

The *Microelectronics Integration Curriculum Development Framework* was based on the *STEM Integration Curriculum Assessment Framework* set forth by Moore & Guzey (2017) and adapted to fit the integration of high-level content (specifically, microelectronics) into K-12 curriculum for any course. This tool is meant to be used as a curriculum development or assessment tool for microelectronics (ME) integration curricula. It can be easily changed for other high-level content.

## **I. Motivating and Engaging Context**

- Students can make sense of the situation based on extensions of their own personal knowledge and experiences
- Curriculum engages and motivates students from various backgrounds
- Context has a compelling purpose
  - Examples:
    - Involves global, economic, environmental, and/or societal contexts
    - Involves current events and/or contemporary issues
    - Involves human-centered social or community issues
- Curriculum provides opportunities for students to create solutions to realistic problems

## **II. Meaningful Integration of ME**

- Curriculum meaningfully integrates essential ME content, including topics such as semiconductors and microchips, silicon crystals, wafer production, manufacturing processes, automation, and supply chain management
- Curriculum seamlessly integrates ME in a manner that ME content cannot be removed
- Every lesson includes explicit connections to ME so that students understand the importance of each lesson to the ME context
- Curriculum provides opportunities for students to develop a basic understanding of what ME is, why they are learning about ME, and where the US is currently in the ME landscape
- Curriculum promotes understanding about ME career/pathways
- Curriculum promotes understanding of at least one area of ME industry – not application

## **III. A Realistic Client**

- Students work for a client and consider needs and wants of client and end user
- Students explore or develop field related technologies as they solve the problem given by the client
- Students participate in problem scoping. This includes, but is not limited to, identifying the client and end users' diverse needs, criteria, constraints, and areas where more background is needed (e.g., establishing the need for the content)
- Real industrial client and careers utilized and profiled/described, when available

## **IV. Integration of Disciplinary Content**

- Curriculum addresses learning objectives, state standards, or other related learning policies in targeted disciplinary content areas
- Curriculum integrates disciplinary concepts that are developmentally appropriate for the learner
- Students learn, understand, and use fundamental disciplinary concepts and/or big ideas from the targeted disciplines to solve the problem
- Curriculum promotes coherent conceptual understanding of disciplinary concepts
- Curriculum provides opportunities to learn and implement different techniques, skills, processes, and tools related to disciplinary learning

## **V. Instructional Strategies**

- Lessons and activities are student-centered – minds-on and/or minds-on/hands-on
- Some activities require students to collect and analyze information or data before arriving at a solution
- Evidence-based reasoning/argumentation is embedded as a strategy to connect the ME integration and the disciplinary content
- Curriculum includes strategies for orchestrating discussions to encourage evidence-based dialogue between teams
- Activities embed disciplinary concepts to be learned in multiple modes of representation (real-life situations, pictures, verbal symbols, written symbols, manipulatives/concrete models) with an emphasis on translations within and between modes

## **VI. Teamwork**

- Lessons and activities require students to collaborate with others
- Lessons that include teamwork also include opportunities to demonstrate individual responsibility
- Instructional strategies are built in to encourage positive team interactions and cooperative learning
- Each member of the team is needed for completion of activity/task

## **VII. Communication**

- Students communicate disciplinary concepts (e.g., oral, written, or with visual aids such as charts or graphs).
- Students communicate solutions to the client's problem (e.g., oral such as presentations to the client, written such as a memo to the client, technical communication, communication to the user, or visual aids such as schematics)
- Multiple modes of representation (real life situations, pictures, verbal symbols, written symbols, manipulatives/concrete models) are encouraged within communication of learning
- Evidence-based reasoning strategies for communication are included

## **VIII. Organization**

- Curriculum presents clear learning objectives and goals from the disciplines that are tied meaningfully to ME and includes activities/lessons that flow in a logical and sequential order so they build on each other
- Curriculum provides guidance and instructional strategies for teachers who are unfamiliar with the unit

## **IX. Performance and Formative Assessment**

- Performance and formative assessments are closely aligned with the learning objectives and goals from the multiple disciplines
- Assessments are tied meaningfully to state standards and test specifications and possibly go beyond these specifications.
- Assessments provide students opportunities to produce evidence of understanding and abilities in different ways through performance tasks.
- Assessments provide guidance to the teacher that could be used to improve implementation of the curriculum.
- Assessments measure student understanding of ME as used in the learning experience

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