Method's of Teaching

Part 2

Four Year (Chemistry)

Curricula and Methods of Teaching Department

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رؤية الكليـة

كلية التربية بالغردقة مؤسسة رائدة محليًا ودوليًا في مجالات التعليم، والبحث العلمي،وخدمة المجتمع؛ بما يؤهلها للمنافسة على المستوى: المحلى، والإقليمي، والعالمي.

رسالة الكلية

تلتزم كلية التربية بالغردقة بإعداد المعلم أكاديميًا ومهنيًا وثقافيًا، من خلال برامجها المتميزة، بما يؤهله للمنافسة والتميز في مجتمع المعرفة والتكنولوجيا، ومواجهة متطلبات سوق العمل محليًا وإقليميًا، وتهتم بتطوير مهارات الباحثين؛ بما يحقق التمية المهنية المستدامة، وتوفير خدمات تربوية لتحقيق الشراكة بين الكلية والمجتمع.

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Chapter 1

WHY STUDY CHEMISTRY?

Introduction:

Chemistry is the study of matter and energy and the interaction between them. There are many reasons to study chemistry, even if you aren't pursuing a career in science.

Chemistry is everywhere in the world around you! It's in the food you eat, clothes you wear, water you drink, medicines, air, cleaners... you name it. Chemistry sometimes is called the "central science" because it connects other sciences to each other, such as biology, physics, geology, and environmental science. Here are some of the best reasons to study chemistry.

Why study chemistry?

Chemistry helps us to understand the world around us

Chemistry enables us to understand the properties of different materials and to transform materials into new and useful substances. Through chemistry, we can understand changes that we observe in the natural and physical world. Chemistry gives us understandings on which to base educated choices about consumer products and management of resources.

Chemistry solves problems

Chemistry enables us to develop a range of useful materials such as pharmaceuticals for curing and treating diseases, substances that protect the environment, technologically advanced structures for building, and materials that can be used as alternative energy sources. Chemistry is fundamental to understanding climate change and wise use of the world's energy and water resources.

Learning in chemistry opens up career opportunities

Some chemists work in laboratories designing new materials that are used in products such as medicines, food and beverage flavourings, superconductors, and vaccines. Studying chemistry also provides excellent training for a wide range of careers including marketing and project management, environmental science and forensic science. Employers value the skills of numeracy, problem solving, and communication that are integral to all study in chemistry.

1. Chemistry helps you to understand the world around you. Why do leaves change color in the fall? Why are plants green? How is cheese made? What is in soap and how does it clean? These are all questions that can be answered by applying chemistry.
2. Basic knowledge of chemistry helps you to read and understand product labels.
3. Chemistry can help you make informed decisions. Will a product work as advertised or is it a scam? If you understand how chemistry works you'll be able to separate reasonable expectations from pure fiction.
4. Chemistry is at the heart of cooking. If you understand the chemical reactions involved in making baked goods rise or neutralizing acidity or thickening sauces, chances are you'll be a better cook.

5. A command of chemistry can help keep you safe! You'll know which household chemicals are dangerous to keep together or mix and which can be used safely.
6. Chemistry teaches useful skills. Because it is a science, learning chemistry means learning how to be objective and how to reason and solve problems.
7. Helps you to understand current events, including news about petroleum, product recalls, pollution, the environment and technological advances.
8. Makes life's little mysteries a little less... mysterious. Chemistry explains how things work.
9. Chemistry opens up career options. There are many careers in chemistry, but even if you're looking for a job in another field, the analytical skills you gained in chemistry are helpful. Chemistry applies to the food industry, retail sales, transportation, art, homemaking... really any type of work you can name.
10. Chemistry is fun! There are lots of interesting chemistry projects you can do using common everyday materials. Chemistry projects don't just go boom. They can glow in the dark, change colors, produces bubbles and change states.

Chemistry is the study of matter and energy and the interactions between them. This is also the definition for physics, by the way.

Chemistry and physics are specializations of **physical science**. Chemistry tends to focus on the properties of substances and the interactions between different types of matter, particularly reactions that involve electrons. Physics tends to focus more on the nuclear part of the atom, as well as the subatomic realm. Really, they are two sides of the same coin.

The formal definition of chemistry is probably what you want to use if you're asked this question on a test. You may also need to practice basic chemistry concepts with a quiz.

everyday products that you use.

What Fields of Study Use Chemistry?

You could use chemistry in most fields, but it's commonly seen in the sciences and in medicine. Chemists, physicists, biologists, and engineers study chemistry. Doctors, nurses, dentists, pharmacists, physical therapists, and veterinarians all take chemistry courses. Science teachers study chemistry. Fire fighters and people who make fireworks learn about chemistry. So do truck drivers, plumbers, artists, hairdressers, chefs... the list is extensive.

What Do Chemists Do?

Whatever they want. Some chemists work in a lab, in a research environment, asking questions and testing hypotheses with experiments. Other chemists may work on a computer developing theories or models or predicting reactions. Some chemists do field work. Others contribute advice on chemistry for projects. Some chemists write. Some chemists teach. The career options are extensive.

Chemistry has a reputation as a hard class and difficult science to master. Here's a look at what makes chemistry so hard.

Chemistry Uses Math

You have to be comfortable with math up through algebra to understand and work chemistry problems. Geometry comes in handy, plus you'll want calculus is you take your study of chemistry far enough.

Part of the reason many people find chemistry so daunting is because they are learning (or re-learning) math at the same time they are learning chemistry concepts. If you get stuck on unit conversions, for example, it's easy to get behind.

Chemistry Isn't Just in the Classroom

One common complaint about chemistry is that it counts for the same credit hours as any other class, but requires a lot more from you both in class and outside it.

You've got a full lecture schedule, plus a lab, problems, and a lab write-up to do outside of class, and maybe a pre-lab or study session to attend. That's a big time commitment.

While that may not make chemistry more difficult, it leads to burn-out a lot earlier than with some studies. You've got less free time to wrap your head around the material on your own terms.

Its Own Language

You can't understand chemistry until you understand the vocabulary. There are 118 elements to learn, a lot of new words, and the entire system of writing chemical equations, which is its own special language.

There is more to chemistry than learning the concepts. You have to learn how to interpret and communicate the way chemistry is described.

It's Hard Because of the Scale

Chemistry is a vast discipline. You don't just learn basics and build on them, but switch gears into new territory fairly often.

Some concepts you learn and build on, but there is always something new to throw into the mix. Simply put, there is a lot to learn and only a limited time to get it into your brain.

Some memorization is required, but mostly you need to think. If you're not used to working through how something works, flexing your mind can take effort.

It's Hard Because You Think It's Hard

Another reason chemistry is hard is that you've been told it's hard. If you think something is difficult, you're setting yourself up to fulfill that expectation.

The solution to this is to truly believe *you can learn chemistry.* Achieve this by breaking up study time into manageable sessions, don't fall behind, and take notes during lectures, lab, and during your reading. Don't psych yourself out and don't give up as soon as the going gets tough.

Teaching Strategies Importance and the Difference Between Them and Teaching Methods

Teaching, learning, assessment, curriculum and pedagogy

Teaching, learning and assessment are aspects of the curriculum for which lecturers take responsibility. Having a shared understanding of these aspects is important. Definitions of these aspects are given below:

Teaching

can be defined as engagement with learners to enable their understanding and application of knowledge, concepts and processes. It includes design, content selection, delivery, assessment and reflection.

To teach is to engage students in learning; thus teaching consists of getting students involved in the active construction of knowledge. A teacher requires not only knowledge of subject matter, but knowledge of how students learn and how to transform them into active learners. Good teaching, then, requires a commitment to systematic understanding of learning. The aim of teaching is not only to transmit information, but also to transform students from passive recipients of other people's knowledge into active constructors of their own and others' knowledge. The teacher cannot transform without the student's active participation, of course. Teaching is fundamentally about creating the pedagogical, social, and ethical conditions under which students agree to take charge of their own learning, individually and collectively.

Learning

can be defined as the activity or process of gaining knowledge or skill by studying, practicing, being taught, or experiencing something (Merriam-Webster dictionary). Learning is about what students do, not about what we as teachers do.

Assessment

is defined as the act of judging the amount of learning that took place as a result of learning and teaching.

Another term that might become part of the discourse when these elements are discussed, is **'pedagogy'.**
This term refers to the methods and activities of the practice of teaching.

Differences Between Teaching Strategy and Teaching Method

Although used interchangeably, teaching strategies and teaching methods are different. Landøy et al. (2019) explain that one of the key differences between the two is that teaching strategy are actions that are meant to achieve a certain goal within the learning setting while teaching methods are the different styles that are used to accomplish individual tasks within the same learning environment. Indeed, examples can be given to explain the differences between the two further. An example of a teaching method is a class discussion. In this case, the teacher designs a lesson and chooses an activity that will help in the facilitation of learning. It can be argued that teaching methods help in accomplishing tasks that are set out within the classroom set-up. At the same time, teaching strategy directly impacts the learning environment and its effectiveness is measured through the achievement of the learning goals set.

A second difference between the two is that whereas the strategies are logical and sequential arrangements, methods are often the steps within a procedure. The latter does not have to be logical for it to be effective, whereas the former has to be logical for it to be successful. Further, a third difference is that whereas methods focus on the presentation of the content, strategies focus more on the learning environment. Despite the differences, it is arguable that the two terminologies have a few similarities. One similarity is that both help develops a conducive teaching and learning environment. A second similarity is that both methods and strategies use measures to achieve their objective. For example, strategies use a logical sequence to achieve a set objective whereas methods use several steps within a similar procedure for the same. It can be argued that it is these similarities and differences that make both methods and strategies important within the teaching and learning environment.

Problem Based Learning

In this strategy, the teacher uses real-life problems to teach the students. Those who subscribe to this school of thought argue that it makes the students ready for the outside world as it is practical instead of teaching only concepts and theory. Landøy et al. (2019) explain that this approach has been known to promote critical thinking and problem-solving skills. It is important to note that many of the teachers who use this strategy often rely on group work as well. This goes to show the importance of group work in a class.

An example can be given to explain this concept further. A teacher would like to teach about corporate social responsibility. The teacher brings in material about two companies where one has a corporate social responsibility strategy and the other does not. The students then have to work in groups to check for differences, especially in regards to how the presence or lack of corporate social responsibility affects the companies' public image.

Teaching Methods

The term teaching method refers to the general principles, pedagogy and management strategies used for classroom instruction.

Your choice of teaching method depends on what fits you — your educational philosophy, classroom demographic, subject area(s) and school mission statement.

Teaching theories can be organized into four categories based on two major parameters: a teacher-centered approach versus a student-centered approach, and high-tech material use versus low-tech material use.

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Teacher-Centered Approach to Learning

Taken to its most extreme interpretation, teachers are the main authority figure in a teacher-centered instruction model. Students are viewed as "empty vessels"External link:open_in_new who passively receive knowledge from their teachers through lectures and direct instruction, with an end goal of positive results from testing and assessment. In this style, teaching and assessment are viewed as two separate entities; student learning is measured through objectively scored tests and assessments.
Learn more about the different teaching styles that use a teacher-centered approach.

Student-Centered Approach to Learning

While teachers are still an authority figure in a student-centered teaching model, teachers and students play an equally active role in the learning process.

The teacher's primary role is to coach and facilitate student learning and overall comprehension of material, and to measure student learning through both formal and informal forms of assessment, like group projects, student portfolios, and class participation. In the student-centered classroom, teaching and assessment are connected because student learning is continuously measured during teacher instruction.

Learn more about the different teaching styles that use a student-centered approach.

Teacher-Centered Methods of Instruction

Direct Instruction (Low Tech)

Direct instruction is the general term that refers to the traditional teaching strategy that relies on explicit teaching through lectures and teacher-led demonstrations.

In this method of instruction, the teacher might play one or all of the following roles:

Formal Authority

Formal Authority teachers are in a position of power and authority because of their exemplary knowledge and status over their students. Classroom management styles are traditional and focus on rules and expectations.

Expert

Expert teachers are in possession of all knowledge and expertise within the classroom. Their primary role is to guide and direct learners through the learning process. Students are viewed solely as the receptors of knowledge and information (“empty vessels”).

Differentiated Instruction (Low Tech)

Differentiated instruction is the teaching practice of tailoring instruction to meet individual student needs. It initially grew popular with the 1975 Individuals with Disabilities Education ActExternal link:open_in_new (IDEA), which ensured all children had equal access to public education. The Individualized Education ProgramsExternal link:open_in_new (IEPs) that started under IDEA helped classroom teachers differentiate for students with special needs. Today, differentiated instruction is used to meet the needs of all types of learners.

Teachers can differentiate in a number of ways: how students access content, the types of activities students do to master a concept, what the end product of learning looks like, and how the classroom is set up. Some examples of differentiation include: having students read books at their own reading levels, offering different spelling lists to students, or meeting in small groups to reteach topics.

Though differentiation is focused on individual student needs, it is mostly planned and implemented by the teacher. And technology, though a potential aid, is not a hallmark of the differentiated teaching style, making it a fairly traditional, low-barrier method to adopt.

Inquiry-based Learning (High Tech)

Based on student investigation and hands-on projects, inquiry-based learning is a teaching method that casts a teacher as a supportive figure who provides guidance and support for students throughout their learning process, rather than a sole authority figure.

Exercise 1:

WHY STUDY CHEMISTRY?

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Exercise 2:

What is Differences Between Teaching Strategy and Teaching Method

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Exercise 3:

What is Differences Between Teaching and Learning

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Exercise 4:

WHAT IS Teacher-Centered Methods of Instruction ?

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Exercise 5:

What is Student-Centered Approach to Learning

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Exercise 6:

Select a Chemistry lesson and show us how to plan and teach it in a way which demonstrates that science could be a common language among all humans.

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Exercise 8:

Select a science lesson and re organize it in a way that show the spirit of scientific inquiry.

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Exercise 9:

Tell us in one page how chemistry benefited you on the personal level.

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CHAPTER 2

What is STS Science Teaching?

Focus Questions:

- What are objective-related principles and their implications to teaching?
- What are the three domains of learning objectives?
- How do we write good lesson objectives?

Guiding Principles in Determining and Formulating Learning Objectives:

1. “Begin with the end in mind.”
2. Share lesson objective with students.
3. Lesson objectives must be in the two or three domains – knowledge (cognitive), skill (psychomotor), and values (affective).
4. Work on significant and relevant lesson objectives.
5. Lesson objective must be aligned with the aims of education as embodied in the Philippine Constitution and other laws and on the vision-mission statements of the educational institution of which you are a part.
6. Aim at the development of critical and creative thinking.
7. For accountability of learning, lesson objectives must be SMART, i.e., Specific, Measurable, Attainable, Result-oriented and Relevant, Time-bounded and Terminal.

What is STS?

Science and Technology Studies (STS) is a relatively new academic field. Its roots lie in the interwar period and continue into the start of the Cold War, when historians and sociologists of science, and scientists themselves, became interested in the relationship between scientific knowledge, technological systems, and society. The best known product of this interest was Thomas Kuhn’s classic 1962 study, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS. This influential work helped crystallize a new approach to historical and social studies of science, in which scientific facts were seen as products of scientists’ socially conditioned investigations rather than as objective representations of nature. Among the many ramifications of Kuhn’s work was a systematic effort by social scientists to probe how scientific discovery and its technological applications link up with other social developments, in law, politics, public policy, ethics, and culture.

STS, as practiced in academia today, merges two broad streams of scholarship. The first consists of research on the nature and practices of science and technology (S&T). Studies in this genre approach S&T as social institutions possessing distinctive structures, commitments, practices, and discourses that vary across cultures and change over time. This line of work addresses questions like the following: is there a scientific method; what makes scientific facts credible; how do new disciplines emerge; and how does science relate to religion? The second stream concerns itself more with the impacts and control of science and technology, with particular focus on the risks, benefits and opportunities that S&T may pose to peace, security, community, democracy, environmental sustainability, and human values. Driving this body of research are questions like the following: how should states set priorities for research funding; who should participate, and how, in technological decisionmaking; should life forms be patented; how should societies measure risks and set safety standards; and how should experts communicate the reasons for their judgments to the public?

The rise of STS as a teaching field reflects a dawning recognition that specialization in today's research universities does not fully prepare future citizens to respond knowledgeably and reflectively to the most important challenges of the contemporary world. Increasingly, the dilemmas that confront people, whether in government, industry, politics or daily life, cut across the conventional lines of academic training and thought. STS seeks to overcome the divisions, particularly between the two cultures of humanities (interpretive inquiry) and natural sciences (rational analysis).

Four aspects of a curriculum will be explored to clarify the imprecision in STS science teaching:

🎬 1. Function -- what are the goals for teaching science through STS?

2. Content -- what should be taught?

3. Structure -- how should the science and STS content be integrated?

4. Sequence -- how can we design STS instruction?

The chapter does not offer a definitive answer to these questions, but it does sketch the territory that must be explored when we try to answer the questions for ourselves.

Function

When compared to the function of the traditional science curriculum, STS science represents a type of Kuhnian paradigm shift in goals. STS education embraces the successes of the old paradigm but with a different world view on science teaching. This world view is described here.

Fundamentally, STS science teaching is student-oriented, as contrasted with the scientist orientation of tradition science teaching. The student-oriented character of STS science is represented in Figure 5.1 by the central position given to the student.

STS science is about making sense out of life today and for the future. But for what purpose? What are the goals of STS science education? Themes have emerged from section 1 of this book. These themes are summarized here..

STS science is also expected to fill a critical void in the traditional curriculum -- the social responsibility in collective decision making on issues related to science and technology. Such issues require a harmonious mix of a scientific-technical elite with an informed attentive citizenry. Together both groups will need to make complex decisions that involve "the application of scientific knowledge, technological expertise, social understanding, and humane compassion" (Kranzberg, 1991, p. 238). The pervasive goal of social responsibility in collective decision making leads to numerous related goals: individual empowerment (Aikenhead, 1985a, b; Fleming, 1989; Layton, 1986; Solomon, 1993); intellectual capabilities such as critical thinking, logical reasoning, creative problem solving, and decision making (Bybee, 1987); national and global citizenship, usually "democracy" or "stewardship" (Gilliom et al., 1991, 1992); socially responsible action by individuals (Rubba, 1991; De Vore 1992); and an adroit work force for business and industry (Bondi, 1985; Hurd, 1989; Moore, 1991; Wirth, 1991). These goals emphasize an induction into a world increasingly shaped by science and technology, more than they support an induction into a scientific discipline.

STS science courses differ widely because of their different goals. Upon closer examination, however, this variation reflects differences in the balance among similiar goals. In other words, most STS science courses harbor similar goals but give different priorities to different goals. The idea of balance is captured by the slogan "scientific literacy" (Hart, 1989; Roberts, 1983). Although "scientific literacy" provides an element of persuasion in rationalizing science programs (who can be against scientific literacy?), the term can be useful in defining a goal cluster.

For Bybee (1985b, p.85), the balance for STS science education is among three general goals:

1. Acquisition of knowledge (concepts within, and concepts about, science and technology) for personal matters, civic concerns, or cultural perspectives.

2. Development of learning skills (processes of scientific and technological inquiry) for information gathering, problem solving, and decision making.

3. Development of values and ideas (dealing with the interactions among science, technology, and society) for local issues, public policies, and global problems.

Another cluster of goals for STS science has been identified by Waks and Prakash (1985, pp. 108-114):

1. Cognitive competency -- standardized knowledge and skills needed for reading and speaking accurately about STS issues; for example: conservation of energy in science means something different than it does in everyday use; controlling variables is essential to good experiments; research and development is a combination of science and technology.

2. Rational/academic -- a grasp of the epistemology and sociology of science required for understanding the dynamics at play in STS issues; for example: scientific observations are theory-laden; scientific beliefs are reached by consensus making; epidemiology can have political dimensions.

3. Personal -- students understand their everyday lives better; for example: money invested in insulation has benefits in cold climates; you are what you eat; giving careful attention to words on labels can save you problems.

4. Social action -- students participate in responsible political action; for example: making consumer choices to affect global environments; writing letters to government or industries; participating in the resolution of a local issue.

All four goals may have a place within a single curriculum, but some goals will have higher priority than others. For example, the fourth goal -- social action -- is usually a high priority for environmental courses (Rubba, 1991). This goal may have a low priority in some educational jurisdictions where communities discourage students from engaging in social action. An STS science course would likely embrace all four goals, though each goal with a different emphasis.

Content

There is a marked difference between the content of university STS courses and the content of high school STS science courses. University courses invariably deal with science and technology policy, development, and/or discourse (Layton, chapter 4; Lepkrowski, 1989; McGinn, 1991). The subject is abstract. On the other hand, high school STS courses position themselves among the concrete experiences of students. These courses provide high school students with a simplified, although intellectually honest, perspective on the human and social aspects of science.

The content of STS science will include both science content and STS content. Here I focus on STS content. In the section that follows, "Integrative Structure," I explore how this STS content can be integrated with science content.

Many educators, particularly in North America, conceive of STS science content as dealing mainly with social issues that connect science with a societal problem (Yager, 1992a). Rosenthal (1989) and Ziman (1984) remind us, however, that there are two types of social issues in STS science:

1. Social issues external to the scientific community ("science and society" topics; for example; energy conservation or pollution),

2. Social aspects of science -- issues internal to the scientific community (the social epistemology of science; for example, the nature of scientific theories, or the cold fusion controversy).

The full range of STS content in science education is made evident in Cheek's (1992c) thorough review of 15 STS projects, syllabi, guidelines and major policy statements. He analyzed projects from all over the world, but gave special attention to the STS content proposed by Rubba and Weisenmayer, (1985a), Waks (1987a), Aikenhead (1986), and the Science Through STS Project (1985).

The science education community holds a variety of views concerning STS content. Nevertheless, a succinct definition of STS content is offered here. The definition attempts to encompass the full range of views held by science educators. STS content in a science education curriculum is comprised of an interaction between science and technology, or between science and society; and any one or combination of the following:

. A technological artefact, process, or expertise

. The interactions between technology and society

. A societal issue related to science or technology

. Social science content that sheds light on a societal issue related to science and technology

. A philosophical, historical, or social issue within the scientific or technological community.

This broad definition is used in the next section to describe the structure of STS curricula.

Integrative Structure

Various STS science curricula embrace different goals and content due to different views about the nature of STS. To clarify STS education further, a descriptive scheme is proposed, "Categories of STS Science" (Table 5.1). It delineates the diversity in STS science in terms of the degree and manner in which STS content is integrated with traditional science content. In other words, the scheme deals with the integrative structure of STS science education.

Before describing the scheme, let me comment on its limitations. The scheme does not attempt to evaluate different approaches to STS science. Nor does it attempt to prescribe any particular set of goals, or goal priorities, mentioned above. Moreover, the scheme does not address: teaching methods (for example, inquiry, problem solving, decision making), contexts for instruction (for example, local issues, public policies, global problems), and assumptions about how students learn (though constructivism predominates in STS science; Cheek, 1992c).

The proposed scheme, "Categories of STS Science" (Table 5.1), characterizes STS science in terms of:

🎬 . Content structure -- the proportion of STS content compared with traditional science content, and the way the two are combined;

. Student evaluation -- the relative emphasis given to STS versus traditional content. The description is an approximate indicator of relative emphasis, rather than a prescription for classroom practice.

. Concrete examples of STS science. Each category in Table 5.1 is illustrated by titles of published teaching materials for schools, along with the names of their publishers. Due to space limitations, the list of titles is incomplete.

A spectrum underlies the proposed scheme. The spectrum expresses the relative importance afforded STS content in a science course. At one end of the spectrum (category one), STS content is given lowest priority compared with traditional science content, while at the other end (category eight), it is given highest priority. The eight categories of the spectrum are:

(1) motivation by STS content, (2) casual infusion of STS content, (3) purposeful infusion of STS content, (4) singular discipline through STS content, (5) science through STS content, (6) science along with STS content, (7) infusion of science into STS content, and (8) STS content. One can think of each category as a conveniently identified point along the spectrum. Although no particular category can be said to represent "true" STS science instruction, categories three to six represent views most often cited by STS science leaders. Table 5.1 was inspired by a table about technology education in an article by Fensham (1988).

STS science teaching conveys the image of socially constructed knowledge. Its student-oriented approach (Figure 5.1) emphasizes the basic facts, skills, and concepts of traditional science (John Ziman's "valid" science, chapter 3), but does so by integrating that science content into social and technological contexts meaningful to students. The priority of goals for STS science teaching will vary in each country and community. A curriculum's STS content will alter accordingly. Nevertheless, I proposed a broad definition of STS content in order to help articulate the kinds of variations that exist in STS science teaching today.

The priority of STS goals may also affect the structure of an STS science course. Various structures are represented in Table 5.1. A recommended sequence in the design of STS science is suggested in Figure 5.2.

Good science-technology-society science education is relevant, challenging, realistic, and rigorous. STS science teaching aims to prepare future scientists/engineers and citizens alike to participate in a society increasingly shaped by research and development involving science and technology.

TABLE 5.1: Categories of STS Science

🎬 1. MOTIVATION BY STS CONTENT

Traditional school science, plus a mention of STS content in order to make a lesson more interesting. (The low status given to STS content explains why this category is not normally taken seriously as STS instruction).

Students are not assessed on the STS content.

EXAMPLES: What many teachers do now to spice up the pure science content.

🎬 2. CASUAL INFUSION OF STS CONTENT

Traditional school science, plus a short study (about 1/2 to 2 hours in length) of STS content attached onto the science topic. The STS content does not follow cohesive themes.

Students are assessed mostly on pure science content and usually only superficially (such as memory work) on the STS content (for instance, 5% STS, 95% science).

EXAMPLES: Science and Technology in Society SATIS (U.K.: Association for Science Education), Consumer Science (U.S.A.: Burgess), Values in School Science (U.S.A.: R. Brinckerhoff, Phillips Exeter Academy, Exeter, New Hampshire).

3. PURPOSEFUL INFUSION OF STS CONTENT

🎬 Traditional school science, plus a series of short studies (about 1/2 to 2 hours in length) of STS content integrated into science topics, in order to systematically explore the STS content. This content forms cohesive themes.

Students are assessed to some degree on their understanding of the STS content (for instance, 10% STS, 90% science).

EXAMPLES: Harvard Project Physics (U.S.A.: Holt, Rhinehart and Winston), Science and Social Issues (U.S.A.: Walch), Science and Societal Issues (U.S.A.: Iowa State University), Nelson Chemistry (Canada: Nelson), Interactive Teaching Units for Chemistry (U.K.: Newcastle Polytechnic), Science, Technology and Society, Block J (U.S.A.: New York State Education). Three SATIS 16-19 modules (What is Science? What is Technology? How Does Society Decide? U.K.: Association for Science Education.)

4. SINGULAR DISCIPLINE THROUGH STS CONTENT

STS content serves as an organizer for the science content and its sequence. The science content is selected from one science discipline. A listing of pure science topics looks quite similar to a category 3 science course, though the sequence would be quite different.

5. SCIENCE THROUGH STS CONTENT

STS content serves as an organizer for the science content and its sequence. The science content is multidisciplinary, as dictated by the STS content. A listing of pure science topics looks like a selection of important science topics from a variety of traditional school science courses.

6. SCIENCE ALONG WITH STS CONTENT

STS content is the focus of instruction. Relevant science content enriches this learning.

Students are assessed about equally on the STS and pure science content.

7. INFUSION OF SCIENCE INTO STS CONTENT

STS content is the focus of instruction. Relevant science content is mentioned, but not systematically taught. Emphasis may be given to broad scientific principles. (The materials classified as category 7 could be infused into a standard school science course, yielding a category 3 STS science course.)

8. STS CONTENT

🎬 A major technology or social issue is studied. Science content is mentioned but only to indicate an existing link to science. (The materials classified as category 8 could be infused into a standard school science course, yielding a category 3 STS science course.)

Students are not assessed on pure science content to any appreciable degree.

Science, Technology, Society and Environment Education

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Science, technology, society and environment (STSE) education, originates from the science technology and society (STS) movement in science education. This is an outlook on science education that emphasizes the teaching of scientific and technological developments in their cultural, economic, social and political contexts. In this view of science education, students are encouraged to engage in issues pertaining to the impact of science on everyday life and make responsible decisions about how to address such issues (Solomon, 1993 and Aikenhead, 1994)

technology and society technology science education

3. STSE Education

There is no uniform definition for STSE education. As mentioned before, STSE is a form of STS education, but places greater emphasis on the environmental consequences of scientific and technological developments. In STSE curricula, scientific developments are explored from a variety of economic, environmental, ethical, moral, social and political (Kumar and Chubin, 2000 & Pedretti, 2005) perspectives.

At best, STSE education can be loosely defined as a movement that attempts to bring about an understanding of the interface between science, society, technology and the environment. A key goal of STSE is to help students realize the significance of scientific developments in their daily lives and foster a voice of active citizenship (Pedretti & Forbes, 2000).

3.1. Improving Scientific Literacy

Over the last two decades, STSE education has taken a prominent position in the science curricula of different parts of the world, such as Australia, Europe, the UK and USA (Kumar & Chubin, 2000). In Canada, the inclusion of STSE perspectives in science education has largely come about as a consequence of the *Common Framework of science learning outcomes, Pan Canadian Protocol for collaboration on School Curriculum (1997)*. This document highlights a need to develop scientific literacy in conjunction with understanding the interrelationships between science, technology, and environment. According to Osborne (2000) & Hodson (2003), scientific literacy can be perceived in four different ways:

- **Cultural**: Developing the capacity to read about and understand issues pertaining to science and technology in the media.
- **Utilitarian**: Having the knowledge, skills and attitudes that are essential for a career as scientist, engineer or technician.
- **Democratic**: Broadening knowledge and understanding of science to include the interface between science, technology and society.
- **Economic**: Formulating knowledge and skills that are essential to the economic growth and effective competition within the global market place.

3.2. Goals

In the context of STSE education, the goals of teaching and learning are largely directed towards engendering cultural and democratic notions of scientific literacy. Here, advocates of STSE education argue that in order to broaden students' understanding of science, and better prepare them for active and responsible citizenship in the future, the scope of science education needs to go beyond learning about scientific theories, facts and technical skills. Therefore, the fundamental aim of STSE education is to equip students to understand and situate scientific and technological developments in their cultural, environmental, economic, political and social contexts (Solomon & Aikenhead, 1994; Bingle & Gaskell, 1994; Pedretti 1997 & 2005). For example, rather than learning about the facts and theories of weather patterns, students can explore them in the context of issues such as global warming. They can also debate the environmental, social, economic and political consequences of relevant legislation, such as the Kyoto Protocol. This is thought to provide a richer, more meaningful and relevant canvas against which scientific theories and phenomena relating to weather patterns can be explored (Pedretti *et al.* 2005).

In essence, STSE education aims to develop the following skills and perspectives[2]

- Social responsibility
- Critical thinking and decision making skills
- The ability to formulate sound ethical and moral decisions about issues arising from the impact of science on our daily lives
- Knowledge, skills and confidence to express opinions and take responsible action to address real world issues

3.3. Curriculum Content

Since STSE education has multiple facets, there are a variety of ways in which it can be approached in the classroom. This offers teachers a degree of flexibility, not only in the incorporation of STSE perspectives into their science teaching, but in integrating other curricular areas such as history, geography, social studies and language arts (Richardson & Blades, 2001). The table below summarizes the different approaches to STSE education described in the literature (Ziman, 1994 & Pedretti, 2005):

3.4. Summary Table: Curriculum Content

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Exercise 9:

What is Opportunities and Challenges of STSE Education.?

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Exercise 10:

Do you think that Scientific Literacy can Improving? Explain.

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Exercise 11:

Analyze a unit in science textbook and extract STS included in it.

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Exercise 12:

What is Science, Technology, Society and Environment Education

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Exercise 15:

Analyze a unit in science textbook and extract . PURPOSEFUL INFUSION OF STS CONTENT included in it.

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CHAPTER 3

WHAT IS PROJECTBASED LEARNING?

2.1 Introduction:

Project-based learning (PBL) involves students designing, developing, and constructing hands-on solutions to a problem. The educational value of PBL is that it aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams. Typically, PBL takes students through the following phases or steps:

1. Identifying a problem
2. Agreeing on or devising a solution and potential solution path to the problem (i.e., how to achieve the solution)
3. Designing and developing a prototype of the solution
4. Refining the solution based on feedback from experts, instructors, and/or peers

Depending on the goals of the instructor, the size and scope of the project can vary greatly. Students may complete the four phases listed above over the course of many weeks, or even several times within a single class period.

Because of its focus on creativity and collaboration, PBL is enhanced when students experience opportunities to work across disciplines, employ technologies to make communication and product realization more efficient, or to design solutions to real-world problems posed by outside organizations or corporations. Projects do not need to be highly complex for students to benefit from PBL techniques. Often times, quick and simple projects are enough to provide students with valuable opportunities to make connections across content and practice.

Implementing Project-Based Learning

As a pedagogical approach, PBL entails several key processes: (1) defining problems in terms of given constraints or challenges, (2) generating multiple ideas to solve a given problem, (3) prototyping — often in rapid iteration — potential solutions to a problem, and (4) testing the developed solution products or services in a "live" or authentic setting.

What is Project Based Learning?

- Project Based Learning (PBL) is a model and framework of teaching and learning where students acquire content knowledge and skills in order to answer a driving question based on an authentic problem, need, challenge, or concern.
- Project Based Learning is done collaboratively and within groups, using a variety of employability skills such as critical thinking, communication, and creativity.
- PBL incorporates student voice and choice as well as inquiry.
- Authentic PBL involves a community partner and a publicly presented end product.

- Project Based Learning involves an ongoing process of feedback and revision as well as reflection.

PBL CORE COMPONENTS

PROJECT BASED LEARNING UNITS INCLUDE THE FOLLOWING CORE COMPONENTS:

- Collaboration
- Employability (21st Century) Skills
- Community Partners
- Feedback & Revision
- Publicly Presented Product
- Reflection
- Standards: Content Knowledge & Skills
- Authenticity & Relevance: Addresses a real-world challenge, need, problem, or concern
- Inquiry
- Student Voice & Choice

The PBL Core Components make up the most important and crucial pieces of every PBL Unit. For PBL fidelity, it is important to embed each of these components into the PBL design process…PBL CORE COMPONENTS CONTINUED.

Characteristics of Project Based Learning

Here are three characteristics of meaningful project based learning activities that lead to deeper student understanding:

1.) Interdisciplinary

Project based curriculum is designed to engage students using real-world problems. This is an interdisciplinary approach because real-world challenges are rarely solved using information or skills from a single subject area. Projects require students to engage in inquiry, solution building, and product construction to help address the issue or challenge presented. As students do the work, they often use content knowledge and skills from multiple academic domains to successfully complete the project.

2.) Rigorous

Project based education requires the application of knowledge and skills, not just recall or recognition. Unlike rote learning to assess a single fact, PBL assesses how students apply a variety of academic content in new contexts. As students engage in a project, they begin with asking a question. Inquiry leads the student to think critically as they are using their academic knowledge in real-world applications. The inquiry process leads to the development of solutions to address the identified problem. They show their knowledge in action through the creation of products designed to communicate solutions to an audience.

3.) Student-centered

In PBL, the role of the teacher shifts from content-deliverer to facilitator/project manager. Students work more independently through the PBL process, with the teacher providing support only when needed. Students are encouraged to make their own decisions about how best to do their work and demonstrate their understanding. The PBL process fosters student independence, ownership of his/her work, and the development of 21st century/workplace skills.

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BENEFITS OF PROJECT-BASED LEARNING

Below are some of the widely cited benefits of implementing project-based learning in the classroom.

- Presents opportunities for deeper learning in context and for the development of important skills relating to college and career readiness
- Boosts student engagement and achievement and helps students develop the 21st-century skills they need to succeed in their future careers. These include critical thinking, communication, collaboration, and creativity, among others
- Makes room for student choice, allowing students to feel like architects of their own learning journey
- Improves student attitudes toward education, thanks to its ability to keep students engaged
- Provides plenty of opportunities for feedback and revision of the plan and the project
- Encourages students to make meaningful connections across content areas, rather than thinking about each subject area in isolation (multi-disciplinary pedagogical approach)
- Engages students in real-world learning, giving them a deeper understanding of concepts through relevant and authentic experiences. This prepares students to

accept and meet challenges in the real world, mirroring what professionals do every day

EXAMPLES OF PROJECT-BASED LEARNING

There are countless ways that project-based learning can be implemented into various subjects in the classroom.

Here are just a few examples:

PROJECT-BASED LEARNING IN ENVIRONMENTAL SCIENCE

In one science-based project, students begin with a visit to a zoo, learning about animal habitats and forming opinions on which habitats best suit a selected animal. For this example, the project component includes teams of students collaborating to develop a research-supported habitat plan for presentation to professional and student zoologists.

HOW TO IMPLEMENT PROJECT-BASED LEARNING IN THE CLASSROOM

It can seem daunting when using project-based learning in your classroom for the first time. However, small steps can lead to huge strides.

Project-based learning isn't something schools master in a matter of weeks, or even months. Instead, it's more a journey that unfolds year over year, as teachers develop their practice, learn with their students and grow through experience.

Here are some tips to help you implement project-based learning in the classroom.

1. START WITH SMALL, WELL ORCHESTRATED CHANGES

Carol Ann Tomlinson, when writing about differentiation in the classroom, advised teachers to start with "small, well orchestrated changes".

Select a few targeted goals you wish to work on this year with regards to project-based learning, and focus on doing those things well, concentrating on growth. This might mean keeping the scope and duration of a project to a minimum; using or renovating an existing project, and taking the time to get meaningful feedback from both students and relevant professionals.

2. LOOK AT THINGS FROM A STUDENT'S POINT OF VIEW

You can gain insight into how to get started with project-based learning by flipping your perspective and looking at it from a student's point of view.

Think about what questions they might have when it comes to this new way of learning. Provide them with valuable, easy-to-understand resources to help them make sense of PBL as a concept and the practical steps once they are engaged in the process.

Project-based learning often requires many skills that students may not be used to, such as researching, summarising, problem-solving, working as a team, learning to spot fake news etc. A good idea is to use any early foray into project-based learning to build these skills in a fun way.

3. HOLD AN IMMERSIVE, MULTI-DAY WORKSHOP

Many educators who have been successful with PBL say that the ideal way to get into it is through an immersive, multi-day workshop. This can be facilitated independently with somebody familiar with PBL practices at your school. However, in most cases it will be necessary to bring in an external facilitator – who is an experienced PBL practitioner – into the mix.

4. GENERATE POTENTIAL PROJECT IDEAS

There are plenty of places online teachers can find inspiration for possible project ideas to kick off their PBL journey. For example, you can find over 60 Gold Standard PBL project ideas over in the PBLWorks database.

However, online is not the only place to look to for ideas. Common types of project include:

- addressing a real-world problem (e.g. climate change);
- meeting a design challenge (creating a physical or digital artefact, or piece of writing; developing a plan; producing an event or providing a service);
- exploring an abstract question (e.g. when is violence justified?)
- conducting an investigation (e.g. a historical event or natural phenomenon)
- Taking a position on an issue (such as a present day or historical controversy).

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PRINCIPLES OF PROJECT METHOD:-

1. The Principle of freedom.
2. The Principle of purpose.
3. The Principle of activity.
4. The Principle of interest.
5. The Principle of utility.
6. The Principle of correlation.
7. The Principle of sociability.

8. The Principle of experience.

9. The Principle of reality.

10. The Principle of learning by doing.

TYPES OF PROJECT:-

All the project can be divided majorly into two types.

(i) Individual Project.

(ii) Group Project.

According to W.H. Kilpatrick projects are of four project.

i) Producer projects

ii) Consumer projects

iii) Problem projects

iv) Drill projects.

PRODUCER PROJECT: -

Here the emphasis is on actual construction of a material object or article.

CONSUMER PROJECT: -

Here the emphasis is gain on obtaining either direct or vicarious experience, such as reading and learning stories, listening to a musical delectation etc.

PROBLEM PROJECTS:-

The main purpose is to solve a problem using intellectual process, such as determining the density of a certain liquid.

DRILL PROJECTS: -

This type of project emphasizes on attaining a certain degree of skill in a reaction as learning a vocabulary.

Steps of Project Method:-

1. PROVIDING A SITUATION: -

The teacher provides a situation to the students which must create same problems and students must feel interested to work.

2. CHOOSING AND PURPOSING: -

The students are tempted to choose a project. The teacher should stimulate discussion by suggestion. While choosing the project the teacher should bear in need that it should be of real need to students. The purpose of project must be clearly defined to the students. The project must be common and acceptable to all. In case of wrong choosing, teacher must help students tactfully to see that the students choose a better project. They should be asked to write down the reasons for selection.

3. PLANNING: -

The success of the project lies in the good planning. The students should plan out ht whole project under the guidance of teacher. Every child must be encouraged to participate in the discussion and make suggestion. All the students are encouraged to write down the plan neatly and properly.

4. EXECUTING: -

Execution of different activities to different students on the basis of their capacity leads to successful completion of the project work. It is the longest step and requires meticulous assignment of duties to different students or groups the teacher must guide and encourage students. It is the duty of the teacher to keep watch on the process of activities and instruct as and when requirement.

5. EVALUATION: -

This is very important step as; the students review the project and find out mistakes if any. Self-Criticism is very important at this stage. The students discuss their work and rectify their mistakes and recollect useful knowledge. The teacher sees that the objectives of the project have been achieved.

6. RECORDING: -

The students keep a complete record of entire activity. How they planned, discussions were held, how duties are assigned, how criticism were made, which will help them in their future work.

EXAMPLES OF PROJECTS: -

i) Arrangement of science fair.

ii) Preparation of soap/chalk/candle/ink etc.

iii) Improvise apparatus.

iv) Beautifying campus.

v) Establishing science museum.

vi) Establishing physical science laboratory.

vii) Painting iron apparatus to present it from rusting.

ROLE OF TEACHER: -

1) Teacher must be a friend, guide and working partner.

2) Teacher must have through knowledge of individual student and allot work accordingly.

3) Provide democratic atmosphere.

4) He should learn with students and should not claim to know everything.

5) He must be inexperienced, initiative and process tact for creating positive ambience.

MERITS OF PROJECT METHOD: -

1) It promotes Co-operative activity.

2) It arouses and maintains interest of students.

3) It keeps the students on freedom of thought and action while doing the work.

4) It develops scientific attitude.

5) It widens the mental horizon of student.

6) It develops dignity of labour.

7) The students learn by self activity.

8) It supports all the laws of learning i.e., law of readiness, law of exercise, law of effect.

9) The correlation of subjects is best followed in this method. The subjects are not treated as water tight compartments.

10) This is a psychological method.

DEMERITS OF PROJECT METHOD: -

1. The knowledge is not acquired in a sequential manner.
2. There may be a chance of overlapping of subject matter.
3. If not planned and executed properly them, it may not be completed in time.
4. It is a time consuming process.
5. It may be a costly affair where in same items/things may not be available at times.
6. There may be overdevelopment of individualism and under development of co-operation and group responsibility.
7. If the topic in wrongly selected them the objective may not be achieved.
8. It gives to students a superficial knowledge of great many things. Therefore it is not suitable for all types of students.
9. This method is not suitable for a mature teacher.
10. The whole syllabus, for higher classes cannot be accomplished with this method.

SUGGESTIONS TO IMPROVE: -

1. The topic should have same educational value.
2. Project should be selected according to the student's interest.
3. Entire course should not be planned only using this method.
4. The objectives of the project must be clear and defined.

5. Students should be assigned various duties according to their capabilities.

6. The students should be given freedom to interact among themselves.

https://www.youtube.com/watch?v=mcDZL8xH_7Y

https://unacademy.com/lesson/natural-science-aims-objectives/RVVWT6NW

https://www.youtube.com/watch?v=JDEHA06RQbc

Scientific Investigation

Definition

Scientific investigation is the process through which scientists pose a research question and then observe and test varying phenomena. It also refers to the data collection and analysis after the experiment and the guidelines psychologists abide by when conducting research. However, scientific investigations are also daily instances when we make an observation and try to figure out the solution. Scientific investigations allow us to think critically about the world around us, especially in sciences and psychology.

Although scientific investigations are sometimes seen as synonymous with the scientific method, they should be viewed as the umbrella term that the scientific method falls under.

Scientific Investigation Steps

The method of scientific investigation follows a couple steps that help ensure that the research being conducted is as reliable and replicable as possible. Its sibling, the scientific method, has more structural and rigid steps that are to be followed.

For more on the scientific method, click here!

For scientific investigation, there are a couple key parts of the study that need to be done in order to have it follow the steps of the scientific investigation. Researchers need to make sure they design and execute an experiment following the scientific method, analyze their data, and ensure that all ethical guidelines are met.

Types of Scientific Investigation

There are three main types of scientific investigation – descriptive, comparative, and experimental. Looking for answers to research questions is what these three types have in common. However, there are distinct differences that set them apart from one another.

Descriptive Investigations

A key aspect of descriptive investigations is right there in the name – descriptions. **Descriptive investigations** are concerned with describing the world around us. They rely on highly detailed observations to bolster the investigation. This type of investigation does not need a hypothesis since it is simply based on observations.

An example of a descriptive investigation would be observing the stars. You can't actually conduct a typical scientific study on stars (also known as an experimental investigation), so your investigation would rely on detailed observations. Although there is a research question driving the study, there's no hypothesis able to be made since you can't create independent and dependent variables with the stars.

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Comparative Investigations

Comparative investigations focus on collecting data from different populations and then comparing the data. Unlike the descriptive, these investigations need a hypothesis since there is something to compare. An example of a comparative investigation would be gathering data on high school seniors across different high schools. There would be no control group since the data from the two populations is just being compared, but your experiment would still have a research question, hypothesis, predictions, and the collection of evidence.

Experimental Investigations

Experimental investigations are probably the investigations you first think of when someone mentions an experiment. These are the investigations that require the scientific method, variables, and a hypothesis. It requires the psychologist, scientist, or researcher to design a study that will fairly test the hypothesis. An example of an experimental investigation would be trying to determine how much attention someone thinks they're getting if they're wearing a T-shirt with an embarrassing image on it. The researchers would have to completely design an experiment using the scientific method, of course including a research question, hypothesis, predictions, and collect evidence.

Importance of Scientific Investigation

This structured scientific investigation is the backbone of furthering our knowledge of psychology.

Without the scientific method and a regulated way of conducting experiments, there would be no accurate way of determining if experiments produce consistent results. It is these results that we base our understanding of psychology on. For example, a psychologist decides to study the impact that inconsistent sleep has on memory. Then, they decide to test this by having participants vary their amount of sleep. On the first night, the participants sleep for four hours. The next night they sleep for nine and carry on this pattern for two weeks.

Sign up for free to unlock all images and more.

Fg.2 How do you reliably test sleep? pixabay.com/ddimitrova

If another psychologist wants to study the same theory but has the participants vary their sleep by only one hour a night; would this be testing the same theory as the first psychologist? What if the other psychologist kept the sleep pattern the same, but tested for six months instead of two weeks? It would still be studying the effect of inconsistent sleep on memory, but would not be studying the identical relationship as the original study.

This aspect of scientific investigation allows for a continued collection of data to bolster existing experiments.

Additionally, it ensures that the participants in the study remain physically and mentally safe not only during the study but also after. The American Psychological Association (APA), has guidelines to make certain the participants are safe and that there are no long-lasting effects from any experiments in which they participate. These guidelines were first implemented in 2003, with the latest revision in 2017.

Scientific Investigation - Key takeaways

- Scientific investigations are how scientists, psychologists, and researchers examine varying phenomena.
- Descriptive investigations are just recording data about an observation you have. They don't require a hypothesis since they are based on observations and data recording.
- Comparative investigations collect data from different groups and then compare the data. They do need a hypothesis, as researchers are required to formulate a theory and test it during their experiment.
- Experimental investigations are what you usually think of when imagining a scientific investigation - they need a hypothesis, and have to follow the scientific method.
- Scientific investigations require researchers to follow the APA ethical guidelines to protect the safety (physical and mental) of the participants.

What is scientific investigation?

Scientific investigation is a process by which scientists observe and test varying phenomena.

What are the steps in a scientific investigation?

The steps in a scientific investigation are: Designing and executing an experiment using the scientific method, analyzing data, and ensuring ethical guidelines are met. The steps of the scientific method are: Make an observation and ask a question, do background research and make a hypothesis, conduct an experiment, collect data, and draw conclusions.

What is the main purpose of a scientific investigation?

The main purpose of a scientific investigation is to provide structure to research through the scientific method, data analysis, and ethical guidelines.

Which components are part of all scientific investigations?

Components that are part of all scientific investigations are, among others, recording data, analysis of data, and conclusion are part of all scientific investigations. Since descriptive investigations do not require a hypothesis, that cannot be included.

What is an example of a scientific investigation in psychology?

An example of scientific investigation in psychology is the (in)famous Little Albert experiment.

Chances are you've heard of the scientific method. But what exactly is the scientific method?

Is it a precise and exact way that all science must be done? Or is it a series of steps that most scientists generally follow, but may be modified for the benefit of an individual investigation?

Figure 2: Marbled emperor moth Heniocha dyops in Botswana. (CC-SA-BY-4.0; Charlesjsharp).

Does this moth remind you of an owl?

Asking a Question

Observations often lead to questions. For example, you might ask yourself why the moth has eye spots that make it look like an owl's face. What reason might there be for this observation?

Forming a Hypothesis

The next step in a scientific investigation is forming a hypothesis. A **hypothesis** is a possible answer to a scientific question, but it isn't just any answer. A hypothesis must be based on scientific knowledge, and it must be logical. A hypothesis also must be falsifiable. In other words, it must be possible to make observations that would disprove the hypothesis if it really is false. Assume you know that some birds eat moths and that owls prey on other birds. From this knowledge, you reason that eye spots scare away birds that might eat the moth. This is your hypothesis.

Testing the Hypothesis

To test a hypothesis, you first need to make a prediction based on the hypothesis. A **prediction** is a statement that tells what will happen under certain conditions. It can be expressed in the form: If A occurs, then B will happen. Based on your hypothesis, you might make this prediction: If a moth has eye spots on its wings, then birds will avoid eating it.

Next, you must gather evidence to test your prediction. **Evidence** is any type of data that may either agree or disagree with a prediction, so it may either support or disprove a hypothesis. Evidence may be gathered by an **experiment**

Drawing Conclusions

Evidence that agrees with your prediction supports your hypothesis. Does such evidence prove that your hypothesis is true? No; a hypothesis cannot be proven conclusively to be true. This is because you can never examine all of the possible evidence,.

Communicating Results

The last step in a scientific investigation is communicating what you have learned with others. This is a very important step because it allows others to test your hypothesis.

Exercise 1:

What is an example of a scientific investigation in psychology?

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Exercise 2:

Give an example of the Scientific Method

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Exercise 3:

. Describe the stages of a scientific investigation in brief

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Exercise 4:

Describe the process of formation of a hypothesis

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Exercise 5:

Describe the steps of making an Observation.

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Exercise 8:

Why is the process of Scientific investigation necessary

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CHAPTER 4

INSTRUCTIONAL TECHNIQUES AND METHODOLOGY

INTRODUCTION:

Instruction refers to a set of activities and interaction design to facilitate desirable changes in the behaviour of a learner. According to Heinich et. Al. (1982), it is “Communication specifically designs to broaden and extend the field of experience of learner”. On the other hand, technique is a way of doing something.

In the context above, an instructional technique is a way by which any chosen method can best be used to deliver a particular topic to the learners.

PROBLEM SOLVING METHOD: -

Science subject is one of the important subjects in school education. However, really the traditional teaching methods are challenged for their inability to foster critical thinking, holistic learning environment among children. The science subject must develop science process skills where children, observe, measure, classify, process information, interpret think on solving problems, analyze, synthesize, formulate conclusions, etc. but, it should be kept in mind that, creativity in an essential element of P.S.

In a problem solving method, children learn by working on problems. This enables the students to learn new knowledge by facing the problems to be solved. The students are expected to observe, understand, analyze, interpret find solutions, perform applications that lead to a holistic understanding of the concept. This method develops scientific process skills. This method helps in developing brainstorming approach to learning concepts.

The students thinking on problem and their understanding of the science behind it is based on common sense. It does not start from textual knowledge. Rather it proceeds from experiencing to gradually forming concepts through books at later stage. It is a process from practice to theory not vice versa. Knowledge here is not a goal but a natural out came of working on tasks. Students live in the real world and like to deal with concrete things where they can touch, feel manipulate things then the method is useful in igniting the process of science learning.

PRINCIPLES OF PROBLEM SOLVING METHOD: -

1. Principle of learning by doing.
2. Principle of purpose.

3. Principle of freedom of thought.
4. Principle of learning by experiencing.
5. Principle of utility.
6. Principle of scientific attitude.
7. Principle of interest.
8. Principle of reality.
9. Principle of concreteness.
10. Principle of objectivity.

STEPS IN PROBLEM SOLVING METHOD: -

1. Selection of problem.
2. Presentation of problem.
3. Collection of facts.
4. Drawing an outlines.
5. To reach a satisfactory conclusion.
6. Evaluation.
7. Writing report.

1) SELECTION OF THE PROBLEM: -

A remember of problems are confronted by the students in the class or outside. They are made to select a problem as per their capacity and interest.

2) PRESENTATION OF PROBLEM: -

Each student is made to feel responsible for presenting the problem in front of the teacher and class as per his insight. The students are free to give their suggestions on the problem.

3) COLLECTION OF FACTS: -

All the facts related to problem are collected either by a students or group. As a number of facts will be collected, it will help the students to keep the most pertinent facts and discard rest.

4) DRAWING AN OUTLINE: -

This is most important phase as a proper outline at this stage will lead to purposeful activity. The teacher will guide students to draw exact plan and follow it properly so that the solution to problem is reached. It is more or less like planning stage, where in a clear indication of outline leads to better result.

5) TO REACH A SATISFACTORY CONCLUSION: -

It is the longest step and requires outmost patience. The tentative solutions which are offered by students are properly noted down. A good number of arrangements, discussion, brainstorming results in reaching a satisfactory conclusion. The teacher has to be very careful at this stage as, if may lead to wrong conclusions. The discussions must be healthy and conducive atmosphere must be provided in the classroom for it.

6) EVALUATION: -

The students review the entire process and find out each and every stage where in they have made any mistakes. Self-criticism and Self-realization will give training of self confidence. The teacher must see that objective have been achieved.

7) WRITING REPORT: -

A complete report must be written by students. This will include, how they planned, what discussions were held, how duties were assigned, how satisfactory conclusion was reached

etc. the writing of report will be maintained as a record which will be used in future course of time.

ROLE OF TEACHER: -

1. Teacher must work as a facilitator.
2. Teacher must keep in mind that if in a child-directed learning not teacher-directed.
3. Teacher must provide situation for all students to come formed and contribute towards the success of the activity.
4. He must be alert and active to arouse interest among students.
5. Teacher must provide democratic atmosphere.
6. He must be initialize, tactful and we experienced.

MERITS OF PROBLEM SOLVING METHODS: -

1. Students develop democratic feting.
2. This method follows the principle of learning by doing.
3. They learn to use old facts in new references.

4. They become capable to generalize.

5. Students learn to find solution to their problem.

DEMERITS OF PROBLEM SOLVING METHOD: -

1. It is not economical from time and money point of view.

2. There is always a doubt of drawing wrong conclusions.

3. There is short of talented teachers to practice this method.

4. This is not suitable for all level students.

SUGGESTIONS TO IMPROVE: -

1. The time period must be fixed.

2. The objective should be fixed for a problem.

3. Proper attention must be gain by teacher towards students activities.

4. All students should be given equal opportunity to put forth their problems and ideas.

5. As far as possible the process of group formation should be psychological.

6. Apart from improvement of teaching the objective of this method should be development of routine problem solving skills.

Exercise 1:

WHY MERITS OF PROBLEM SOLVING METHODS?

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Exercise 2:

What is PRINCIPLES OF PROBLEM SOLVING METHOD

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Exercise 3:

What is Differences Between Teaching and Learning

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CHAPTER 5

Theory of Multiple Intelligences

INTRODUCTION:

Gardner himself asserts that educators should not follow one specific theory or educational innovation when designing instruction but instead employ customized goals and values appropriate to teaching, subject-matter, and student learning needs. Addressing the multiple intelligences can help instructors pluralize their instruction and methods of assessment and enrich student learning This

Howard Gardner of Harvard University originally identified seven distinct intelligences. According to Gardner, this theory, which emerged from **cognitive research**, "documents the extent to which students possess different kinds of minds and therefore learn, remember, perform, and understand in different ways."

In greater detail, the **theory** proposes that "we are all able to know the world through language, logical-mathematical analysis, spatial representation, musical thinking, the use of the body to solve problems or to make things, an understanding of other individuals and an understanding of ourselves. Where individuals differ is in the strength of these intelligences and the ways in which such intelligences are invoked and combined to carry out different tasks, solve diverse problems and progress in various domains." **Hani Morgan** (2014) supports Gardner's theory. Morgan's research indicated that differentiated instruction benefits all students, but must be presented by well-prepared, experienced and knowledgeable teachers.

This diversity, according to Gardner, should impact the way people are educated. He stated that these differences "challenge an educational system that assumes that everyone can learn the same materials in the same way and that a uniform, universal measure suffices to test student learning." **Joan Hanifin**, an Irish researcher, determined in a 2014 publication that the outdated system of education in Ireland was adversely affecting students in the long-term. By not embracing multiple methods of teaching based on different intelligences, students often left school feeling "under-valued."

THE 9 MULTIPLE INTELLIGENCES

Gardner claims that all human beings have multiple intelligences. These multiple intelligences can be nurtured and strengthened or ignored and weakened. His research from 1991 identified seven intelligences; in the intervening time, he has come to believe there are a total of nine intelligences:

- **Verbal-Linguistic Intelligence:** Well-developed verbal skills and sensitivity to the sounds, meanings and rhythms of words.
- **Mathematical-Logical Intelligence:** The ability to think conceptually and abstractly, and the capacity to discern logical or numerical patterns.
- **Musical Intelligence:** The ability to produce and appreciate rhythm, pitch and timbre.
- **Visual-Spatial Intelligence:** The capacity to think in images and pictures, to visualize accurately and abstractly.

- **Bodily-Kinesthetic Intelligence:** The ability to control one's body movements and to handle objects skillfully.
- **Interpersonal Intelligence:** The capacity to detect and respond appropriately to the moods, motivations and desires of others.
- **Intrapersonal Intelligence:** The capacity to be self-aware and in tune with inner feelings, values, beliefs and thinking processes.
- **Naturalist Intelligence:** The ability to recognize and categorize plants, animals and other objects in nature.
- **Existential Intelligence:** The sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why we die and how we got here.

While all people possess some level of each intelligence, most will experience more dominant intelligences that impact the way they learn and interact with the world around them.

MULTIPLE INTELLIGENCES AND LEARNING STYLES

Some may find it an impossible task to teach to all learning styles. However, teachers are using multimedia, so it is becoming easier. As teachers begin to understand learning styles more effectively, it is clear why multimedia is good for all learners and why a variety of media is more effective. Multimedia inherently speaks to the different types of learning preferences that one person has and has the potential to impart knowledge to a diverse class or group.

There are specific modes of multimedia and instruction techniques, which include the following:

- **Visuals:** Visual media help students acquire concrete concepts, such as object identification, spatial relationship or motor skills.
- **Printed words:** While the printed word is the most common method of dispensing information, some argue that audio is superior.
- **Sound:** Sound media offer a stimulus for sound recognition or recall. Audio narration is a useful tool for students who struggle with reading.
- **Motion:** Motion depicts human performance so that learners can copy the movement. This kinesthetic method can be essential for understanding some subject matter.
- **Color:** Choices on color display are required if it is essential to what is being learned (such as, the sky is blue).
- **Realia:** Realia teaches cognitive and motor skills with objects. Realia can be used with individuals or groups, depending on

the situation. Realia may be used to present information realistically, or with the way learners internalize information.

- **Instructional Setting:** Design must include what materials are being used, as well as the environment in which it is to be taught. Printed materials should be individualized to allow the learner to set the pace.
- **Learner Characteristics:** Teaching models must consider learner characteristics, as media may be interpreted in various ways by different learners. Research has not provided definitive methods in matching the media most suitable for types of learners.
- **Reading Ability:** Pictures aid learning for poor readers who understand spoken words rather than printed words; good readers can control the pace, and print allows for easier review.
- **Categories of Learning Outcomes:** Categories ranged from three to eleven and most include some or all of Gagne's (1977) learning categories: intellectual skills, motor skills, verbal information, overall attitudes and use of cognitive strategies.
- **Events of Instruction:** Teachers have to choose the external events which support internal learning with events of instruction. This occurs in the planning stage and before selection of appropriate media.
- **Performance:** It is important for students to perform tasks that demonstrate learning and retention. The elicited performances can be categorized by type: covert, overt, motor, verbal, constructed and select. Media should be selected to correspond with the desired outcome.

MULTIPLE INTELLIGENCES IN THE CLASSROOM

Educators have positively responded to Gardner's theory. It has been embraced by a range of educational theorists and, significantly, applied by teachers and policymakers to the problems of schooling.

Many schools in North America have sought to structure curricula according to the intelligences and to design classrooms—even whole schools—to reflect the understandings that Howard Gardner develops.

All intelligences are needed to live life well. Teachers, therefore, need to attend to all intelligences, not just the first two of verbal-linguistic or mathematical-logical intelligences, which have historically taken precedence.

MULTIPLE INTELLIGENCE ACTIVITIES

One of the most significant results of the theory of multiple intelligences is how it has provided eight different potential pathways to learning. If a teacher is having difficulty reaching a student in the more traditional linguistic or logical ways of instruction, the theory of multiple intelligences suggests several other ways in which the material might be presented to facilitate effective learning:

- Words (linguistic intelligence).
- Numbers or logic (logical-mathematical intelligence).

- Pictures (spatial intelligence).
- Music (musical intelligence).
- Self-reflection (intrapersonal intelligence).
- A physical experience (bodily-kinesthetic intelligence).
- A social experience (interpersonal intelligence).
- An experience in the natural world (naturalist intelligence).

You don't have to teach or learn something in all eight ways. However, simply knowing the possibilities available can enable you to decide which particular pathways interest you the most or seem to be the most effective teaching or learning tools.

The theory of multiple intelligences is so intriguing because it expands our horizon of available teaching and learning tools beyond the conventional linguistic and logical methods used in most schools (e.g. lecture, textbooks, writing assignments, formulas, etc.).

HOW DO WE BENEFIT FROM UNDERSTANDING MULTIPLE INTELLIGENCES?

When educators are given the freedom to move away from the traditional, visually-based methods of teaching, they will have the opportunity to reach more students, more effectively. By teaching to the dominant learning intelligences, teachers will find students to be more productive, more receptive and more willing to engage in the learning process.

As so many educators have already embraced this theory, it is time for educational administrators to take notice of new techniques that can be successful based on the research of Howard Gardner and the other researchers who have followed.

Types of Intelligence

Howard Gardner's theory of multiple intelligences categorizes at least eight different types of intelligence beyond "general intelligence" (*G factor*), which is just one categorization of human intellect.[2]

G factor has been used to assess how "smart" people are using the same conventional intelligence measurements, such as intelligence quotient (IQ) testing, since 1905.[3]

Gardner's MI theory broadens the scope of how we view "being intelligent" and opens our eyes to how people can be smart in many different ways.

Below are detailed descriptions of Gardner's eight multiple intelligences.

Visual-Spatial Intelligence

Having strong visual-spatial intelligence means that someone is especially good at perceiving real-world visual information accurately, visualizing imaginary things in their mind’s eye, and using visual and spatial representations to perform activities such as drawing, interpreting maps, or navigation.

Visual-Spatial Intelligence: Strengths and Skills

- Solving puzzles

- Drawing and painting
- Graphic design
- Making sculptures
- Interpreting charts and graphs
- Mapless navigation
- Detailed "mind's eye" visualizations
- Reading maps

Interestingly, you can have excellent visual-spatial intelligence without using your eyes. Gardner notes that other senses aside from sight are involved in visual-spatial intelligence.[2] For example, a person with vision loss can have extraordinary visual-spatial intelligence based on their ability to use other senses to create accurate representations of the world in their mind's eye.

Linguistic-Verbal Intelligence

The ability to express yourself and communicate ideas using spoken or written words is often a sign of strong linguistic-verbal intelligence.

Reading comprehension or having someone write an essay is a way of measuring this type of intelligence. Having the ability to persuade others using rhetoric during a debate is another sign of linguistic-verbal intelligence.[4]

Linguistic-Verbal Intelligence: Strengths and Skills

- Reading comprehension
- Storytelling
- Fictional writing
- Nonfiction writing
- Public speaking
- Persuasive use of rhetoric
- Winning debate competitions

Storytelling and fictional narratives rely on this type of intelligence. Nonfiction writing and public speaking also benefit from strong linguistic-verbal skills.

Logical-Mathematical Intelligence

People with robust logical-mathematical intelligence excel at solving complex problems and calculating numerical values.

Children who display this type of intelligence tend to think methodically and in a linear order. Students' logical-mathematical intelligence can be assessed based on their ability to classify and understand patterns and relationships.[5]

Logical-Mathematical Intelligence: Strengths and Skills

- Analytical reasoning
- Logical problem-solving
- Solving math problems
- Conducting scientific research
- Identifying patterns

- "Connecting the dots" in new and useful ways

People with strong logical-mathematical intelligence often like working with facts and figures. Their propensity for analytic thinking and solving problems based on data makes them good at things like computer programming, scientific research, engineering, and accounting.

Bodily-Kinesthetic Intelligence

Performing actions that require fluid physical coordination and controlled muscle movements requires bodily-kinesthetic intelligence.

Professional athletes, elite-level dancers, and surgical specialists become best in class by refining their motor skills using this type of intelligence.

By first grade, students are already displaying low, medium, and high levels of bodily-kinesthetic intelligence.[6]

But even if you weren't born with extraordinary athletic prowess or outstanding hand-eye coordination, with daily practice, your dexterity and motor coordination can improve.

Bodily-Kinesthetic Intelligence: Strengths and Skills

- Hand-eye coordination
- Fluid body movements

- Refined motor skills
- Playing sports
- Choreographed dancing
- Performing surgery
- Touch typing (without looking at the keyboard)

Musical Intelligence

As its name implies, musical intelligence refers to appreciating music and being able to recognize differences in pitch, timbre, rhythm, and tone.

Accumulating evidence suggests that musicality and perfect pitch are strongly influenced by genetics.[7]

Writing a catchy melody or composing a symphony both rely on musical intelligence. Even though legendary composers like Mozart and Beethoven are often heralded as musical geniuses, contemporary songwriters and "rock stars" like Ed Sheeran or The Beatles are, too.

Of course, you don't have to be famous to have plenty of musical intelligence.

Musical Intelligence: Strengths and Skills

- Reading music
- Writing songs
- Singing on key
- Having perfect pitch

- Playing an instrument
- Understanding musical structure
- Differentiating tone and timbre

Interpersonal Intelligence

The prefix *inter-* means "between." *Interpersonal* refers to relationships and communication between people. Having strong interpersonal intelligence means that you're good at interacting with others and understanding social dynamics.

Unlike someone with encyclopedic knowledge who is viewed as "book smart," someone with this type of intelligence would be considered "people smart."

Someone who's a "people person" is likely to have strong interpersonal intelligence. Working with the public in retail jobs or serving as a frontline worker in the service industry relies on this type of intelligence.

Politicians who are good at "schmoozing" flex their interpersonal skills during meet-and-greets with potential voters. Counselors and psychotherapists use their interpersonal intelligence to understand what clients are going through and give personalized help.

Interpersonal Intelligence: Strengths and Skills

- Ability to pick up on people's emotions
- Sensitivity to nonverbal cues and others' moods
- Can take a "fly on the wall" view
- Can put oneself in someone else's shoes
- Understands group dynamics
- Cooperative team player
- Social grace and finesse
- Engaging conversationalist

Intrapersonal Intelligence

The prefix *intra-* means "within." *Intrapersonal* refers to the thoughts within a person's mind. The metacognitive ability to think about one's thinking utilizes intrapersonal intelligence. Introspection and self-reflection are key to this type of intelligence. Highly creative individuals and daydreamers with vivid imaginations tend to have strong intrapersonal intelligence.

People with intrapersonal intelligence tend to be good at figuring out what makes them tick. This type of intelligence benefits self-starters and entrepreneurs who like to be their own bosses.

Intrapersonal intelligence can fortify people's intrinsic motivation to set and achieve personal goals. Notably, this type of intelligence often fuels learning motivation and the desire to become "smarter" at other intelligences like mathematics or foreign languages.[8]

Intrapersonal Intelligence: Strengths and Skills

- Self-awareness
- Introspection
- Metacognition
- Intuitive thinking
- Daydreaming
- Vivid imagination
- Creativity
- Intrinsic motivation
- Setting and achieving goals
- Entrepreneurship

Naturalistic Intelligence

Howard Gardner added naturalistic intelligence to MI theory in a 2006 book, "Multiple Intelligences: New Horizons in Theory and Practice."[9]

This type of intelligence refers to someone's ability to connect with nature and is marked by a heightened interest in other species, the outdoors, and exploring the wilderness.

Botanists who study plants and flowers fortify this type of knowledge with the help of their linguistic-verbal intelligence. Surfers who become one with the waves and rock climbers who scale mountains cultivate innate naturalistic intelligence via lived experience and bodily-kinesthetic intelligence.

People with naturalistic intelligence are more likely to be interested in sustainability and preserving the environment. Conservationists who dedicate their lives to protecting nature and wildlife can use their knowledge about the impacts of climate change to motivate others to reduce their carbon footprint.

Naturalistic Intelligence: Strengths and Skills

- Appreciation of nature
- Recognizing flora and fauna
- Gardening and horticulture
- Zoology
- Birdwatching
- Awe-inspired walking or jogging outside
- Hiking
- Rock climbing
- Surfing
- Conservationism
- Summary
- Howard Gardner's theory of multiple intelligences shatters the notion that IQ testing is the only way to measure human intellect.
- According to the theory, there are at least eight different types of human intelligence. Although someone may not do well on

standardized tests that measure "general intelligence" or *G factor,* it doesn't mean they're not "smart" in other ways. MI theory reminds us that the scope of human intelligence is broad and multidimensional.

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Exercise 1:

- **WHO have Musical Intelligence?**

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Exercise 2:

- **What is Differences Between Musical Intelligence: Visual-Spatial Intelligence**

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Exercise 3:

- **What is Differences Between Verbal-Linguistic Intelligence and Mathematical-Logical Intelligence**

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Exercise 4:

- ## WHAT IS Visual-Spatial Intelligence?

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CHAPTER 6

Constructivism theory IN SCIENCE TEACHING

INTRODUCTION:

Constructivism is an important learning theory that educators use to help their students learn. Constructivism is based on the idea that people actively construct or make their own knowledge, and that reality is determined by your experiences as a learner. Basically, learners use their previous knowledge as a foundation and build on it with new things that they learn. So everyone's individual experiences make their learning unique to them.

Constructivism is crucial to understand as an educator because it influences the way all of your students learn. Teachers and instructors that understand the constructivist learning theory understand that their students bring their own unique experiences to the classroom every day. Their background and previous knowledge impacts how they are able to learn. Educators are able to use constructivist learning theory to help their students understand their previous knowledge. If you're a current or aspiring educator, it's important to get the education and credentials you need. But it's also important to understand learning theories and how they impact you and your students. This guide will tell you more about the constructivist learning theory and how it helps you as a teacher.

Principles of constructivism.

There are many specific elements and principles of constructivism that shape the way the theory works and applies to students. Learn about the different principles of constructivism and how they make up the whole theory.

- Knowledge is constructed. This is the basic principle, meaning that knowledge is built upon other knowledge. Students take pieces and put them together in their own unique way, building something different than what another student will build. The student's previous knowledge, experiences, beliefs, and insights are all important foundations for their continued learning.
- People learn to learn, as they learn. Learning involves constructing meaning and systems of meaning. For example, if a student is learning the chronology of dates for a series of historical events, at the same time they are learning the meaning of chronology. If a student is writing a paper about history, they are also learning principles of grammar and writing as well. Each thing we learn gives us a better understanding of other things in the future.
- Learning is an active process. Learning involves sensory input to construct meaning. The learner needs to do something in order to learn, it's not a passive activity.

Learners need to engage in the world so they are actively involved in their own learning and development. You can’t just sit and expect to be told things and learn, you need to engage in discussions, reading, activities, etc.

- Learning is a social activity. Learning is directly associated to our connection with other people. Our teachers, our family, or peers, and our acquaintances impact our learning. Educators are more likely to be successful as they understand that peer involvement is key in learning. Isolating learnings isn’t the best way to help students learn and grow together. Progressive education recognizes that social interaction is key to learning and they use conversation, interaction, and group applications to help students retain their knowledge.
- Learning is contextual. Students don’t learn isolated facts and theories separate from the rest of our lives—we learn in ways connected to things we already know, what we believe, and more. The things we learn and the points we tend to remember are connected to the things going on around us.
- Knowledge is personal. Because constructivism is based on your own experiences and beliefs, knowledge becomes a personal affair. Each person will have their own prior

knowledge and experiences to bring to the table. So the way and things people learn and gain from education will all be very different.

- Learning exists in the mind. Hands-on experiences and physical actions are necessary for learning, but those elements aren't enough. Engaging the mind is key to successful learning. Learning needs to involve activities for the minds, not just our hands. Mental experiences are needed for retaining knowledge.

Motivation is key to learning. Students are unable to learn if they are unmotivated. Educators need to have ways to engage and motivate learners to activate their minds and help them be excited about education. Without motivation, it's difficult for learners to reach into their past experience and make connections for new learning

Constructivist Learning Theory in Practice

How does constructivism impact your training programme? Let's take a look!

The Learner

According to constructivist learning theory, each learner constructs knowledge based on prior information and experiences. As such, you should take care to treat every learner as an individual.

They will naturally make their own deductions based on their background or culture.

This means learner-led experiences, personalisation and open access to training content are the order of the day. After all, the expectation for learners to take charge of their learning is greater.

However, as we've seen from social constructivist theory, this individualism should not prevent you from adopting a social learning strategy. Each individual learner can still construct their knowledge through interactions with others.

The Instructor

Despite the focus on the individual, instructors still play an important role! After all, to help encourage learners to construct their own interpretations, you'll need to create a supportive learning environment.

The right instructor can help to make this happen.

With a social constructivist approach, instructors need to become adept at facilitating learning rather than delivering it. Instead of telling learners about concepts, *ask* them so they can draw their own conclusions.

Consequently, the learning process becomes much more active and learners are much more engaged. According to Gallup, engaged learners are 2.5 times more likely to report good test results!

Characteristics of Constructivism

Let's take a look at some of the key characteristics of a constructivist learning / teaching approach:

- Learning is a never ending experience. Our understanding of the world is constantly expanding.

- In this sense, learning could be seen as a search for meaning.
- We should make sure that we understand concepts as a whole, rather than just in parts.
- Curricula should be customised for different students.
- Collaborative and conversational learning can be remarkably effective.
- And regular assessments and assignments are useful to check understanding.

Now let’s take a look at a few of the ways constructivist learning theory can help with your online learning initiatives

Online Learning and Constructivist Learning Theory

Increased Collaboration

As mentioned earlier, social constructivist theory frames learning in a more collaborative context. A lot of social constructivist models make it clear that collaboration between learners is essential.

Therefore, making use of collaborative tools on an online learning platform is really beneficial.

On Growth Engineering LMS, there are features that facilitate this. For example, learners are able to post to various Social Feeds on the platform. Social Feeds provide learners with a comprehensive view of discussions and enable them to join in on the action.

As a facilitator rather than teacher, you can ask a discussion question on a social feed and wait for learners to chime in. Learners can then collaborate and bounce ideas off of each other.

Social Feeds also help to provide a safe space where learners can reflect on their experiences and connect it with new knowledge.

This can help to drive real business impact. Did you know that collaborative tools are able to increase workplace productivity by 30%? That’s the power of social!

In addition, a Raconteur survey found that 56% of employees ranked a collaborative measure as the top reason for improved profitability.

Increased Communication

With any training initiative, communication with your learners is vital. A survey of 400 companies found that those with poor communication reported an average loss of $62.4 million per year.

This is why social features on an LMS are great to use in conjunction with constructivist theory. Together they have the power to cause an incredible increase in knowledge retention and performance. Features include:

1. **Expert Area:** In this area, subject matter experts (SMEs) reside to answer any questions that your learners may have. What's more, all questions and answers are made available for everyone to view! Therefore, saving people time asking the same questions over and over again.

2. Live Chat: This puts the power of instant messaging in the hands of learners. They can easily discuss topics with each other in a free-flowing environment.

Working together to draw conclusions has been shown to help learners learn quicker and make information stickier. Additionally, research has shown that they test better too!

3. Clubs: On Growth Engineering LMS, you have the ability to create Clubs. These Clubs can be based on any topic that you choose.

Learners are then able to join Clubs relating to a topic they want to learn about. As learners add their own contributions to the discussion, Clubs become a library of user-generated content.

Consequently, any future learner who wants to find out more about something can head there! In a world that's increasingly shifting towards remote learning, this is a major benefit to take advantage of.

Lastly, there also needs to be increased communication between you and your learners.

With constructivist learning approaches, your role becomes more of a facilitator than instructor. Therefore, you should also make use of push notifications.

On Growth Engineering Learning App, you can send learners custom notifications. This way you'll be able to direct them to new content, or exciting discussions taking place.

As a result, learners still remain in control of their learning, they just have a little more guidance and direction.

Increased Motivation

Constructivist learning theory is also great for boosting the motivation of your learners. As you've trusted them to be in charge of their own learning, they will feel more empowered.

Exercise 1:

WHY STUDY CONSTRUCTIVIST LEARNING THEORY?

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Exercise 2:

What is Differences Between Constructivist learning theory And others theories..

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Exercise 4:

WHAT IS theory?

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Exercise 5:

What is Student-Centered Approach to Learning

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Exercise 6:

Select a Chemistry lesson and show us how to plan and teach it in a way which demonstrates that science could be a common language among all humans.

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CHAPTER 7

Cooperative Learning

7.1INTRODUCTION:

What is Cooperative Learning?

What most people think of when they hear the term **cooperative learning** is group projects. However, cooperative learning is an organized strategy to use groups to help students work together to accomplish a task or to learn new material. Cooperative learning requires all members of a group to participate since each individual should hold responsibilities necessary for the group to complete the task. When many people think of group work they may think of conflicts between group members, or uneven distribution of tasks by group members. Cooperative learning is not this; it is a way to use small groups to enhance learning, not inhibit it. When done correctly, cooperative learning enhances the classroom, as well as teaches students to work as a team, a skill necessary in any job.

Cooperative Learning Examples

There are many different ways to implement cooperative learning in the classroom. Here are some examples of cooperative learning in action.

Some groups require students to meet temporarily for a small period of time during class, usually not for more than a class period. This may be for a moment when the teacher asks a question to open the class such as, "Why do you think the colonists decided to write the Declaration of Independence?" The teacher will have pre-assigned partners for the class and ask students to meet with their partner to discuss this question.

In other groups, students work together for longer periods of time. For example some teachers implement a peer tutoring system in their classes, where a student who performed well on the last unit will be paired with a student who needs additional help. They may work for the next few class periods to cover the material again. During this process the more advanced student gets to apply their knowledge by teaching it to someone else, and the struggling student gets additional assistance.

How To Group Students

One of the most difficult parts of leading cooperative learning can be forming groups for students to work in. Working as a team is a learned skill. Sometimes there will be difficulties in the process such as mismatched ability levels, or negative group dynamics, but these can be fixed with simple adjustments.

Usually cooperative groups are organized to include a mix of students at different ability levels. This way, students can help each other learn. This could mean that a group of four may have two above average students and two below average students. The above average students receive enrichment by helping, and the below average students receive additional assistance, which frees up time for the teacher to manage the groups throughout the task.

Students forming their own groups can lead to distraction, or ability groups that are too homogeneous. It can help to have students work in the same groups over a period of several weeks. This gives them time to get to know each other and establish norms and group dynamics. According to the cooperative learning model the best practice is to have students work in this group for about two months.

Benefits of Cooperative Learning in the Classroom

There are many benefits of implementing cooperative learning strategies in the classroom.

- Cooperative learning is specifically designed so that groupings provide the maximum amount of benefit for students. Groups are organized to enrich students at all levels.

- Many students enjoy cooperative learning and find it fun. It makes them excited to complete tasks. While learning should be the priority, it is good for students' development for them to work together, and socialize with one another.
- It is also very engaging for students because this form of learning is much more interactive than individual learning. This makes students active participants in their own learning.
- Cooperative learning allows students to talk to one another, through discussion. When done well it can help them develop their critical thinking skills.
- It can also help them better retain the information they have learned. They tend to learn more and remember what they have learned for a longer time through cooperative learning.

- **Cooperative learning is defined as students working together to "attain group goals that cannot be obtained by working alone or competitively"** (Johnson, Johnson, & Holubec, 1986).

- The main purpose of cooperative learning is to actively involve students in the learning process; a level of student empowerment which is not possible in a lecture format. The underlying premise is founded in constructivist epistemology.

- It is a process which requires knowledge to be discovered by students and transformed into concepts to which the students can relate. The knowledge is then reconstructed and expanded through new learning experiences.

- Learning takes place through dialog among students in a social setting.

Cooperative learning is a methodology that employs a variety of learning activities to improve students' understanding of a subject by using a structured approach which involves a series of steps, requiring students to create, analyze and apply concepts (Kagan, 1990). Cooperative learning utilizes ideas of Vygotsky, Piaget, and Kohlberg in that both the individual and the social setting are active dynamics in the learning process as students attempt to imitate real-life learning.

By combining teamwork and individual accountability, students work toward acquiring both knowledge and social skills. It is a teaching strategy which allows students to work together in small groups with individuals of various talents, abilities and backgrounds to accomplish a common goal. Each individual team member is responsible for learning the material and also for helping the other members of the team learn.

Students work until each group member successfully understands and completes the assignment, thus creating an "atmosphere of achievement" (Panitz, 1996). As a result, they frame new concepts by basing their conclusions on prior knowledge. This process results in a deeper understanding of the material and more potential to retain the material.

Implementation of Cooperative Learning

There are three phases of the implementation of cooperative learning.

1. The first phase is the **pre-implementation phase**, which includes: specifying instructional objectives, determining group sizes and assigning students to groups, arranging room, planning instructional materials to promote interdependence, assigning group roles, assigning tasks, explaining the criteria for success, structuring positive interdependence and accountability, and specifying desired behaviors.
2. The second phase is **implementation** which includes: monitoring behavior, intervening if needed, assisting with needs, and praise.
3. The third phase is **post-implementation** which includes: providing closure through summarization, evaluating students' learning, and reflecting on what happened.

Pre-Implementation

After deciding to implement cooperative learning, the biggest challenge will be planning and readying the classroom and students for CL. According to Johnson, Johnson, and Smith (1991), there are several tasks that an instructor must accomplish before implementing cooperative learning in the classroom. This section will detail those responsibilities.

Specify Instructional Objectives (academic and social) of CL– The instructor must explain why she is using CL, describe its benefits, and the results typically found from using CL. To aid in this explanation, the instructor might produce and distribute a handout that describes collaborative learning.

Determine Group Size and Assign Students to Groups– Group size can range from two to four students, depending on the CL task. These groups can be homogeneous or heterogeneous. Groups can be formed by putting students together who share common strengths, interests, etc, or they can be randomly assigned. Once the groups are assigned, though, they should not be changed too often; students need time to develop a cohesive group and work together for a while before moving to a different group.

Arrange room– Instructors should optimize the space in their classroom so that students/groups can interact and move about the room easily. It is essential that a group's seats face one another. Further, research tools should be made easily available either in the classroom or in another room near the classroom (see, Resource-based Learning chapter for a more detailed discussion of this).

Plan instructional materials to promote interdependence– The instructional methods and materials that an instructor chooses must allow each individual to contribute to the group's success in a unique and meaningful way. Without these unique contributions, a group's structure and cohesion will be put in jeopardy.

Assign group roles– There is some debate about whether or not the instructor should play a role in this decision. Whether or not an instructor chooses to assign roles within a group, they should make sure there is a distinct role for each student. Also, the instructor should choose or assist the students in choosing roles that use their strengths and improve their areas of weakness. Instructors should also oversee that students don't choose the same role over and over again. Some of the roles that could be chosen or assigned include facilitator, timekeeper, recorder, checker (for understanding), summarizer, elaborator (on prior knowledge or discussion points), research-runner (gets materials), and wild card (does anything else that needs to be done).

Assign task– When picking an assessment task (product to be produced), the instructor should choose one standard to address and match it to the learning approach. The cooperative learning group's task should be interesting, challenging, and motivating. It should also be a performance driven and authentic task. The instructor should clearly explain procedures for the task, provide structure (especially useful for inexperienced CL students), and set a specific time frame for each part and the whole task. Finally, the instructor should question the students to check for understanding of the task and its procedures.

Explain Criteria for Success– The instructor should communicate the group-work skills that will be evaluated. A rubric should also be created, possibly with the students' assistance, which will be used to evaluate the group-work skills as well as the assessment task.

Structure positive interdependence and accountability– Group size should be kept small so that each member participates and contributes uniquely to the group. Instructors should also "test" groups and individuals by asking questions of both. A group should be asked to collectively explain its results and individuals should be able to defend their own position as well as the group's as a whole.

Specify desired behaviors– An essential part of cooperative learning's success is teaching students how to work in a group. To accomplish this, the instructor can conduct mini-lessons on ways to respect others (i.e. praise, taking turns, and shared decision making). Students also need to be trained in conflict-resolution. Finally, it would be wise to use icebreaker activities before beginning so that students find that they have something in common.

Before the actual implementation of cooperative learning, students also have several tasks. First, they can help the instructor generate an evaluation rubric, and they could possibly help design the assessment task if the instructor is willing to let the students participate in this capacity. By playing a part in the production of these items, students will have a greater motivation to participate in the group work (see Six C's of Motivation chapter about choice and control as methods to increase motivation).

Finally, the students' most important role at this point in CL is to question the instructor if anything is unclear to them. Without students' complete understanding of the goals, objectives, and procedures, cooperative learning will not be a success.

As illustrated in the scenario at the beginning of the chapter, the students in Mrs. Solomon's classroom are very diverse and appear not to get along. Before implementing CL, it will be vitally important that Mrs. Solomon spend some time teaching respect, conflict-resolution, and other group work skills. It is probably a good idea to use some icebreaker activities so that the students learn that they have some commonalities with other class members.

In addition, because of the tension among them, Mrs. Solomon will want to assign students to cooperative learning groups; she may even want to assign each individual their role. As Mrs. Solomon designs and assigns the task to the students, it will be imperative that she chooses a structured, authentic assignment. This will assist the students in remaining on-task, and it will help with transferring their knowledge to real-world applications.

Monitor behavior– During the implementation of cooperative learning, the instructor should circulate throughout the classroom, visiting each group.

Intervene if needed– While circulating, if the instructor notices any group conflict or off-task behavior, she should intervene. Small-group conflict should be resolved as soon as possible, and students should be shown how to prevent problems in the future. The instructor might use a conflict resolution checklist to resolve the group's conflict. This checklist includes items such as explaining the importance of listening to everyone in the group, defining responsibilities, valuing each person's gifts, modeling excellence, and promoting humor. Having these listed on a handout for each group could prevent group discord and off-task behavior.

Assist with needs– While monitoring the groups' work, the instructor should assist groups with their needs. This might involve pointing out additional resources and/or points-of-view, and it also includes helping the students reflect on the work they have completed and their progress.

Praise– Students need to know if they are completing the assignment in a satisfactory manner, especially if they are inexperienced at working in cooperative groups. For this reason, the instructor should let individual students and groups know when they do something right or well.

Post Implementation

After many hours are spent planning for cooperative learning groups, the plan is then put into action. Johnson, Johnson, and Smith (1991) give three jobs for the instructor to complete after the students have worked together to complete and submit the task.

Provide closure through summarization– The instructor should reconvene the entire group of students. At this point, the instructor can summarize the important points of the lesson/unit. Another suggestion is to have each group summarize their work and points that they think were important. This helps the instructor to know exactly in which knowledge level the groups are working. This is also very much in line with the idea of articulation and reflection in the Cognitive Apprenticeships chapter.

Evaluate students' learning– The instructor should use a rubric to grade/ evaluate each group's assessment task. They should also be evaluated on their group work using a rubric. These rubrics should have been created during the pre-implementation phase of cooperative learning, and the students might have had input into their content. After the instructor has completed the evaluations, it is important that they provide feedback to the students about their product and their group performance. Without this information, the students will not be able to improve their cooperative learning skills.

Reflect on what happened– Instructors should keep a record of what worked and why it worked each time they undertake a CL lesson or unit. This information can and should be shared with their cooperative learning support group. The instructor should also adjust their lessons based on the reflection and feedback of the students. This will prevent the stagnation of a CL unit; it will grow and change with each group of students.

After completing the group work and assessment task, the student's job is to reflect on the work that was accomplished in their group. What worked and what did not work? What would they change or keep next time they work together? The students should also give feedback to their instructor. They should be able to tell the instructor what worked or what was good about this unit, and they should point out what did not work well. This information can be written down or informally discussed in class.

At the conclusion of Mrs. Solomon's first cooperative learning lesson, it will be important for her to get feedback from the students about how they thought the lesson went. In turn, she will also have to provide feedback to the students about their group work skills and their assignment. This may involve teaching or re-teaching group work skills and/or adjusting the procedures for the next cooperative learning lesson.

Frequently Asked Questions about Cooperative Learning

When is the best time to begin implementing cooperative learning?

The best time to begin using CL in the classroom is at the start of a new term or school year. This way, the students will not be exposed to individual work and then have to "switch gears" and learn to work in a group in the middle of the year.

Do you have to use cooperative learning all the time?

No, it is not necessary to use CL in your classroom at all times. It is often advised to use CL for a unit or two, use another teaching method for a while, and then revisit CL at a later time.

Should you include parents in cooperative learning?

Yes, parents and the community should be included in all school activities, including CL. This can be done through newsletters and/or special programs when parents and the community, visit the classroom and view the groups' assessment tasks.

What happens if one group finishes early?

If one group finishes early, the instructor can provide extension activities/tasks for that group. As more groups finish, pairs of groups can team up and share/comment on each other's work.

Other Forms of Cooperative Learning Groups [2]

3-step interview– Members of a group choose one partner from the group. The individuals interview their partners by asking questions. Then, they reverse roles and share their responses with the rest of the group.

3-review– The instructor gives the teams 3 minutes to review/clarify what has been said.

Numbered Heads– Group members are assigned a number. The group discusses as one, and then the instructor calls one number. The person with that number answers for the group.

Team-pair-solo– Students do the problem(s) first as a team, then in a pair, and finally, solo.

Circle the sage– The instructor polls the students looking for special knowledge on a certain topic. Those with the knowledge spread out around the room. (They are the sages.) The other students (no two from the same team) circle the sage, take notes on the information they are presenting, and question them. Then, the group reforms and each explains what they have learned. If there is a disagreement, it is aired as a group with the whole class, and it is resolved there.

Structured problem solving– Groups are given a problem to solve within a specified time. All members must agree and all must be able to explain the solution.

Send-a-problem– Several groups generate solutions to problems. The problem is clipped to the outside of a folder, and all solutions from that group are written down and placed inside the folder. The folder is passed to a different group who reads the problem, but not the solutions. They write their solutions and put them inside the folder. A third group selects the two best solutions and amends them as necessary.

Benefits of Cooperative Learning

Ted Panitz (1996) lists over 50 benefits provided by cooperative learning. These benefits can be summarized into four major categories: social, psychological, academic and assessment.

Cooperative learning promotes social interactions; thus students benefit in a number of ways from the social perspective. By having the students explain their reasoning and conclusions, cooperative learning helps develop oral communication skills. Because of the social interaction among students, cooperative learning can be used to model the appropriate social behaviors necessary for employment situations.

By following the appropriate structuring for cooperative learning, students are able to develop and practice skills that will be needed to function in society and the workplace. These skills include: leadership, decision-making, trust building, communication and conflict-management.

The cooperative environment also develops a social support system for students. Other students, the instructor, administrators, other school staff, and potentially parents become integral parts of the learning process, thus supplying multiple opportunities for support to the students (Kessler and McCleod, 1985).

Students also benefit psychologically from cooperative learning. Johnson and Johnson (1989) claim, “cooperative learning experiences promote more positive attitudes” toward learning and instruction than other teaching methodologies. Because students play an active role in the learning process in cooperative learning, student satisfaction with the learning experience is enhanced.

Cooperative learning also helps to develop interpersonal relationships among students. The opportunity to discuss their ideas in smaller groups and receive constructive feedback on those ideas helps to build student self-esteem. In a lecture format, individual students are called upon to respond to a question in front of the entire class without having much time to think about his/her answer.

Cooperative learning creates a safe, nurturing environment because solutions come from the group rather than from the individual. Errors in conclusions and thought processes are corrected within the group before they are presented to the class.

Students also tend to be inspired by instructors who take the time to plan activities which promote an encouraging environment (Janke, 1980). Receiving encouragement in a cooperative setting from both the instructor and peers helps to develop higher self-efficacy (see the Motivation chapter). As a result of higher self-efficacy, student grades tend to increase; thus, cooperative learning methods provide several academic benefits for https://www.edsys.in/innovative-science-teaching-methods/

https://www.youtube.com/watch?v=XIYrc9p1gOI

https://www.youtube.com/watch?v=uMPk722ETLU

https://www.stem.org.uk/best-evidence-science-teaching

https://www.youtube.com/watch?v=4YG5d8xL_hw

Final Draft of Lesson Plan for Teaching Based on Cooperative Learning Method

(Format by Johnson et al. [15])

School: ——

Period: —— Duration: ——

Subject Area: —— Date: ——

Lesson: —— Class: ——

Numbers of Students: —— Number of Groups: ——

Objectives: ——(i)Academic: ——(ii)Social Skills: ——

Cooperative Strategy: Jigsaw

Area of Expertise: ——(i)Academic Task ——(ii)Criterion for Success ——(i)Positive Interdependence ——(ii)Individual Accountability ——(iii)Expected Behaviour ——

Monitoring. Teacher would monitor and organize the whole class; intergroup and intragroup interactions would be organized in an effective way. It would be seen whether the groups are working as a team or they are just putting forward their views without listening to others. Teacher would resolve the conflict (if any) within a group or between two groups.

Behaviour Observed. The behavior of the students would be observed by observation schedule, a tool made by teacher. Assessment of Learning:(i)Small Group Processing ——(ii)Goal Setting ——(iii)Whole Class Processing ——Task steps and procedures (Structuring the task) Positive Interdependence: ——Individual Accountability: Individual and Group assessment End by: ——Note

Small Group Processing. The interaction and discussions among the members of the same group.

Whole Class Processing. The interaction among the experts of every group on the same subtopic.

Positive Interdependence and Individual Accountability. Elements of cooperative learning in the group.

Jigsaw Technique of Cooperative Learning. Groups with five students are set up. Each group member is assigned some unique material to learn and then to teach his group members. To help in the learning students across the class working on the same subsection get together to decide what is important and how to teach it [21]. After practice in these “expert” groups the original groups reform and students teach each other. Tests or assessment follows.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper

EVALUATION
and Assessment IN Chemistry

1Introduction:

Evaluation is a methodological area that is closely related to, but distinguishable from more traditional social research. Evaluation utilizes many of the same methodologies used in traditional social research, but because evaluation takes place within a political and organizational context, it requires group skills, management ability, political dexterity, sensitivity to multiple stakeholders and other skills that social research in general does not rely on as much. Here we introduce the idea of evaluation and some of the major terms and issues in the field.

4.1.1.a. Objectives/Learning Outcomes

• To explain types of formative and summative evaluation in science

• To classify different types of evaluation in science.

• To make effective use of objectives for achievement tests in science.

- To develop competency through effective use of achievement tests in science.

4.1.2 Definitions of Evaluation

Probably the most frequently given definition is:

Evaluation is the systematic assessment of the worth or merit of some object

This definition is hardly perfect. There are many types of evaluations that do not *necessarily* result in an assessment of worth or merit -- descriptive studies, implementation analyses, and formative evaluations, to name a few. Better perhaps is a definition that emphasizes the information-processing and feedback functions of evaluation. For instance, one might say:

Evaluation is the systematic acquisition and assessment of information to provide useful feedback about some object

Both definitions agree that evaluation is a *systematic* endeavor and both use the deliberately ambiguous term 'object' which could refer to a program, policy, technology, person, need, activity, and so on. The latter definition emphasizes *acquiring and assessing information* rather than *assessing worth or merit* because all evaluation work involves collecting and sifting through data, making judgments' about the validity of the information and of inferences we derive from it, whether or not an assessment of worth or merit results.

Check your progress

Read the following and answer the question:

Q1)What do you mean by Evaluation?

4.1.3 The Goals of Evaluation

The generic goal of most evaluations is to provide "useful feedback" to a variety of audiences including sponsors, donors, client-groups, administrators, staff, and other relevant constituencies. Most often, feedback is perceived as "useful" if it aids in decision-making. But the relationship between an evaluation and its impact is not a simple one -- studies that seem critical sometimes fail to influence short-term decisions, and studies that initially seem to have no influence can have a delayed impact when more congenial conditions arise. Despite this, there is broad consensus that the major goal of evaluation should be to influence decision-making or policy formulation through the provision of empirically-driven feedback.

4.1.4 Types of Evaluation

There are many different types of evaluations depending on the object being evaluated and the purpose of the evaluation. Perhaps the most important basic distinction in evaluation types is that between ***formative*** and ***summative*** evaluation. Formative evaluations strengthen or improve the object being evaluated -- they help form it by examining the delivery of the program or technology, the quality of its implementation, and the assessment of the organizational context, personnel, procedures, inputs, and so on. Summative evaluations, in contrast, examine the effects or outcomes of some object -- they summarize it by describing what happens subsequent to delivery of the program or technology; assessing whether the object can be said to have caused the outcome; determining the overall impact of the causal factor beyond only the immediate target outcomes; and, estimating the relative costs associated with the object. **4.1.4(a) FORMATIVE EVALUATION** *Formative evaluation is primarily a building process which accumulates a series of components of new materials, skill, and problems into an ultimate meaningful whole -Wally Guyot* Formative evaluation (sometimes referred to as internal) is a method of judging the worth of a program while the program activities are *forming* (in progress). This part of the evaluation focuses on the process. Thus, formative evaluations are basically done on the fly. They permit the designers, learners, and instructors to monitor how well the instructional goals and objectives are being met. Its main purpose is to catch deficiencies so that the proper learning interventions can take place which allows the learners to master the required skills and knowledge. Formative evaluation is also useful in analyzing learning materials, student learning achievements, and teacher effectiveness. In this sense formative evaluation is a part of the instructional process, underpinning the importance of student involvement. Students need to be involved both as assessors of their own learning and as resources to other students bringing into focus the importance of self and peer assessment besides teacher assessment. Research shows that the involvement in and ownership of their work increases students' motivation to learn. The most significant advantage of formative evaluation is that it makes learning an enjoyable experience because of student involvement, enhanced learning.

Formative evaluation is a tool used by the teacher to continuously monitor student progress in a non threatening, supportive environment. It involves regular descriptive feedback, a chance for the students to reflect on their performance, take advice and improve upon it. It involves students' being an essential part of assessment from designing criteria to assessing self or peers. If used effectively it can improve student performance tremendously while raising the self esteem of the child and reducing the work load of the teacher.

4.1.4(b) SUMMATIVE EVALUATION

All assessments can be summative (i.e., have the potential to serve a summative functions.

-*Scriven(1967)* The summative evaluation (sometimes referred to as external) is a method of judging the worth of a program at the end of the program activities (summation). The focus is on the outcome. The

various instruments used to collect the data are questionnaires, surveys, interviews, observations, and testing. The model or methodology used to gather the data should be a specified step-by-step procedure. It should be carefully designed and executed to ensure the data is accurate and valid.Questionnaires are the least expensive procedure for external evaluations and can be used to collect large samples of graduate information. They should be trialed before using to ensure the recipients of the questionnaire understand their operation the way the designer intended. When designing questionnaires, keep in mind the most important feature is the guidance given for its completion. All instructions should be clearly stated...let nothing be taken for granted. Summative evaluation constitutes a public recognition of achievement and we are fairly familiar with most of the tools and procedures of summative evaluation. However, many teachers may find it a challenge to develop effective formative evaluation tools; they may also experience some difficulties in integrating them with classroom instruction.

Summative evaluation is carried out at the end of a course of learning. It measures or ‘sums up’ how much a student has learned from the course. It is usually a graded test, i.e., it is marked according to a scale or set of grades. Assessment that is predominantly of summative nature will not by itself be able to yield a valid measure of the growth and development of the child. It, at best, certifies the level of achievement only at a given point of time. The paper pencil tests are basically a one-time mode of assessment and to exclusively rely on them to decide about the development of a child is not only unfair but also unscientific. Over emphasis on examination marks focusing on only scholastic aspects makes children assume that assessment is different from learning,resulting in the ‘learn and forget’ syndrome. Besides encouraging unhealthy competition, the overemphasis on Summative Assessment system also produces enormous stress and anxiety among the learners.

Why Is it Important to Understand Types of Assessment in Education?

Assessments help us answer key questions about student learning. But in order for assessment data to help drive decisions, it's imperative that we use an assessment tool that is appropriate to the task at hand. **Understanding the types of assessments is the first step to using assessment data to effectively support students.**

For instance, progress monitoring assessments are extremely sensitive to growth and designed to measure small increases in progress. Other types of assessments aren't structurally designed to measure those small increases in growth; using an interim assessment weekly or bi-weekly will not help educators accurately track student progress and might lead to confusing or misleading results.

Without a sound understanding of assessment types and purposes, it's easy to use an assessment for a mismatched task. For that reason, **it's important that all educators have a foundational understanding of assessment types**—and what each assessment type can and cannot tell us about student learning.

To learn more about assessment types and how to build a comprehensive assessment system that meets your unique needs, download our Complete Guide to Comprehensive Assessment Systems eBook.

Types of Assessment

What Are the Types of Assessment in Education? 6 Types of Assessments

Although nomenclature can vary from district to district, there are six main types of assessments in education:

1. Just-In-Time/Short Cycle Assessments (Formative)
2. Universal Screening Assessments
3. Diagnostic Assessments
4. Progress Monitoring Assessments
5. Interim Assessments
6. Summative Assessments

Let's explore how each type of assessment helps analyze and support learning in the sections below.

Just-In-Time / Short-Cycle Assessments (Formative)

Formative assessment is a process used by teachers and students during instruction. It creates feedback and reveals needed adjustments for ongoing teaching and learning in order to increase students' achievement of intended instructional outcomes. **Just-in-time/short cycle assessments are assessments used as tools to inform and fuel the formative assessment process on an ongoing, frequent basis (even daily).**

When used formatively, assessments can overcome some traditional, commonly-conceived limitations of "tests." With the right tools in place, such as DnA's Live Proctoring tool, short-cycle assessments can be spun up quickly and adapt to meet immediate student needs during the learning process. **Using these just-in-time assessments can yield rich information to feed instructional processes and deepen student metacognitive processes.**

Examples of Just-In-Time / Short-Cycle Assessments (Formative)

EXAMPLES INCLUDE:

- Classroom assessments
- Quick quizzes
- Discussion
- Observations
- Comprehension checks
- Entrance/exit tickets

Keep in mind that any assessment can be a part of the formative process as long as it's used to provide data to inform instruction.

UNIVERSAL SCREENING ASSESSMENTS

Universal screening is the process of gathering **academic and social-emotional behavior (SEB) data about all the students in a class, grade, school, or district** in order to identify which students need additional assistance to meet learning goals.

Universal screening assessments are administered as tools to inform and fuel that process. They're most often administered to all students in the areas of reading, math, and SEB. Screening happens early in the year and can also occur at other points throughout the year.

They should be valid, reliable, and have a high degree of predictive validity with high-stakes tests. Universal screening assessments are critical to an effective multi-tiered system of support (MTSS) implementation, as they identify Tier 1 needs as well as students who may be at risk and in need of additional support.

Examples of Universal Screening Assessments

FastBridge is an example.

Diagnostic Assessments

Diagnostic assessment is the process of using multiple measures and reports to **identify what a student does or does not know in relation to specific learning goals** in order to guide academic, curricular, and instructional decisions.

Diagnostic assessments can be administered as a tool to inform and fuel that process. They're often administered to students, grade levels, and/or groups flagged by universal screening to pinpoint specific learning needs (e.g., calculation vs math).

Examples of Diagnostic Assessment

High-quality universal screeners, such as *FastBridge*, provide diagnostic reporting as part of the universal screening results. Diagnostic assessment is critical to MTSS implementations, as it helps ensure interventions are appropriately aligned to students' specific needs.

In any case, these data should be used in conjunction with other data—as part of an evaluation of a student's academic and SEB learning needs—before reaching diagnostic conclusions about student performance.

TYPES OF ASSESSMENT OFTEN USED IN THE DIAGNOSTIC ASSESSMENT PROCESS:

PROGRESS MONITORING ASSESSMENTS

Progress monitoring is a standardized process of evaluating progress toward a performance target, based on rates of improvement from frequent (usually weekly) assessment of a specific skill.

Progress monitoring assessments are administered as a tool to inform and fuel that process. They're typically administered to all students receiving Tier 2 or Tier 3 interventions.

Progress monitoring assessments are very sensitive to growth and are aligned to the skill or need that is targeted by an intervention. They help measure whether an intervention is working and if it's working fast enough.

Examples of Types of Progress Monitoring Assessments

EXAMPLES INCLUDE:

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- FastBridge
- Running records
- Mastery measurement

- Curriculum-based measurement
- Direct Behavior Ratings

Interim Assessments

Interim assessments measure students' standards proficiency. They're typically administered periodically or seasonally (e.g., fall, winter, spring).

These assessments are aligned to a pacing calendar and the district's scope and sequence (or the progressive order in which students encounter the content that they're expected to master by the end of a course, study, or curriculum).

Interim assessments are often used to predict the students' end-of-year proficiency. They are usually created either by a professional assessment vendor or by using a valid and reliable item bank in order to ensure quality.

Examples of Interim Assessments

Illuminate's Inspect pre-built assessments are an example.

Summative Assessments

Summative assessment is the process of evaluating or certifying learning at the end of a specific period of instruction.

Summative assessments are often used for grading students and can be used to measure growth or change in student learning. They're typically administered at the end of the year, end of course, or end of term.

Summative assessments can provide a lot of useful data regarding student achievement, while also guiding decision-making around changes in curriculum, instructional strategies, staffing ratios, course offerings, and professional development needs.

Examples of Summative Assessments

Examples include:

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- High-stakes state standards assessments
- SAT
- ACT
- Inspect Comprehensives

Just as formative assessment is a process, so is summative assessment. Any assessment is part of the summative assessment process if it's used to evaluate or certify learning after instruction has occurred. Many teachers employ unit exams and Friday spelling tests, for example, as summative assessments.

What Are Assessments in Education?

Different assessments yield different data that can be used to support different insights.

So, to help you understand what type of assessment to use at which point in your teaching journey, I'll describe the different types of assessments that may fit with your intended purpose and the ways that you can use assessment data to inform decision-making.

Educational measurement is about identifying what it is you're trying to measure, figuring out what you can do to elicit that from a student, and then establishing a process to assign what you've elicited into a quantitative statement or number that can be evaluated. Essentially, as a measurement expert, I am trying to assign numerals to traits such as achievement, interest, attitudes, aptitude, intelligence, and performance to infer abilities and proficiencies of students.

Educators and administrators use assessments for a variety of purposes, such as identifying levels of achievement, evaluating strengths and weaknesses, and measuring progress. The assessment results can then be used to derive a variety of insights, such as how to personalize practice, differentiate instruction, and support accountability requirements.

What Are the 3 Types of Assessment?

Based on what it is you need from your assessments you can build a system of assessment that typically comprises three different educational assessment types that serve different purposes depending on when they are administered: **diagnostic**, **formative**, and **summative**. There are other labels for assessments like pre-test, post-test, progress monitor, benchmark, or growth assessment, but those all fall into one or more of these three broad categories.

1. **Diagnostic:** When we think about educational measurements, each assessment is designed for a specific time and purpose. When an assessment happens before the learning activity, these are called diagnostic because the results can be used to diagnose problem areas to focus on during the teaching to come.

2. **Formative:** When assessment happens during the learning process, these are called formative because the results can be used to inform what to do next for individuals or groups of students as learning is occurring. Both diagnostic and formative are types of assessment *for* learning - meaning you are assessing to support decisions made before or during learning.
3. **Summative:** When assessments happen after the learning activity, these are called summative because the results are a summation *of* learning that has occurred.

Diagnostic Assessment

Let's dive deeper into each of these types of assessments. Let’s start with **diagnostic** assessments. In general, educators use these types of assessments to identify what students have yet to learn, diagnose any gaps in learning that will impede progress towards current learning objectives, or uncover any strengths that can be encouraged. Educators can then use this information to guide lesson and curriculum planning. Diagnostic assessments are most often thought of as being used at the beginning of the year, but they can occur at any time throughout the school year (e.g., to evaluate prerequisite knowledge gaps before moving on to the next unit of study).

Diagnostic assessments can be particularly helpful to teachers and administrators who may have a lot of new incoming students with unknown ability levels. Administrators can use diagnostic assessment information to decide on the curricula needed to support these students. Teachers can use the results to formulate personalized learning plans for individuals and assign students to groups for small group instruction.

Formative Assessment

Formative assessments are administered throughout the year, usually by classroom teachers. Their primary purpose is to inform teachers about how their students are progressing, where gaps exist in students' learning, and how their instruction needs to be adjusted to improve student learning, possibly by slowing down the pace, repeating instruction, or even challenging some students with new and potentially more difficult tasks.

Formative assessments don't have to be formal tests. They often include informal activities like hand signals, brain dumps, and entry/exit tickets, which give teachers informal and immediate feedback on student learning. They are often embedded as learning activities such as using concept maps or journal entries which means this can be assessment **as** learning. Even though some of these are very informal (like a thumbs up or thumbs down), teachers can use this data (be it quantitative or qualitative) to adjust their instructional groupings or reteach specific skills to students who seem to need help.

In fact, any systematically collected and evaluated display of learning can give teachers the insight they need to inform instruction. Formative feedback (be it more formal, like a quiz—or informal, like a thumbs-up) should be used daily to inform instruction and planning. By having the right data at the right time, you can make sure that:

- Instruction is appropriate for student's levels of development and needs
- Instruction is efficient and seamless
- Instruction provides students the time they need to grow or master the skills that are taught

- Instruction is sequenced flexibly and accommodates individual progress and answers the question ”what next?”

By evaluating along the way throughout the year and making micro just-in-time course corrections, you’ll be more likely to garner the best outcomes you intend for your students to achieve.

Summative Assessment

The final type of assessment is **summative.** Summative assessments occur after the learning activities or units of study have concluded. This is measurement **of** learning, and they are typically focused on evaluating proficiency or mastery of content after the end of a chapter, the end of the school year, or anything in between. These are measurements that conclude the learning process, such as final exams, end of unit tests, or large-scale standardized tests, and rarely inform instruction. They are mostly focused on measuring whether students grew their mastery or understanding of a pre-defined set of criteria (e.g., state standards).

A robust assessment system will include diagnostic, formative, and summative assessments in a comprehensive plan. The goal of such a system is to extend the effectiveness of teachers and administrators by providing them actionable data that diagnoses skill deficits, informs day-to-day instruction, measures mastery of intended learning objectives, and informs curricula choices.

In the best assessment systems, there is a strong focus on *growth*, not proficiency or mastery. There are many advantages to this focus:

- Growth targets allow teachers to set realistic learning goals that are individualized for all students based on where they are starting off their learning journey.
- Growth lets educators evaluate students individually and assess the impact of various learning solutions that have been provided.
- Growth recognizes that the teachers' impact on student learning is not the same for each student due to variables outside of their control.

- And, most importantly, focusing on growth allows students of all ability levels to demonstrate improvement and achievement throughout the year.

It’s perfectly common for students to show growth yet still miss the idealized targets of proficiency or mastery. Focusing on growth is encouraging and validates the students’ hard work as they show progress on their individual learning journey.

Evaluation -Suggested Assessment Tools and Techniques in Science

Experiments, Information gathering and deducing, Presentations on science concepts/ experiments, Investigations for stated problems,MCQs and Science Quiz, Simple and interesting assignments, Group assignments and projects, Model Making, Science symposium/ seminar, Preparation of various compounds/salts, Explanation of different natural phenomenon using scientific principles.

• Class Response Assessment worksheets

Demonstration based, Graph based, Diagram based, Numerical based, Flow chart, Crossword puzzle/games, Writing of Balanced chemical Equations/Formulae/Units,MCQs

• Active-learning assessment tools

Model making, Chart making,Assignments,Popular Science Book Review, Current Science events/news report, Hands-on practical examination, Class work/home work Assessment, Group work - Seminar/Symposium/Presentation/Bulletin Board Display/Role Play, Survey/Field Visit, Project Work-Group or individual, Short formal written Paper-pen test.

4.2 DEVELOPMENT OF OBJECTIVES FOR ACHEIVEMENT TESTS IN SCIENCE The purpose of achievement testing is to measure some aspect of the intellectual competence of human beings: what a person has learned to know or to do. Teachers use achievement tests to measure the attainments of their students. In any circumstances where it is necessary or useful to distinguish persons of higher from those of lower competence or attainments, achievement testing is likely to occur. The varieties of intellectual competence that may be developed by formal education, self-study, or other types of experience are numerous and diverse. There is a corresponding number and diversity of types of tests used to measure achievement. In this article attention will be directed mainly toward the measurement of cognitive achievements by means of paper and pencil tests. The justifications for this limitation are (1) that

cognitive achievements are of central importance to effective human behavior, (2) that the use of paper and pencil tests to measure these achievements is a comparatively well-developed and effective technique, and (3) that other aspects of intellectual competence will be discussed in other articles, such as those on motivation, learning, attitudes, leadership, aesthetics, and personality.

4.3 OBJECTIVES FOR ACHEIVEMENT TESTS IN SCIENCE:

1) To test the understanding of the pupil to the world in which he lives and the impact of science on society so as to enable him to adjust himself to his environment.

2) To test the acquaintance of the pupil with the scientific method and to enable him to develop the scientific attitude.

3) To test the acquisition of experimental skills such as_

a) Handling the apparatus and the instruments.

b) Arranging the apparatus for an experiment

c) Preserving apparatus , chemicals, specimens, models etc.

4) To test the acquisition of instructional skills such as:-

a) Improving simple instruments and appliances

b) Repairing certain instruments and appliances of everyday use.

5) To develop drawing skills such as:-

a) Drawing and sketching certain objects and instruments

b) Photography in certain objects and specimens.

6) To test the power of oral expression in science so as to discuss, argue, describe and raise questions using scientific terminology.

7) To test the interest in scientific reading and Hobbies.

8) To test the appreciation of the impact of science on life, both personal and social, the struggle trough which science has advanced and the inspiring work done in the field of science.

9) To test the role of Indian scientist in the development of science.

10) To test the knowledge of judicious use of natural resources and avoid any wastage of natural resources.

11) To test the experimental skills such as to prepare simple useful materials like soap, boot-polish, ink, kaleidoscope, simple camera, magnetic compass, models etc.

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https://www.youtube.com/watch?v=9G_bL9itxt4

Exercise 1:

FORMATIVE ASSESSMENTS?

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Exercise 2:

What is Differences Between Diagnostic Assessment and Summative Assessment

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Exercise 3:

What is Differences Between Assessment and Evaluation

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Exercise 4:

WHAT IS Summative Assessment?

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Exercise 5:

What is The purpose of achievement testing

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Exercise 6:

Select a Chemistry lesson and show us how to Summative Assessment for it………………………………………………………………………………………………………

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