STEP 4: Matching Concepts and Ideas to Research Findings
Conservation of Matter Topic Study

Science Concepts and Ideas	Research Findings
Properties ▪ Objects have many observable properties, including size weight, and shape. Those properties can be measured using tools such as rulers and balances. (*NSES* K-4 p 127) ▪ Materials can exist in different states- solid, liquid, and gas. (*NSES* K-4 p 127) ▪ Air is a substance that surrounds us, takes up space, and whose movements we feel as wind. (*BSL* 3-5 p 68) **Physical and Chemical Change** ▪ Water can be a liquid or solid and can go back and forth from one form to another. If water is turned into ice and then ice is allowed to melt, the amount of water is the same as it was before freezing. (*BSL* K-2 p 67) ▪ No matter how parts of an object are assembled, the weight of the whole object made is always the same as the sum of the parts; and when a thing is broken into parts, the parts have the same total weight as the original thing. (*BSL* 3-5 p 77) ▪ Substances react chemically in characteristic ways with other substances to form new substances with different characteristic properties. In chemical reactions, the total mass is conserved. (NSES 5-8 p 154) **Interactions in a Closed System** No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same. (*BSL* 6-8 p 79) **Particulate Matter** The idea of atoms explains the conservation of matter: If the number of atoms stays the same no matter how they are rearranged, then their total mass stays the same. (*BSL* 6-8 p 79)	**Matter and Its Properties** ▪ Students need to have a concept of matter in order to understand conservation of matter. (*BSL* p 336) ▪ Students need to accept weight as an intrinsic property of matter to use weight conservation reasoning. (*BSL* p 336) ▪ Confusion between weight and density contributes to difficulty understanding conservation of matter. (*BSL* p 336) ▪ The concept of mass develops slowly. Mass is often associated with the phonetically similar word 'massive' and thus may be equated with an increase in size or volume. (Driver p 78) ▪ The idea that gases possess material character is difficult. Students may not regard gases as having weight or mass. Until they accept gas as a substance, they are unlikely to conserve mass in changes that involve gases. (Driver p 80) **Physical and Chemical Change** ▪ There is often a discrepancy between weight and matter conservation with dissolving. Some students accept the idea that the substance is still there but the weight is negligible, is "up in the water', or it no longer weighs anything. (Driver p 84) ▪ Some students believe one state of matter of the same substance has more or less weight than a different state. (Driver p 80) ▪ In changes that involve a gas, students are more apt to understand matter is conserved if the gas is visible. (*BSL* p 337) ▪ Weight conservation during chemical reactions is more difficult for students to understand, particularly if a gas is involved. (*BSL* p 337) ▪ Many students do not view chemical changes as interactions. They have difficulty understanding the idea that substances can form from a recombination of the original atoms. (*BSL* p 337) ▪ Students have more difficulty with the quantitative aspect of chemical change and conservation. (Driver p 88) ▪ The way a student perceives a chemical or physical change may determine whether they understand matter is conserved. For example, if it looks as if something has disappeared or spread out more, then student may think the mass changes. (Driver p 77) **Particle Ideas** ▪ Newly constructed ideas of atoms may undermine conservation reasoning. For example, if a material is seen as being dispersed in very small particles, then it may be regarded as having negligible weight or more spread out and less heavy. (Driver p 77)

Adapted from CTS and the Maine Mathematics and Science Alliance (http://www.mmsa.org).

BSL: *Benchmarks for science literacy.* American Association for the Advancement of Science (AAAS). (1993). New York: Oxford University Press.
CTS: *Curriculum topic study: Bridging the gap between standards and practice*. Keeley, P. (2005). Thousand Oaks, CA: Corwin Press.
Driver: Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). *Making Sense of Secondary Science.* New York, NY: Routledge.
NSES: National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

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