit, or course.</td>
</tr>
</tbody>
</table>
### Stage 2 – Evidence and Assessment

<table>
<thead>
<tr>
<th>Evaluative Criteria</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERFORMANCE TASK(S):</strong></td>
<td>Refers to the authentic performance task(s) that students will complete to demonstrate the desired understandings or demonstrate they have attained the goals. The performance task(s) are typically larger assessments that coalesce various concepts and understandings like large projects or papers.</td>
</tr>
<tr>
<td><strong>OTHER EVIDENCE:</strong></td>
<td>Refers to other types of evidence that will show if students have demonstrated achievement of the desired results. This includes quizzes, tests, homework, etc. This is also a good point to consider incorporating self-assessments and student reflections.</td>
</tr>
</tbody>
</table>

### Stage 3 – Learning Plan

*Summary of Key Learning Events and Instruction*

This stage encompasses the individual learning activities and instructional strategies that will be employed. This includes lectures, discussions, problem-solving sessions, etc.
**Template 2**

**Directions:** Use this planning worksheet to follow the three steps of the backwards design process in order to plan an effective lesson.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Lesson Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standard</td>
<td></td>
</tr>
</tbody>
</table>

**Step One: Write a Student-Centered Learning Objective** – Must be specific, measurable, and clearly stated.

<table>
<thead>
<tr>
<th>Behavior – WHAT the learner will be able to do.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes a verb!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition – HOW the learner will perform the behavior. Refers to a tool, reference, aid, or context they will or will not be able to use.</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Criterion – How WELL the learner must perform to demonstrate content mastery. Refers to a degree of accuracy, number of correct responses, or time limit.</th>
<th></th>
</tr>
</thead>
</table>

| Learning Objective – Put all three parts together. |  |
**Step Two: Create a Plan for Assessment** – Used to gather information about a student’s progress towards mastery of the learning objective, help the teacher identify what instruction is working well and what needs refinement, and informs the students about their learning.

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Options to Consider</th>
<th>Specific Plan</th>
</tr>
</thead>
</table>
| **Diagnostic / Pre-Assessment** – Used to check prior knowledge before a lesson. | ☐ Self-Assessment  
☐ Writing Prompts  
☐ Running Records  
☐ Performance Task  
☐ Other | | |
| **Formative** –           | ☐ Learning / Response Log  
☐ Admit / Exit Ticket  
☐ Think / Pair / Share  
☐ One Minute Paper  
☐ Other | | |
| **Summative** –          | ☐ End of Unit Tests  
☐ Final Exams or Mid-Term Exams  
☐ State Tests  
☐ Culminating Project  
☐ Portfolio | | |
Step Three: Choose Learning Strategies and Activities – How you present new content to your students, and how your students will actually interact with the content. Add additional rows as needed.

<table>
<thead>
<tr>
<th>Strategy 1:</th>
<th>Activities Planned: □ Active □ Passive</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Direct Teach</td>
<td></td>
</tr>
<tr>
<td>□ Demonstration</td>
<td></td>
</tr>
<tr>
<td>□ Cooperative Learning</td>
<td></td>
</tr>
<tr>
<td>□ Discover /Inquiry-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Project-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Other: ___________________________</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strategy 2:</th>
<th>Activities Planned: □ Active □ Passive</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Direct Teach</td>
<td></td>
</tr>
<tr>
<td>□ Demonstration</td>
<td></td>
</tr>
<tr>
<td>□ Cooperative Learning</td>
<td></td>
</tr>
<tr>
<td>□ Discover /Inquiry-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Project-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Other: ___________________________</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strategy 3:</th>
<th>Activities Planned: □ Active □ Passive</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Direct Teach</td>
<td></td>
</tr>
<tr>
<td>□ Demonstration</td>
<td></td>
</tr>
<tr>
<td>□ Cooperative Learning</td>
<td></td>
</tr>
<tr>
<td>□ Discover /Inquiry-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Project-Based Learning</td>
<td></td>
</tr>
<tr>
<td>□ Other: ___________________________</td>
<td></td>
</tr>
</tbody>
</table>
Template 2 Example

**Directions:** Use this planning worksheet to follow the three steps of the backwards design process in order to plan an effective lesson.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Math</th>
<th>Lesson Date</th>
<th>5/8/21</th>
</tr>
</thead>
</table>

**Content Standard** Determine the volume of a rectangular prism with whole number side lengths in problems related to the number of layers times the number of unit cubes in the area base.

**Step One: Write a Student-Centered Learning Objective** – Must be specific, measurable, and clearly stated.

<table>
<thead>
<tr>
<th>Behavior – WHAT the learner will be able to do.</th>
<th>Calculate volume of a rectangular prism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes a verb!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition – HOW the learner will perform the behavior.</th>
<th>When given a formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refers to a tool, reference, aid, or context they will or will not be able to use.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criterion – How WELL the learner must perform to demonstrate content mastery.</th>
<th>4 out of 5 examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refers to a degree of accuracy, number of correct responses, or time limit.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Objective – Put all three parts together.</th>
<th>When given the correct formula, students will accurately calculate the volume of a rectangular prism at least 4 out of 5 times.</th>
</tr>
</thead>
</table>
Step Two: Create a Plan for Assessment – Used to gather information about a student’s progress towards mastery of the learning objective, help the teacher identify what instruction is working well and what needs refinement, and informs the students about their learning.

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Options to Consider</th>
<th>Specific Plan</th>
</tr>
</thead>
</table>
| **Diagnostic / Pre-Assessment** – Used to check prior knowledge before a lesson. | ☐ Self-Assessment  
☑ Writing Prompts  
☐ Running Records  
☐ Performance Task  
☐ Other | Student warm-up -- journal prompt: Write what you know about volume of a 3-D shape. |
| **Formative** – Used during a lesson to check progress, identify any misconceptions, and give feedback to students. | ☐ Learning / Response Log  
☑ Admit / Exit Ticket  
☐ Think / Pair / Share  
☐ One Minute Paper  
☐ Other | Students will complete an exit ticket with 2 sample volume problems.  
Students will solve sample problems on a white board. |
| **Summative** – Used at the end of a lesson to check student mastery of the objective. | ☑ End of Unit Tests  
☐ Final Exams or Mid-Term Exams  
☐ State Tests  
☐ Culminating Project  
☐ Portfolio | Students will have a 10 question quiz at the end of the week, 5 questions will involve calculating volume. |
### Step Three: Choose Learning Strategies and Activities

How you present new content to your students, and how your students will actually interact with the content. Add additional rows as needed.

<table>
<thead>
<tr>
<th>Strategy 1:</th>
<th>Activities Planned:</th>
<th>Direct Teach</th>
<th>Demonstration</th>
<th>Cooperative Learning</th>
<th>Discover /Inquiry-Based Learning</th>
<th>Project-Based Learning</th>
<th>Other: ___________________________</th>
</tr>
</thead>
</table>

- Direct Teach
- Demonstration
- Cooperative Learning
- Discover /Inquiry-Based Learning
- Project-Based Learning
- Other: ___________________________

Students will use base 10 blocks to find the area of a 2x4 rectangle (8 units). They will then explore what happens when they stack more 2x4 rectangles on top of the original. (Two levels - volume is 16 units, 3 levels - volume is 24 units, etc.). Students will be encouraged to try other example until the concept of volume is solidified in their mind.

<table>
<thead>
<tr>
<th>Strategy 2:</th>
<th>Activities Planned:</th>
<th>Direct Teach</th>
<th>Demonstration</th>
<th>Cooperative Learning</th>
<th>Discover /Inquiry-Based Learning</th>
<th>Project-Based Learning</th>
<th>Other: ___________________________</th>
</tr>
</thead>
</table>

- Direct Teach
- Demonstration
- Cooperative Learning
- Discover /Inquiry-Based Learning
- Project-Based Learning
- Other: ___________________________

Students will watch a Khan Academy video introducing volume. This will then lead to a class discussion about the formula for volume and how it is related to the hands-on work they just did. (https://www.khanacademy.org/math/basicgeo/basic-geo-volume-sa/volume-rectprism/v/how-we-measure-volume)

<table>
<thead>
<tr>
<th>Strategy 3:</th>
<th>Activities Planned:</th>
<th>Direct Teach</th>
<th>Demonstration</th>
<th>Cooperative Learning</th>
<th>Discover /Inquiry-Based Learning</th>
<th>Project-Based Learning</th>
<th>Other: <strong><strong><strong>Practice</strong></strong></strong>__</th>
</tr>
</thead>
</table>

- Direct Teach
- Demonstration
- Cooperative Learning
- Discover /Inquiry-Based Learning
- Project-Based Learning
- Other: ______Practice________

Students will complete an independent practice worksheet, with sample problems done on their own for a quick check for understanding.

<table>
<thead>
<tr>
<th>Strategy 3:</th>
<th>Activities Planned:</th>
<th>Direct Teach</th>
<th>Demonstration</th>
<th>Cooperative Learning</th>
<th>Discover /Inquiry-Based Learning</th>
<th>Project-Based Learning</th>
<th>Other: <strong><strong><strong>Assessment</strong></strong></strong>__</th>
</tr>
</thead>
</table>

- Direct Teach
- Demonstration
- Cooperative Learning
- Discover /Inquiry-Based Learning
- Project-Based Learning
- Other: ______Assessment________

Students will complete an exit ticket as they leave class. The 3 questions on the exit ticket will be formatted similarly to the questions on the district unit assessment.
Template 3

This template is formatted in a print only version by its creators. A PDF version of it is available at https://www.sfsu.edu/~teachers/download/Inquiryframework.pdf to be printed. This template is accompanied by instructions that would allow the template to be used as a guide for planning material following the steps provided in another document or on a sheet of paper.

Successive Approximation Model

SAM does not have traditional lesson planning templates however when creating the method Michael Allen created many charts and models detailing how to implement SAM. These charts and models can be found in Leaving ADDIE for SAM or on Michael Allen’s website (alleninteractions.com). Not all charts and models are available on the website.

Design Thinking Method

The curriculum innovation canvas from The Curriculum Innovation Canvas: A Design Thinking Framework for the Engaged Educational Entrepreneur has been reformatted to fit in this guide.
General Pedagogy Resources

Below is a list of resources that have been recommended by educators and curriculum development experts throughout the creation of this guide. Each is a vast well of knowledge created and curated by educational professionals.

1. [www.cultofpedagogy.com](http://www.cultofpedagogy.com)
   a. Cult of Pedagogy is an organization that posts materials about teaching and classroom. Run by former and current teachers, it has blogs, podcasts, and videos covering many different subjects surrounding teaching.

2. [www.edutopia.org](http://www.edutopia.org)
   a. Run by the George Lucas Educational Foundation, Edutopia is a site that shares how educators “can adopt or adapt best practices,” and “tell[s] stories of innovation and continuous learning” according to their website.

3. [inservice.ascd.org](http://inservice.ascd.org) and [ascd.org](http://ascd.org)
   a. ASCD is an international nonprofit education association that provides educators with materials to empower their learners. It has resources created by people who work in various educational fields designed to aid educators in creating a better classroom.

Also many universities and colleges have fantastic resources associated with their teaching programs. Many of these resources are available for free on their websites and can be found with a quick google search. The universities’ materials used or referenced in this guide are:

- Vanderbilt University,
- Western Washington University,
- University of Central Florida,
- Kennesaw State University,
- Northeastern University, and
- San Francisco State University

While not every one of these schools have a complete, easily accessible online source of pedagogy material the resources they provide are all very informational. These are also not the only universities or colleges with strong education programs and other schools resources may prove equally valuable.
Any of the sources or resources referenced or suggested in other sections may also have additional resources available, however these materials have not been vetted to the same level as material directly included in the guide.
DEVELOPED FOR PHYSICALLY ACTIVE YOUTH

RESEARCH METHODS

Professional Development Resource Guide
Research Methods

A large portion of creating a new curriculum for learners is finding sources. Researching is an important tool that if implemented properly, can provide a myriad of resources and tools. Proper researching methods and techniques are important concepts to grasp in order to find reliable and credible sources. It is important to have dependable sources when it comes to curriculum design to assure learners are receiving accurate and viable information.

How to Begin Researching

The first step to conducting research is to have a topic in which to research. Having a solid understanding of what needs to be researched is important. Without a solid understanding, it may be hard to find proper sources that relate to the topic. Once a generalized topic is decided upon, the next step would be to narrow down the focus. One way to narrow down the generalized topic would be to use concept mapping. Concept mapping is a tool that helps one visualize the related terms and material to the general topic\(^{47}\). It is a way to organize all the subsets of the topic that may be useful. Take the simple example of the concept map for animals shown in Figure 4. It starts with the general topic of all animals, then goes to more specifics by breaking it into animal classes, and then more specific within those classes.

\(^{47}\) Kevin J. Miller, Concept Mapping as a Research Tool to Evaluate Conceptual Change Related to Instructional Methods, [https://doi.org/10.1177/0888406409346149](https://doi.org/10.1177/0888406409346149)
Once a background and idea of concepts is established, the next step in researching is collecting sources. The first step to finding sources is to know where and how to find them. There are countless free online resources to find reliable sources. Part of finding the sources is searching through online search engines. Many popular search engines have techniques to narrow down and refine searches, to provide the most accurate and useful sources. A few common techniques that popular search engines use include, but are not limited to: quotation marks, dashes, limiting the dates of creation, and boolean phases such as AND and OR. When applied, these techniques will provide the optimal options for sources best related to the topic at hand.

Overall research is about going more in depth into a topic that is of interest. When applying research to curriculum development it is important to make sure the sources are reliable and credible.

---

48 Teacherstream, Animal Mind Map, [https://en.calameo.com/books/0041247228382deaa40e](https://en.calameo.com/books/0041247228382deaa40e)
49 Proceed Innovative, Refine your Search with These Google Search Tricks, [https://www.proceedinnovative.com/blog/google-search-tricks/](https://www.proceedinnovative.com/blog/google-search-tricks/)
Investigating Sources

With the wide variety of information available it is easy to find sources. But not all sources may be reliable or unbiased. When it comes to researching for curriculum design, it is imperative to find credible sources to provide learners with the most accurate information. To ensure the sources are within this scope, there are ways to vet a source to provide learners with the most accurate and insightful.

One common method for researching is known as the C.R.A.P. method as shown in Figure 5. The “C” of the C.R.A.P. method stands for currency. This section of the research method focuses on making sure the information is current. For example if one was to look up the design of a car engine, they could find a model from 1989. Although this is not completely incorrect it is not the most relevant and car engines have evolved since 1989. It is important to make sure the information found is current to provide learners with the most up to date information.

---

The “R” of the C.R.A.P. method stands for reliability. To provide learners with correct information, one must first have reliable sources. One way to check if a source is reliable is to see if the information provided in the source is made up mostly of opinion or facts. If a majority of the source is opinion, it may not be reliable. If it is mostly facts and provides references and sources it is more reliable and has a higher chance of providing accurate information.

The “A” of the C.R.A.P. method stands for authority. The author of the source is an important detail when it comes to reliability and accuracy. One must analyze the author and ask questions such as: who is the author? What are their credentials? Are their advertisements on the site? Are they reputable? These kinds of questions help narrow down the credibility of the author and decide if they are a reliable source. For example if one was researching dinosaurs, an article
or journal written by a Paleontologist would be more reliable than an article written by an enthusiast. Searching for an author is an important step in the researching process.

The “P” in the C.R.A.P. method stands for purpose/point of view. This section focuses on any biases of the author and what the purpose of the source is. If it is an article that is an advertisement for cologne, but one is researching the history of cologne, then it may not be the best source. Another part of this section is to think about if the source is mostly fact or opinion. Sources should be mostly facts or opinions that are based in facts and research. The purpose of the source is an important quality to consider when researching,

The C.R.A.P. method is a research guide that arms the researcher with techniques to properly understand how to critically analyze sources. It provides the researcher with possible questions to vet sources and test the credibility of them. Finding reliable and accurate information to provide students is an important part of curriculum development. When finding sources, it is important to analyze them and approach the search critically.

We have provided an Information Search Process guide for vetting sources\textsuperscript{51}. This guide provides examples of questions that should be asked when looking for sources. It will provide guidance on finding reliable and credible sources. It is a tool for a more effective researching process.

\textsuperscript{51} Gordon Library. (2021). ID2050 library research assignment – Information search process [worksheet]. Worcester Polytechnic Institute
## Information Search Process Tool

**Instructions:**
1. Choose five different search tools (such as google scholar and differing data bases).
2. Use each search tool to look for a curriculum topic information source (such as a journal article, book, news article, etc.) for a total of five (5) sources – one using each search tool.
3. Answer the questions about each source and the search process.

<table>
<thead>
<tr>
<th>Information Source One</th>
<th>Information Source Two</th>
<th>Information Source Three</th>
<th>Information Source Four</th>
<th>Information Source Five</th>
</tr>
</thead>
</table>

1. a. Where did you find the source (Google Scholar, a database, etc.)?
   b. Why did you choose this search tool?

2. a. What search words or phrases did you use?
   b. Did you use any filters or Advanced search features to refine your results? If yes, which ones?

3. a. Why did you choose this source? What was your process of elimination for articles you did not select?
   b. Which aspect of the project, such as technical, social, or local, does this source meet, and why?

**Continuing Your Research:**
1. In addition to the keywords listed above, what other keywords will you use as you continue to look for sources? Possible other key words:
2. In addition to the search tools listed above, what other search tools will you use as you continue to look for sources? List at least one example for each of the following categories:
   a. Library database:
   b. Website for an organization, association, or government agency that is doing similar work to your project:
   c. Newspaper from the geographic region:
## Information Search Process Tool-Filled Out Example

### Instructions:
4. Choose five different search tools (such as google scholar and differing data bases).
5. Use each search tool to look for a curriculum topic information source (such as a journal article, book, news article, etc.) for a total of five (5) sources – one using each search tool.
6. Answer the questions about each source and the search process.

<table>
<thead>
<tr>
<th>Information Source One</th>
<th>Information Source Two</th>
<th>Information Source Three</th>
<th>Information Source Four</th>
<th>Information Source Five</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> a. Where did you find the source (Google Scholar, a database, etc.)? b. Why did you choose this search tool?</td>
<td>a. JSTOR b. It is a reliable database of academic journals and resources</td>
<td>a. JSTOR b. It is a reliable database of academic journals and resources</td>
<td>a. Gordon library search b. It is a reliable source that gives me access to a wide range of resources</td>
<td>a. Google Scholar b. It has a wide range of academic sources</td>
</tr>
<tr>
<td><strong>3.</strong> a. Why did you choose this source? What was your process of elimination for articles you did not select? b. Which aspect of the project, such as technical, social, or local, does this source meet, and why?</td>
<td>a. This source was chosen because it spoke of how engineering and robotics can impact children’s learning and gave a specific example of how it was implemented in schools b. This would fall</td>
<td>a. This source was chosen because it was the most relevant source to what was being</td>
<td>a. This source was chosen because it was most relevant to the aspect of the Namibian school</td>
<td>a. It is another case study about a robotics event held in African schools. It demonstrates an approach like that of</td>
</tr>
</tbody>
</table>

37
under the technical aspect of the project because it is related to the goal of the project.

looked for. Other suggested articles were either not related to the schooling in Africa or focused on more focused aspects of African school systems.

b. This article relates to the local and social aspect of the project. It relates to the social aspect due to its background of teachers overall and local due to its specific look into Namibian teachers.

system that we would be working with.

b. This source relates to the local and social aspect of the project. It relates to the social aspect due to its background of teachers overall and local due to its specific look into Namibian teachers.

how similar projects were implemented in areas similar to where we will be working.

our own project.

b. This source is technical because it includes examples of robotics curriculums

<table>
<thead>
<tr>
<th>Continuing Your Research:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In addition to the keywords listed above, what other keywords will you use as you continue to look for sources? Possible other key words: Namibian learning, aspects of teaching, teaching teachers, teacher professional development courses.</td>
</tr>
<tr>
<td>2. In addition to the search tools listed above, what other search tools will you use as you continue to look for sources? List at least one example for each of the following categories:</td>
</tr>
</tbody>
</table>
a. Library database: SAGE Journals
b. Website for an organization, association, or government agency that is doing similar work to your project:

c. Newspaper from the geographic region: https://www.namibian.com.na/
DEVELOPED FOR PHYSICALLY ACTIVE YOUTH

SKILL MAPPING

Professional Development Resource Guide
Concept Mapping for Skills and Lessons

The concept mapping method, common for organizing research, can be applied in many ways. When applied to course topics for the VEX IQ curriculum created by WPI, as well as instructional videos targeted at educators and the lessons included in the official VEX IQ “STEM Labs” curriculum, planning lessons around concepts that span these 3 becomes easier. For each piece of content, a set of connections are made. Each item has a list of other lessons or topics that it depends on. In the visualization used, the concepts or lessons are shown as circles. The arrows on the diagrams point from formative concepts towards lessons that build on these concepts. Inevitably, more content will be found that should go in the curriculum. When new lesson ideas come up, using the concept mapping strategy, the instructor can quickly figure out what steps need to be taken to integrate a lesson, by looking back down the tree to find what other lessons are relevant.

Figure 6: Concept map of included content
Why map out skills to teach?

Concept maps are a powerful tool in organizing thoughts and ideas. When it comes to organizing lessons, they are an equally strong tool. When choosing an order to teach lessons in, it is important to make sure that students have requisite knowledge for a lesson before they are asked to complete it. If a student does not have the necessary knowledge to complete the lesson without assistance, it becomes a hindrance to a large portion of the class when the instructor must take time out of the lesson to review. In order to minimize the amount of time spent reviewing past topics, it is important to occasionally use skills derived from said topic, and to try and introduce new topics immediately after reinforcing the skills and concepts they depend on. Through use of a concept map, the instructor can determine which concepts must be "fresh" in students' minds for them to best understand the explanation of the lesson topic.

How to use the tool:

In order to use the concept mapping tool, visit the webpage with the embedded tool. Concepts can be moved and reordered by clicking and dragging them. The connections to their related topics are force-driven, so the concept map should settle in a way that minimizes on-screen distance between related topics.
Conclusion

The purpose of developing this document was to provide the instructors with knowledge on developing new curricula. Through understanding this document, instructors will have a new organizational tool to help them develop their own lessons. In the case that these educators want to expand past the material created by previously, they will now have the framework and structure to create these lessons.

Our research showed that the most efficient method of curriculum design is not one single method, but rather a combination of two or more methods. The purpose of this is to create balanced lessons as each design method has different strengths that can counteract each other's weaknesses. We found that a combination of a method that has more structure to it combined with a method that is more iterative in nature is the strongest combination of methods. We recommend that educators use a combination of backward design and the successive approximation model (SAM). Backward design was consistently held in high regard by the instructors that we interviewed as it has a strong structure designed to ensure that students reach learning objectives while having some flexibility in lesson planning.

Later, we assigned a list of pedagogy resources that defined a list of teacher recommendations from accredited universities and we described the overall research process an instructor could use to construct new material. We utilized resources from the Worcester Polytechnic Institute library department to give recommendations on how to assess material. Finally, we detailed concept mapping, a technique that instructors can use to connect interrelated topics in a visual way that anyone can interpret. On the website for Physically Active Youth’s robotics program, the concept map was live and interactive, however for the case of the document the topics are shown in a single picture.