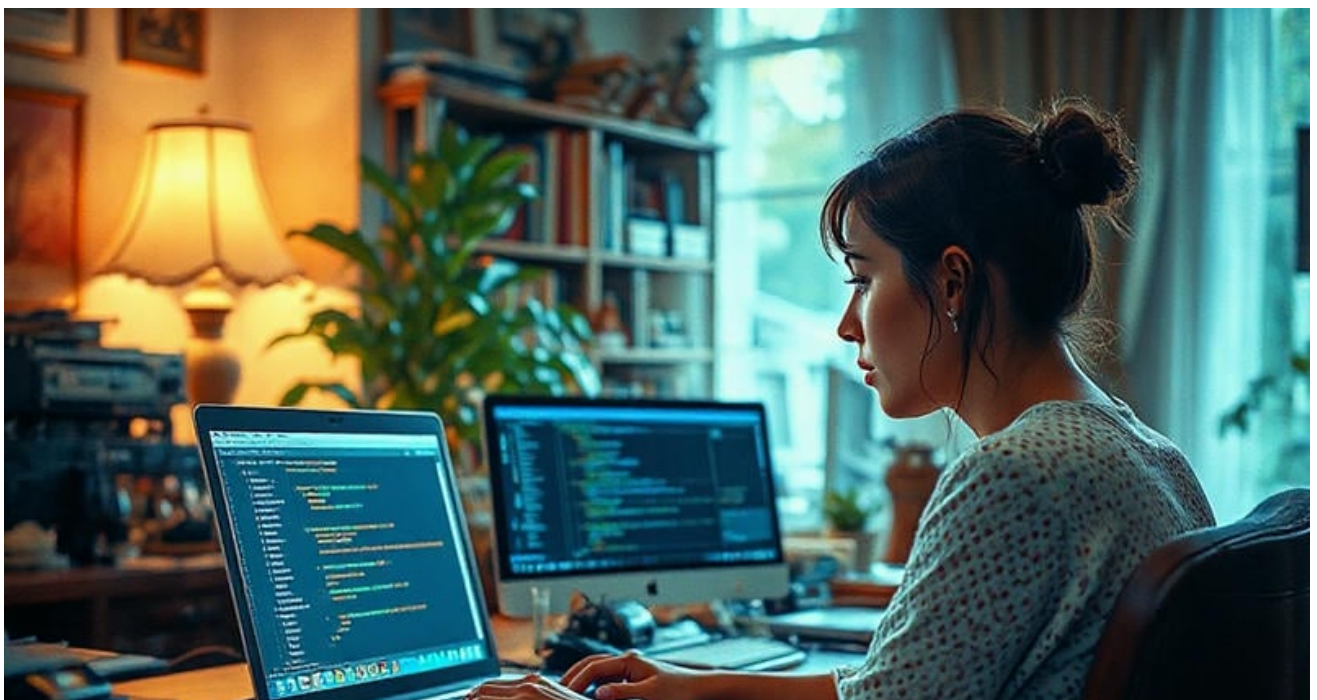


## Medical Staffing



- **Understanding Annual Updates to ICD 10 CM Codes**  
**Understanding Annual Updates to ICD 10 CM Codes Navigating CPT Code Changes for Surgical Procedures The Role of HCPCS Codes in Medical Billing Transitioning from ICD 9 to ICD 10 Challenges Specialty Specific Coding in Oncology Practices How to Avoid Errors in Evaluation and Management Coding Updates to Infectious Disease Coding Guidelines Best Practices for Using Modifiers in Medical Billing Impact of Coding Changes on Reimbursement Rates Training Resources for Mastering ICD 10 CM Coding for Chronic Conditions in Primary Care Future Trends in Medical Coding Systems**
- **Key Elements of HIPAA Compliance in Medical Billing**  
**Key Elements of HIPAA Compliance in Medical Billing Understanding Stark Law and Its Implications Avoiding Civil Monetary Penalties in Healthcare Lessons from False Claims Act Case Studies Managing Whistleblower Risks in Medical Practices Compliance Strategies for Medicaid Billing Ethical Considerations in Medical Coding Audits Documentation Requirements for Legal Protection How to Prepare for RAC Audits Successfully State Specific Compliance Challenges in Healthcare Global Standards for Healthcare Data Privacy Training Staff on Anti Fraud Regulations**
- **About Us**



In the realm of oncology, where precision and meticulousness are paramount, accurate coding holds a place of significant importance. The field of oncology is inherently complex, involving intricate procedures, diverse treatment modalities, and a wide array of diagnostic evaluations. Recruiting through medical staffing agencies saves time and resources for healthcare providers **medical assistant staffing agency** digital marketing. Within this intricate landscape, specialty-specific coding serves as a fundamental pillar that supports various aspects of oncology practices, from clinical decision-making to reimbursement processes.

Accurate coding in oncology begins with the correct identification and documentation of diagnoses and treatments. Oncologists often manage patients with multi-faceted conditions that require personalized treatment plans involving surgery, chemotherapy, radiation therapy, immunotherapy, or combinations thereof. Each treatment path is unique to the patient's specific cancer type and stage. Consequently, precise coding becomes essential to ensure that all aspects of patient care are accurately captured for medical records.

Furthermore, accurate coding is indispensable for effective communication among healthcare providers. Oncology care frequently involves multidisciplinary teams that include surgeons, oncologists, radiologists, pathologists, and nursing staff. Properly coded information enables seamless sharing of patient data within these teams and across different institutions if needed. This not only facilitates better coordination but also enhances the continuity of care.

From an administrative perspective, accurate coding directly impacts the financial health of oncology practices. Coding errors can lead to claim denials or delays in reimbursement from insurance companies and government payers such as Medicare or Medicaid. In some cases, incorrect codes may even result in audits or penalties against healthcare providers. Therefore, having a robust system for ensuring precise coding can prevent financial losses and help maintain economic sustainability within an oncology practice.

Moreover, on a larger scale beyond individual practices, accurate oncology coding contributes significantly to research advancements and public health initiatives. Data collected through meticulously coded patient records are vital for epidemiological studies and clinical trials that drive innovations in cancer treatment protocols. They provide insights into patterns of disease prevalence and effectiveness of therapies across populations.

In conclusion, the importance of accurate coding in oncology cannot be overstated-it is integral not only for individual patient care but also for broader healthcare objectives

including financial stability and research progression. As the field continues to evolve with advancements in technology like artificial intelligence-assisted diagnostics or personalized medicine approaches based on genetic profiling-the demand for precision in specialty-specific coding will only increase further cementing its role as an essential component within modern-day oncology practices.

# Overview of the Update Process for ICD-10-CM Codes

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- Importance of Annual Updates in Medical Coding
- Overview of the Update Process for ICD-10-CM Codes
- Key Changes and Additions to the Latest ICD-10-CM Code Set
- Impact of Updates on Healthcare Providers and Coders
- Strategies for Staying Informed About Code Changes
- Challenges and Solutions in Adapting to New Codes

In the intricate world of healthcare, oncology stands out as a field that not only requires profound medical expertise but also demands precise administrative acumen. One critical aspect of this administration is coding-the language through which healthcare services are translated into standardized codes for billing and data collection purposes. In oncology practices, specialty-specific coding is indispensable in ensuring accurate documentation, appropriate reimbursement, and effective patient care management.

The foundation of oncology coding lies in several common codes and classifications that have been established internationally to streamline operations. Among these, the International Classification of Diseases (ICD) stands as a cornerstone. Currently in its tenth revision (ICD-10), this classification system provides detailed codes for various diagnoses, including cancer types and sites. ICD-10 allows oncologists to specify malignancy behaviors-such as whether a tumor is primary, secondary, or in situ-which aids in tailoring treatment plans and monitoring disease progression.

Complementing the ICD system is the Current Procedural Terminology (CPT), maintained by the American Medical Association. CPT codes are employed to describe medical procedures

and services performed by healthcare providers. In oncology, these might include chemotherapy administration, radiation therapy sessions, or surgical interventions specific to cancer treatments. Accurate CPT coding ensures that providers receive appropriate compensation for their services while also facilitating communication between practitioners regarding patient care.

Another vital component is the Healthcare Common Procedure Coding System (HCPCS), which includes two levels of codes: Level I mirrors CPT codes while Level II covers non-physician services such as chemotherapy drugs or durable medical equipment used in cancer care. For example, specific drugs administered during chemotherapy are coded using HCPCS Level II to ensure proper billing and inventory tracking.

Moreover, Relative Value Units (RVUs) play a significant role in determining reimbursement rates for oncology services under Medicare's Physician Fee Schedule. RVUs reflect the value of physician work involved in providing a service compared to other procedures across specialties. Understanding RVUs allows oncology practices to optimize financial performance without compromising on quality care delivery.

In addition to these systems, many countries have adopted national registries or frameworks tailored specifically for cancer reporting and research purposes. These systems often integrate with international classifications like ICD but provide additional granularity suited for local healthcare landscapes.

Navigating through these complex coding systems requires specialized training and proficiency among oncologists and administrative staff alike. Errors in coding can lead not only to financial discrepancies but also hinder data integrity essential for epidemiological studies and policy development aimed at combating cancer effectively.

Ultimately, mastering specialty-specific coding within oncology practices demands continuous education alongside evolving regulatory changes at both national and global levels—a necessity underscored by ongoing advances within precision medicine fields where genetic information increasingly influences diagnostic pathways requiring new layers of code specificity beyond traditional models.

Thus emerges an appreciation: while clinical breakthroughs capture headlines; it's often within nuanced domains like robustly applied correct codification where sustainable progress against cancer quietly takes root—transforming how we document, treat, verify & ultimately enhance

outcomes across every patient journey traversed therein today tomorrow always anew yet meaningfully accountable still unto itself enacting hope via structured precision amid dedicated compassion interwoven steadfastly together unyieldingly onward evermore so now than ever before indeed!

# Key Changes and Additions to the Latest ICD-10-CM Code Set

Coding in oncology specialties presents a unique set of challenges that can be daunting even for the most experienced coders. The complexity arises from the intricate nature of cancer treatments and the constant evolution of medical knowledge in this field. These challenges are significant because accurate coding is vital for appropriate billing, reimbursement, and maintaining comprehensive patient records.

One of the primary challenges faced by coders in oncology is keeping up with frequent updates to coding systems such as ICD-10, CPT, and HCPCS. Oncology treatments often involve cutting-edge therapies and new pharmaceuticals that require constant updating to coding guidelines. Coders must stay informed about these changes to ensure that they assign the correct codes for procedures and treatments. This need for continual education adds an extra layer of difficulty, as errors can lead to significant financial implications for healthcare providers and patients alike.

Another challenge is the sheer complexity of cancer treatment regimens. Oncology involves a wide array of treatments including surgery, chemotherapy, radiation therapy, immunotherapy, and targeted therapy. Each treatment plan is highly individualized based on factors like cancer type, stage, patient health status, and response to previous treatments. Coders must have a deep understanding of these variables to accurately capture all aspects of a patient's care journey. Misinterpretation or omission can lead to incomplete records or incorrect billing.

Moreover, coders must navigate the intricacies of combination therapies where multiple drugs or modalities are used simultaneously or sequentially. This requires precise documentation practices and thorough comprehension of how different elements interact within a treatment protocol. Coding errors in such complex scenarios not only affect reimbursement but also

impact clinical data accuracy which is crucial for research and quality improvement efforts.

Furthermore, coders often face challenges related to inadequate documentation from healthcare providers. Oncologists are pressed for time due to heavy caseloads which sometimes leads to incomplete or ambiguous medical record entries. Coders must frequently communicate with clinicians to clarify ambiguities or obtain missing information - a task that demands diplomatic skills alongside technical expertise.

Lastly, there's an emotional component involved in oncology coding that can't be overlooked. Coders working in this specialty deal with sensitive cases involving life-altering diagnoses and outcomes which can add emotional stress to their work environment. They play an unseen yet critical role in supporting both healthcare teams and patients throughout difficult journeys.

In conclusion, while oncology coding poses significant challenges due its dynamic nature and complexity; it remains an indispensable part of delivering high-quality care within cancer treatment centers. By investing in continuous professional development opportunities tailored specifically towards oncological specializations along with fostering effective communication channels between coders and clinicians - many barriers can be overcome ensuring accurate coding practices beneficial for all stakeholders involved.







# **Impact of Updates on Healthcare Providers and Coders**



Ensuring compliance and accuracy in specialty-specific coding, particularly within oncology practices, is both a critical and complex endeavor. The intricacies of cancer treatment, coupled with the rapidly evolving landscape of medical codes, demand a robust strategy to mitigate errors and optimize patient care.

One fundamental approach is to invest in regular training and education for coding professionals. As the field of oncology continually advances with new treatments and protocols, staying abreast of these changes through continuous professional development is essential. This includes understanding the nuances of ICD-10-CM codes specific to oncology, as well as CPT codes that pertain to various cancer treatments and procedures. By keeping coders up-to-date with these developments, practices can significantly reduce the risk of miscoding, which could lead to denied claims or inadequate reimbursement.

Another vital strategy is implementing comprehensive auditing processes. Regular internal audits ensure that coding accuracy is maintained over time. These audits should be designed to identify patterns or recurring issues that might indicate systemic problems within the practice's coding procedures. Moreover, external audits conducted by third parties can provide an unbiased assessment of a practice's compliance level and highlight areas for improvement.

Incorporating advanced technology solutions also plays a crucial role in ensuring compliance and accuracy. Computer-Assisted Coding (CAC) systems have become invaluable tools in many oncology practices. These systems utilize natural language processing to analyze documentation and suggest appropriate codes. While CAC should not replace human coders, it can serve as an effective tool for enhancing accuracy and efficiency when used alongside skilled professionals.

Moreover, fostering an environment that encourages communication between coders, clinicians, and administrative staff can enhance overall accuracy in medical coding. Coders must feel comfortable seeking clarification from physicians when documentation is ambiguous or insufficient for code assignment. Collaborative environments ensure that all stakeholders are aligned towards achieving accurate documentation and coding practices.

Lastly, cultivating a culture of accountability within the practice underscores every aspect of compliance efforts. When each team member understands their role in maintaining high standards for documentation accuracy and integrity, it reinforces collective responsibility toward minimizing errors.

In conclusion, ensuring compliance and accuracy in specialty-specific coding within oncology practices requires a multifaceted approach involving education, auditing processes, technology integration, open communication channels among healthcare providers and administrative staff members alike-combined with an overarching culture committed to precision at every level of operation. By adopting these strategies holistically rather than piecemeal efforts alone will enable oncological practices not only meet regulatory demands but ultimately improve patient outcomes through precise billing processes aligned closely with actual clinical services rendered effectively safeguarding both revenue cycle health long-term sustainability goals while most importantly contributing positively towards advancing quality care delivery standards across board pivotal especially given complexities intrinsic treating patients battling cancer today tomorrow beyond too!

# Strategies for Staying Informed About Code Changes

In recent years, the landscape of healthcare has undergone a transformative shift driven by technological advancements, and oncology practices are no exception. The intricate process of coding in oncology, which involves accurately documenting and billing for cancer treatments, has significantly benefited from these technological innovations. By integrating sophisticated technologies into their operations, oncology practices have been able to enhance the accuracy, efficiency, and overall quality of coding practices.

One of the pivotal ways technology enhances oncology coding is through the use of Electronic Health Records (EHRs). EHRs streamline the documentation process by consolidating patient information into a single digital platform. This consolidation not only ensures that coders have access to comprehensive and up-to-date patient data but also minimizes errors that could arise from manual data entry. With structured data input options and automated suggestions for coding based on recorded patient interactions, EHRs enable more precise coding aligned with current standards.

Furthermore, natural language processing (NLP) algorithms are beginning to play a crucial role in refining oncology coding. These algorithms can analyze clinical notes and extract relevant details necessary for accurate code assignment. By parsing through complex medical

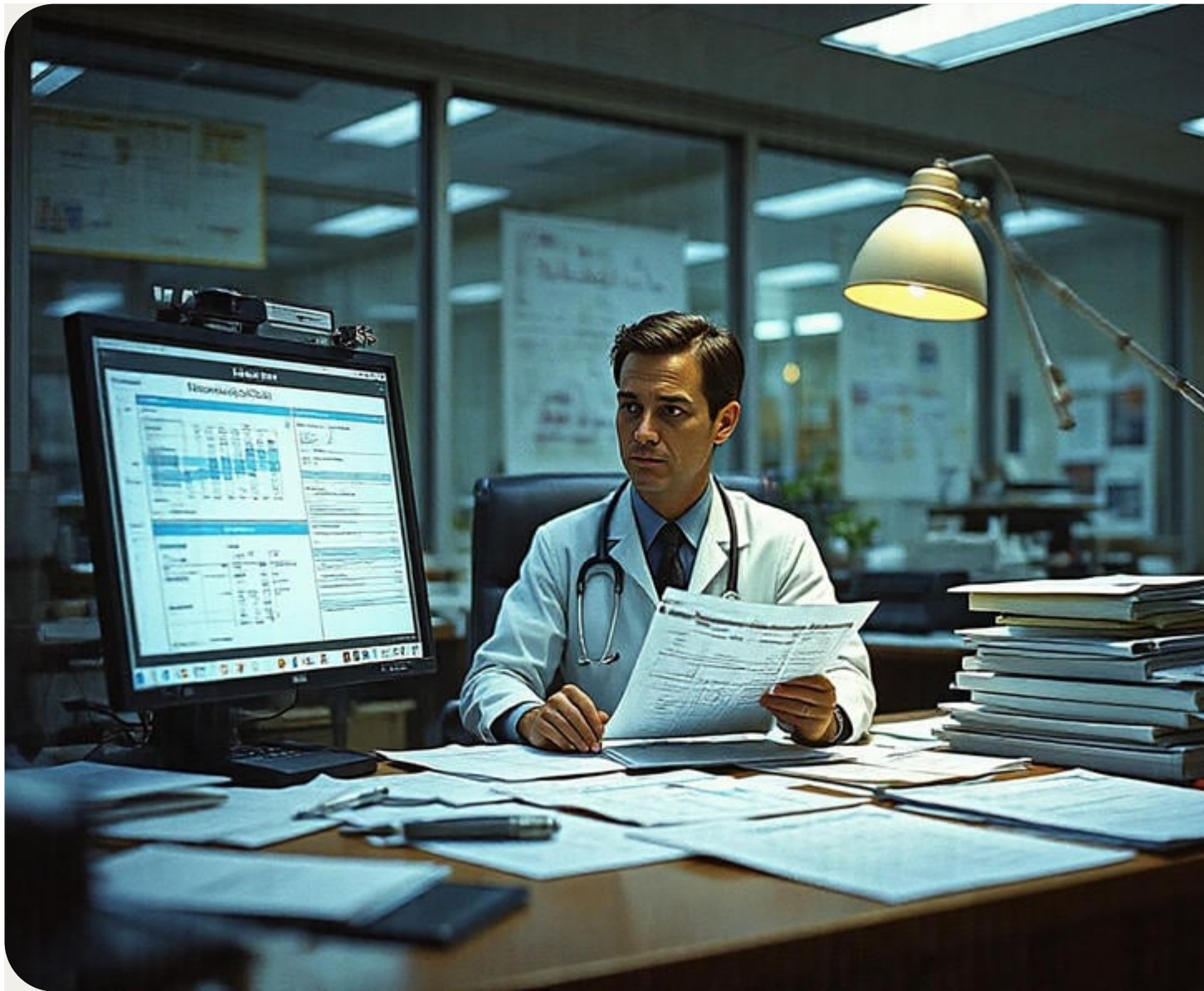
language and identifying key terms related to diagnoses or procedures, NLP reduces the cognitive load on human coders. This assists in maintaining consistency across coded records while ensuring that subtle nuances-such as changes in treatment regimens-are captured correctly.

Additionally, artificial intelligence (AI) is revolutionizing how data-driven insights are incorporated into coding practices. Machine learning models trained on vast datasets can predict potential billing codes based on historical patterns and outcomes observed in similar cases. AI systems can flag anomalies or inconsistencies within codes before submission, thereby reducing claim rejections due to inaccuracies. This capability not only streamlines revenue cycle management but also allows oncologists more time to focus on patient care rather than administrative tasks.

Telemedicine has further expanded the scope of oncology services beyond traditional settings, necessitating adaptations in coding practices to capture virtual consultations and remote monitoring accurately. Technology facilitates this transition by offering platforms that seamlessly integrate telehealth encounters into existing workflows without compromising compliance with regulatory standards like HIPAA.

Moreover, ongoing education facilitated through online modules or interactive software keeps coders abreast of ever-evolving coding guidelines specific to oncology treatments such as chemotherapy protocols or radiotherapy techniques. Continuous learning is crucial given how rapidly both medical treatments and corresponding regulations evolve; technology provides accessible resources ensuring coders remain proficient amidst these changes.

In conclusion, technology plays an indispensable role in enhancing specialty-specific coding within oncology practices today-a trend likely continuing well into the future as further innovations emerge within healthcare IT ecosystems worldwide! Through tools like EHRs equipped with NLP capabilities alongside AI-driven decision support systems paired together effectively-and complemented by educational resources tailored around cutting-edge developments-the promise held offers immense potential toward optimizing operational efficiencies therein ultimately contributing positively toward improved patient outcomes holistically speaking across broader contexts likewise involved too!



# Challenges and Solutions in Adapting to New Codes

Training and education for coders in oncology settings is a crucial element in ensuring the accuracy and efficiency of coding practices within this specialized field. Oncology, with its complex terminologies, treatment modalities, and rapidly evolving medical advancements, demands a high level of expertise from medical coders. These professionals play an indispensable role in translating intricate medical information into standardized codes that are essential for billing, research, and maintaining comprehensive patient records.

The specialty-specific coding in oncology practices requires coders to possess thorough knowledge of cancer types, stages, treatment protocols, and associated medical procedures. This understanding is not only pivotal for accurate coding but also influences reimbursement processes and compliance with healthcare regulations. Therefore, ongoing education and training tailored to the nuances of oncology are fundamental to the development of proficient coders.

One critical aspect of this training involves familiarizing coders with the International Classification of Diseases (ICD) codes specific to oncology. The ICD coding system is frequently updated to accommodate new discoveries in cancer research and treatment options. Consequently, continuous education helps ensure that coders remain current with these updates. Additionally, knowledge about Current Procedural Terminology (CPT) codes used for reporting diagnostic tests, chemotherapy administrations, radiation therapies, and surgical interventions is equally important.

Beyond technical knowledge, effective communication skills are vital for oncology coders who often act as liaisons between healthcare providers and insurance companies. Training programs should therefore also focus on enhancing interpersonal skills so that coders can effectively collaborate with oncologists and other healthcare professionals to clarify documentation or resolve discrepancies.

Moreover, as technology becomes increasingly integrated into healthcare systems through Electronic Health Records (EHRs) and telemedicine platforms, proficiency in using these digital tools is essential. Training programs need to incorporate modules on navigating EHR systems efficiently while ensuring data integrity and security—a critical concern given the sensitive nature of oncology patient information.

Furthermore, ethical considerations in coding must be emphasized during training sessions. Coders are responsible for safeguarding patient confidentiality while adhering to ethical standards that prevent fraudulent practices such as upcoding or unbundling services.

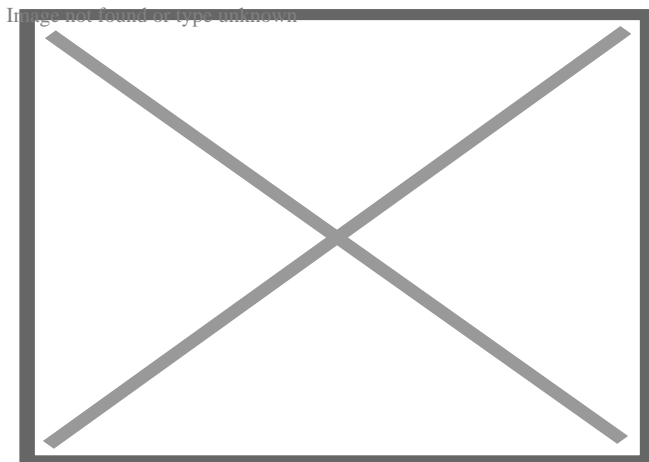


In conclusion, training and education for coders working within oncology settings are indispensable elements that contribute significantly towards achieving excellence in specialty-specific coding practices. By equipping these professionals with comprehensive knowledge on disease classifications along with practical skills related to communication technologies ethics they become instrumental players not only supporting financial aspects but also enhancing overall quality care delivery patients battling cancer face every day life journey against disease itself thrives upon solid foundation laid down precise meticulous work dedicated committed coder community ensures nothing less highest standards upheld across board time again ahead future challenges arise field medicine unfolds further discoveries await embrace together step forward courage resilience compassion above all else guiding principles shared humanity brings closer brighter tomorrow awaits us all alike journey continues steadfast unwavering determination success lies hands capable ready meet head-on ever-changing world medicine beyond imagination holds store today tomorrow always ultimately serves greater good humankind enduring mission healing hope prevails forever more enduring spirit triumphs even darkest times remembered cherished always never forgotten legacy carries forward inspiring generations come yet unborn prepared inherit torch light path others walk before them bravely pave way forward progress innovation limitless potential unlocked discover explore infinite possibilities await discovery adventure beckons calls answer call duty greater purpose awaits fulfillment realization dreams aspirations fuel drive passion dedication commitment excellence unparalleled unrivaled unmatched anywhere else universe limitless opportunity awaits seize moment now never looking back forging ahead unyielding resolve unwavering faith future shines brightly luminous beacon guiding star leads destiny unknown realms unexplored vast expanse cosmos reach grasp behold wonder awe marvel creation surrounds us envelops embraces eternal cycle life death rebirth renewal transformation

## About learning

For the album by Perfume Genius, see *Learning* (album).

Several terms redirect here. For other uses, see Learn (disambiguation), Learned (disambiguation), and Learners (film).



American students learning how to make and roll sushi

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## Cognitive psychology

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### Perception

- o Visual
- o Object recognition
- o Face recognition
- o Pattern recognition

### Attention

### Memory

- o Aging
- o Emotional
- o Learning
- o Long-term

### Metacognition

### Language

Metalanguage

### Thinking

- o Cognition
- o Concept
- o Reasoning
- o Decision making
- o Problem solving

### Numerical cognition

- o Numerosity adaptation effect
- o Approximate number system
- o Parallel individuation system

**Learning** is the process of acquiring new understanding, knowledge, behaviors, skills, values, attitudes, and preferences.[<sup>1</sup>] The ability to learn is possessed by humans, non-human animals, and some machines; there is also evidence for some kind of learning in certain plants.[<sup>2</sup>] Some learning is immediate, induced by a single event (e.g. being burned by a hot stove), but much skill and knowledge accumulate from repeated experiences.[<sup>3</sup>] The changes induced by learning often last a lifetime, and it is hard to distinguish learned material that seems to be "lost" from that which cannot be retrieved.[<sup>4</sup>]

Human learning starts at birth (it might even start before<sup>[5]</sup>) and continues until death as a consequence of ongoing interactions between people and their environment. The nature and processes involved in learning are studied in many established fields (including educational psychology, neuropsychology, experimental psychology, cognitive sciences, and pedagogy), as well as emerging fields of knowledge (e.g. with a shared interest in the topic of learning from safety events such as incidents/accidents,<sup>[6]</sup> or in collaborative learning health systems<sup>[7]</sup>). Research in such fields has led to the identification of various sorts of learning. For example, learning may occur as a result of habituation, or classical conditioning, operant conditioning or as a result of more complex activities such as play, seen only in relatively intelligent animals.<sup>[8][9]</sup> Learning may occur consciously or without conscious awareness. Learning that an aversive event cannot be avoided or escaped may result in a condition called learned helplessness.<sup>[10]</sup> There is evidence for human behavioral learning prenatally, in which habituation has been observed as early as 32 weeks into gestation, indicating that the central nervous system is sufficiently developed and primed for learning and memory to occur very early on in development.<sup>[11]</sup>

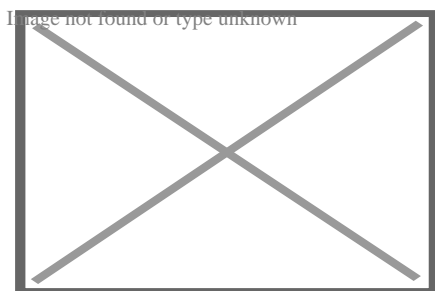
Play has been approached by several theorists as a form of learning. Children experiment with the world, learn the rules, and learn to interact through play. Lev Vygotsky agrees that play is pivotal for children's development, since they make meaning of their environment through playing educational games. For Vygotsky, however, play is the first form of learning language and communication, and the stage where a child begins to understand rules and symbols.<sup>[12]</sup> This has led to a view that learning in organisms is always related to semiosis,<sup>[13]</sup> and is often associated with representational systems/activity.<sup>[14]</sup>

## Types

[edit]

See also: Learning styles and Machine learning § Types of problems and tasks

There are various functional categorizations of memory which have developed. Some memory researchers distinguish memory based on the relationship between the stimuli involved (associative vs non-associative) or based to whether the content can be communicated through language (declarative/explicit vs procedural/implicit). Some of these categories can, in turn, be parsed into sub-types. For instance, declarative memory comprises both episodic and semantic memory.



Children learn to bike in the eighties in Czechoslovakia.

# Non-associative learning

[edit]

*Non-associative learning* refers to "a relatively permanent change in the strength of response to a single stimulus due to repeated exposure to that stimulus."<sup>[15]</sup> This definition exempts the changes caused by sensory adaptation, fatigue, or injury.<sup>[16]</sup>

Non-associative learning can be divided into habituation and sensitization.

## Habituation

[edit]

Main article: Habituation

*Habituation* is an example of non-associative learning in which one or more components of an innate response (e.g., response probability, response duration) to a stimulus diminishes when the stimulus is repeated. Thus, habituation must be distinguished from extinction, which is an associative process. In operant extinction, for example, a response declines because it is no longer followed by a reward. An example of habituation can be seen in small song birds—if a stuffed owl (or similar predator) is put into the cage, the birds initially react to it as though it were a real predator. Soon the birds react less, showing habituation. If another stuffed owl is introduced (or the same one removed and re-introduced), the birds react to it again as though it were a predator, demonstrating that it is only a very specific stimulus that is habituated to (namely, one particular unmoving owl in one place). The habituation process is faster for stimuli that occur at a high rather than for stimuli that occur at a low rate as well as for the weak and strong stimuli, respectively.<sup>[17]</sup> Habituation has been shown in essentially every species of animal, as well as the sensitive plant *Mimosa pudica*<sup>[18]</sup> and the large protozoan *Stentor coeruleus*.<sup>[19]</sup> This concept acts in direct opposition to sensitization.<sup>[17]</sup>

## Sensitization

[edit]

Main article: Sensitization

*Sensitization* is an example of non-associative learning in which the progressive amplification of a response follows repeated administrations of a stimulus.<sup>[20]</sup> This is based on the notion that a defensive reflex to a stimulus such as withdrawal or escape becomes stronger after the exposure to a different harmful or threatening stimulus.<sup>[21]</sup> An

everyday example of this mechanism is the repeated tonic stimulation of peripheral nerves that occurs if a person rubs their arm continuously. After a while, this stimulation creates a warm sensation that can eventually turn painful. This pain results from a progressively amplified synaptic response of the peripheral nerves. This sends a warning that the stimulation is harmful.<sup>[22]</sup><sup>[clarification needed]</sup> Sensitization is thought to underlie both adaptive as well as maladaptive learning processes in the organism.<sup>[23]</sup><sup>[citation needed]</sup>

## Active learning

[edit]

Main article: Active learning

*Active learning* occurs when a person takes control of his/her learning experience. Since understanding information is the key aspect of learning, it is important for learners to recognize what they understand and what they do not. By doing so, they can monitor their own mastery of subjects. Active learning encourages learners to have an internal dialogue in which they verbalize understandings. This and other meta-cognitive strategies can be taught to a child over time. Studies within metacognition have proven the value in active learning, claiming that the learning is usually at a stronger level as a result.<sup>[24]</sup> In addition, learners have more incentive to learn when they have control over not only how they learn but also what they learn.<sup>[25]</sup> Active learning is a key characteristic of student-centered learning. Conversely, passive learning and direct instruction are characteristics of teacher-centered learning (or traditional education).

## Associative learning

[edit]

*Associative learning* is the process by which a person or animal learns an association between two stimuli or events.<sup>[26]</sup> In classical conditioning, a previously neutral stimulus is repeatedly paired with a reflex-eliciting stimulus until eventually the neutral stimulus elicits a response on its own. In operant conditioning, a behavior that is reinforced or punished in the presence of a stimulus becomes more or less likely to occur in the presence of that stimulus.

### Operant conditioning

[edit]



Main article: Operant conditioning

*Operant conditioning* is a way in which behavior can be shaped or modified according to the desires of the trainer or head individual. Operant conditioning uses the thought that living things seek pleasure and avoid pain, and that an animal or human can learn through receiving either reward or punishment at a specific time called trace conditioning. Trace conditioning is the small and ideal period of time between the subject performing the desired behavior, and receiving the positive reinforcement as a result of their performance. The reward needs to be given immediately after the completion of the wanted behavior.<sup>[27]</sup>  
]

Operant conditioning is different from classical conditioning in that it shapes behavior not solely on bodily reflexes that occur naturally to a specific stimulus, but rather focuses on the shaping of wanted behavior that requires conscious thought, and ultimately requires learning.<sup>[28]</sup>

Punishment and reinforcement are the two principal ways in which operant conditioning occurs. Punishment is used to reduce unwanted behavior, and ultimately (from the learner's perspective) leads to avoidance of the punishment, not necessarily avoidance of the unwanted behavior. Punishment is not an appropriate way to increase wanted behavior for animals or humans. Punishment can be divided into two subcategories, positive punishment and negative punishment. Positive punishment is when an aversive aspect of life or thing is added to the subject, for this reason it is called positive punishment. For example, the parent spanking their child would be considered a positive punishment, because a spanking was added to the child. Negative punishment is considered the removal of something loved or desirable from the subject. For example, when a parent puts his child in time out, in reality, the child is losing the opportunity to be with friends, or to enjoy the freedom to do as he pleases. In this example, negative punishment is the removal of the child's desired rights to play with his friends etc.<sup>[29][30]</sup>

Reinforcement on the other hand is used to increase a wanted behavior either through negative reinforcement or positive reinforcement. Negative reinforcement is defined by removing an undesirable aspect of life, or thing. For example, a dog might learn to sit as the trainer scratches his ears, which ultimately is removing his itches (undesirable aspect). Positive reinforcement is defined by adding a desirable aspect of life or thing. For example, a dog might learn to sit if he receives a treat. In this example the treat was added to the dog's life.<sup>[29][30]</sup>

## **Classical conditioning**

[edit]

Main article: Classical conditioning

The typical paradigm for *classical conditioning* involves repeatedly pairing an unconditioned stimulus (which unfailingly evokes a reflexive response) with another previously neutral stimulus (which does not normally evoke the response). Following conditioning, the response occurs both to the unconditioned stimulus and to the other, unrelated stimulus (now referred to as the "conditioned stimulus"). The response to the conditioned stimulus is termed a *conditioned response*. The classic example is Ivan Pavlov and his dogs.<sup>[21]</sup> Pavlov fed his dogs meat powder, which naturally made the dogs salivate—salivating is a reflexive response to the meat powder. Meat powder is the unconditioned stimulus (US) and the salivation is the unconditioned response (UR). Pavlov rang a bell before presenting the meat powder. The first time Pavlov rang the bell, the neutral stimulus, the dogs did not salivate, but once he put the meat powder in their mouths they began to salivate. After numerous pairings of bell and food, the dogs learned that the bell signaled that food was about to come, and began to salivate when they heard the bell. Once this occurred, the bell became the conditioned stimulus (CS) and the salivation to the bell became the conditioned response (CR). Classical conditioning has been demonstrated in many species. For example, it is seen in honeybees, in the proboscis extension reflex paradigm.<sup>[31]</sup> It was recently also demonstrated in garden pea plants.<sup>[32]</sup>

Another influential person in the world of classical conditioning is John B. Watson. Watson's work was very influential and paved the way for B.F. Skinner's radical behaviorism. Watson's behaviorism (and philosophy of science) stood in direct contrast to Freud and other accounts based largely on introspection. Watson's view was that the introspective method was too subjective and that we should limit the study of human development to directly observable behaviors. In 1913, Watson published the article "Psychology as the Behaviorist Views", in which he argued that laboratory studies should serve psychology best as a science. Watson's most famous, and controversial, experiment was "Little Albert", where he demonstrated how psychologists can account for the learning of emotion through classical conditioning principles.

## **Observational learning**

[edit]

Main article: Observational learning

*Observational learning* is learning that occurs through observing the behavior of others. It is a form of social learning which takes various forms, based on various processes. In humans, this form of learning seems to not need reinforcement to occur, but instead, requires a social model such as a parent, sibling, friend, or teacher with surroundings.

## **Imprinting**

[edit]

Main article: Imprinting (psychology)

*Imprinting* is a kind of learning occurring at a particular life stage that is rapid and apparently independent of the consequences of behavior. In filial imprinting, young animals, particularly birds, form an association with another individual or in some cases, an object, that they respond to as they would to a parent. In 1935, the Austrian Zoologist Konrad Lorenz discovered that certain birds follow and form a bond if the object makes sounds.

## Play

[edit]

Main article: Play (activity)

*Play* generally describes behavior with no particular end in itself, but that improves performance in similar future situations. This is seen in a wide variety of vertebrates besides humans, but is mostly limited to mammals and birds. Cats are known to play with a ball of string when young, which gives them experience with catching prey. Besides inanimate objects, animals may play with other members of their own species or other animals, such as orcas playing with seals they have caught. Play involves a significant cost to animals, such as increased vulnerability to predators and the risk of injury and possibly infection. It also consumes energy, so there must be significant benefits associated with play for it to have evolved. Play is generally seen in younger animals, suggesting a link with learning. However, it may also have other benefits not associated directly with learning, for example improving physical fitness.

Play, as it pertains to humans as a form of learning is central to a child's learning and development. Through play, children learn social skills such as sharing and collaboration. Children develop emotional skills such as learning to deal with the emotion of anger, through play activities. As a form of learning, play also facilitates the development of thinking and language skills in children.<sup>[33]</sup>

There are five types of play:

1. Sensorimotor play aka functional play, characterized by the repetition of an activity
2. Roleplay occurs starting at the age of three
3. Rule-based play where authoritative prescribed codes of conduct are primary
4. Construction play involves experimentation and building
5. Movement play aka physical play<sup>[33]</sup>

These five types of play are often intersecting. All types of play generate thinking and problem-solving skills in children. Children learn to think creatively when they learn through play.<sup>[34]</sup> Specific activities involved in each type of play change over time as

humans progress through the lifespan. Play as a form of learning, can occur solitarily, or involve interacting with others.

## Enculturation

[edit]

Main article: Enculturation

*Enculturation* is the process by which people learn values and behaviors that are appropriate or necessary in their surrounding culture.<sup>[35]</sup> Parents, other adults, and peers shape the individual's understanding of these values.<sup>[35]</sup> If successful, enculturation results in competence in the language, values, and rituals of the culture.<sup>[35]</sup> This is different from acculturation, where a person adopts the values and societal rules of a culture different from their native one.

Multiple examples of enculturation can be found cross-culturally. Collaborative practices in the Mazahua people have shown that participation in everyday interaction and later learning activities contributed to enculturation rooted in nonverbal social experience.<sup>[36]</sup> As the children participated in everyday activities, they learned the cultural significance of these interactions. The collaborative and helpful behaviors exhibited by Mexican and Mexican-heritage children is a cultural practice known as being "acomedido".<sup>[37]</sup> Chillihuani girls in Peru described themselves as weaving constantly, following behavior shown by the other adults.<sup>[38]</sup>

## Episodic learning

[edit]

*Episodic learning* is a change in behavior that occurs as a result of an event.<sup>[39]</sup> For example, a fear of dogs that follows being bitten by a dog is episodic learning. Episodic learning is so named because events are recorded into episodic memory, which is one of the three forms of explicit learning and retrieval, along with perceptual memory and semantic memory.<sup>[40]</sup> Episodic memory remembers events and history that are embedded in experience and this is distinguished from semantic memory, which attempts to extract facts out of their experiential context<sup>[41]</sup> or – as some describe – a timeless organization of knowledge.<sup>[42]</sup> For instance, if a person remembers the Grand Canyon from a recent visit, it is an episodic memory. He would use semantic memory to answer someone who would ask him information such as where the Grand Canyon is. A study revealed that humans are very accurate in the recognition of episodic memory even

without deliberate intention to memorize it.<sup>[43]</sup> This is said to indicate a very large storage capacity of the brain for things that people pay attention to.<sup>[43]</sup>

## Multimedia learning

[edit]

Main article: Multimedia learning

*Multimedia learning* is where a person uses both auditory and visual stimuli to learn information.<sup>[44]</sup> This type of learning relies on dual-coding theory.<sup>[45]</sup>

## E-learning and augmented learning

[edit]

Main article: Electronic learning

*Electronic learning* or e-learning is computer-enhanced learning. A specific and always more diffused e-learning is mobile learning (m-learning), which uses different mobile telecommunication equipment, such as cellular phones.

When a learner interacts with the e-learning environment, it is called augmented learning. By adapting to the needs of individuals, the context-driven instruction can be dynamically tailored to the learner's natural environment. Augmented digital content may include text, images, video, audio (music and voice). By personalizing instruction, augmented learning has been shown to improve learning performance for a lifetime.<sup>[46]</sup> See also minimally invasive education.

Moore (1989)<sup>[47]</sup> purported that three core types of interaction are necessary for quality, effective online learning:

- Learner–learner (i.e. communication between and among peers with or without the teacher present),
- Learner–instructor (i.e. student-teacher communication), and
- Learner–content (i.e. intellectually interacting with content that results in changes in learners' understanding, perceptions, and cognitive structures).

In his theory of transactional distance, Moore (1993)<sup>[48]</sup> contented that structure and interaction or dialogue bridge the gap in understanding and communication that is created by geographical distances (known as transactional distance).



# Rote learning

[edit]

Main article: Rote learning

*Rote learning* is memorizing information so that it can be recalled by the learner exactly the way it was read or heard. The major technique used for rote learning is *learning by repetition*, based on the idea that a learner can recall the material exactly (but not its meaning) if the information is repeatedly processed. Rote learning is used in diverse areas, from mathematics to music to religion.

# Meaningful learning

[edit]

See also: Deeper learning

*Meaningful learning* is the concept that learned knowledge (e.g., a fact) is fully understood to the extent that it relates to other knowledge. To this end, meaningful learning contrasts with rote learning in which information is acquired without regard to understanding. Meaningful learning, on the other hand, implies there is a comprehensive knowledge of the context of the facts learned.<sup>[49]</sup>

# Evidence-based learning

[edit]

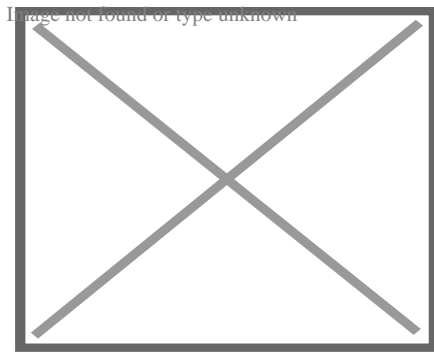
Main article: Evidence-based learning

Evidence-based learning is the use of evidence from well designed scientific studies to accelerate learning. Evidence-based learning methods such as spaced repetition can increase the rate at which a student learns.<sup>[50]</sup>

# Formal learning

[edit]

Main article: Education



A depiction of the world's oldest continually operating university, the University of Bologna, Italy

*Formal learning* is a deliberate way attaining of knowledge, which takes place within a teacher-student environment, such as in a school system or work environment.<sup>[51][52]</sup> The term formal learning has nothing to do with the formality of the learning, but rather the way it is directed and organized. In formal learning, the learning or training departments set out the goals and objectives of the learning and oftentimes learners will be awarded with a diploma, or a type of formal recognition.<sup>[51][53]</sup>

## Non-formal learning

[edit]

Main article: Nonformal learning

*Non-formal learning* is organized learning outside the formal learning system. For example, learning by coming together with people with similar interests and exchanging viewpoints, in clubs or in (international) youth organizations, and workshops. From the organizer's point of reference, non-formal learning does not always need a main objective or learning outcome. From the learner's point of view, non-formal learning, although not focused on outcomes, often results in an intentional learning opportunity.<sup>[54]</sup>

## Informal learning

[edit]

Main article: Informal learning

*Informal learning* is less structured than "non-formal learning". It may occur through the experience of day-to-day situations (for example, one would learn to look ahead while

walking because of the possible dangers inherent in not paying attention to where one is going). It is learning from life, during a meal at the table with parents, during play, and while exploring etc.. For the learner, informal learning is most often an experience of happenstance, and not a deliberately planned experience. Thus this does not require enrollment into any class. Unlike formal learning, informal learning typically does not lead to accreditation.<sup>[54]</sup> Informal learning begins to unfold as the learner ponders his or her situation. This type of learning does not require a professor of any kind, and learning outcomes are unforeseen following the learning experience.<sup>[55]</sup>

Informal learning is self-directed and because it focuses on day-to-day situations, the value of informal learning can be considered high. As a result, information retrieved from informal learning experiences will likely be applicable to daily life.<sup>[56]</sup> Children with informal learning can at times yield stronger support than subjects with formal learning in the topic of mathematics.<sup>[57]</sup> Daily life experiences take place in the workforce, family life, and any other situation that may arise during one's lifetime. Informal learning is voluntary from the learner's viewpoint, and may require making mistakes and learning from them. Informal learning allows the individual to discover coping strategies for difficult emotions that may arise while learning. From the learner's perspective, informal learning can become purposeful, because the learner chooses which rate is appropriate to learn and because this type of learning tends to take place within smaller groups or by oneself.<sup>[56]</sup>

## Nonformal learning and combined approaches

[edit]

The educational system may use a combination of formal, informal, and nonformal learning methods. The UN and EU recognize these different forms of learning (cf. links below). In some schools, students can get points that count in the formal-learning systems if they get work done in informal-learning circuits. They may be given time to assist international youth workshops and training courses, on the condition they prepare, contribute, share, and can prove this offered valuable new insight, helped to acquire new skills, a place to get experience in organizing, teaching, etc.

To learn a skill, such as solving a Rubik's Cube quickly, several factors come into play at once:

- Reading directions helps a player learn the patterns that solve the Rubik's Cube.
- Practicing the moves repeatedly helps build "muscle memory" and speed.
- Thinking critically about moves helps find shortcuts, which speeds future attempts.
- Observing the Rubik's Cube's six colors help anchor solutions in the mind.
- Revisiting the cube occasionally helps retain the skill.

# Tangential learning

[edit]

*Tangential learning* is the process by which people self-educate if a topic is exposed to them in a context that they already enjoy. For example, after playing a music-based video game, some people may be motivated to learn how to play a real instrument, or after watching a TV show that references Faust and Lovecraft, some people may be inspired to read the original work.<sup>[58]</sup> Self-education can be improved with systematization. According to experts in natural learning, self-oriented learning training has proven an effective tool for assisting independent learners with the natural phases of learning.<sup>[59]</sup>

*Extra Credits* writer and game designer James Portnow was the first to suggest games as a potential venue for "tangential learning".<sup>[60]</sup> Mozelius *et al.*<sup>[61]</sup> points out that intrinsic integration of learning content seems to be a crucial design factor, and that games that include modules for further self-studies tend to present good results. The built-in encyclopedias in the *Civilization* games are presented as an example – by using these modules gamers can dig deeper for knowledge about historical events in the gameplay. The importance of rules that regulate learning modules and game experience is discussed by Moreno, C.,<sup>[62]</sup> in a case study about the mobile game *Kiwaka*. In this game, developed by Landka in collaboration with ESA and ESO, progress is rewarded with educational content, as opposed to traditional education games where learning activities are rewarded with gameplay.<sup>[63]</sup><sup>[64]</sup>

# Dialogic learning

[edit]

Main article: Dialogic learning

*Dialogic learning* is a type of learning based on dialogue.

# Incidental learning

[edit]

In *incidental teaching* learning is not planned by the instructor or the student, it occurs as a byproduct of another activity — an experience, observation, self-reflection, interaction,

unique event (e.g. in response to incidents/accidents), or common routine task. This learning happens in addition to or apart from the instructor's plans and the student's expectations. An example of incidental teaching is when the instructor places a train set on top of a cabinet. If the child points or walks towards the cabinet, the instructor prompts the student to say "train". Once the student says "train", he gets access to the train set.

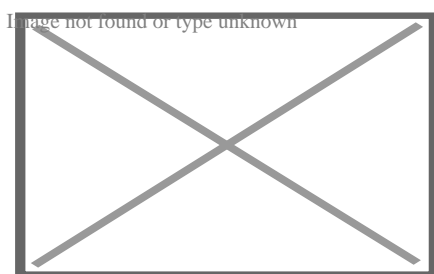
Here are some steps most commonly used in incidental teaching:[<sup>65</sup>]

- An instructor will arrange the learning environment so that necessary materials are within the student's sight, but not within his reach, thus impacting his motivation to seek out those materials.
- An instructor waits for the student to initiate engagement.
- An instructor prompts the student to respond if needed.
- An instructor allows access to an item/activity contingent on a correct response from the student.
- The instructor fades out the prompting process over a period of time and subsequent trials.

Incidental learning is an occurrence that is not generally accounted for using the traditional methods of instructional objectives and outcomes assessment. This type of learning occurs in part as a product of social interaction and active involvement in both online and onsite courses. Research implies that some un-assessed aspects of onsite and online learning challenge the equivalency of education between the two modalities. Both onsite and online learning have distinct advantages with traditional on-campus students experiencing higher degrees of incidental learning in three times as many areas as online students. Additional research is called for to investigate the implications of these findings both conceptually and pedagogically.[<sup>66</sup>]

## Domains

[edit]



*Future school (1901 or 1910)*

Benjamin Bloom has suggested three domains of learning in his taxonomy which are:

- Cognitive: To recall, calculate, discuss, analyze, problem solve, etc.
- Psychomotor: To dance, swim, ski, dive, drive a car, ride a bike, etc.



- Affective: To like something or someone, love, appreciate, fear, hate, worship, etc.

These domains are not mutually exclusive. For example, in learning to play chess, the person must learn the rules (cognitive domain)—but must also learn how to set up the chess pieces and how to properly hold and move a chess piece (psychomotor). Furthermore, later in the game the person may even learn to love the game itself, value its applications in life, and appreciate its history (affective domain).<sup>[67]</sup>

## Transfer

[edit]

Transfer of learning is the application of skill, knowledge or understanding to resolve a novel problem or situation that happens when certain conditions are fulfilled. Research indicates that learning transfer is infrequent; most common when "... cued, primed, and guided..."<sup>[68]</sup> and has sought to clarify what it is, and how it might be promoted through instruction.

Over the history of its discourse, various hypotheses and definitions have been advanced. First, it is speculated that different types of transfer exist, including: near transfer, the application of skill to solve a novel problem in a similar context; and far transfer, the application of skill to solve a novel problem presented in a different context.<sup>[69]</sup> Furthermore, Perkins and Salomon (1992) suggest that positive transfer in cases when learning supports novel problem solving, and negative transfer occurs when prior learning inhibits performance on highly correlated tasks, such as second or third-language learning.<sup>[70]</sup> Concepts of positive and negative transfer have a long history; researchers in the early 20th century described the possibility that "...habits or mental acts developed by a particular kind of training may inhibit rather than facilitate other mental activities".<sup>[71]</sup> Finally, Schwarz, Bransford and Sears (2005) have proposed that transferring knowledge into a situation may differ from transferring knowledge out to a situation as a means to reconcile findings that transfer may both be frequent and challenging to promote.<sup>[72]</sup>

A significant and long research history has also attempted to explicate the conditions under which transfer of learning might occur. Early research by Ruger, for example, found that the "level of attention", "attitudes", "method of attack" (or method for tackling a problem), a "search for new points of view", a "careful testing of hypothesis" and "generalization" were all valuable approaches for promoting transfer.<sup>[73]</sup> To encourage transfer through teaching, Perkins and Salomon recommend aligning ("hugging") instruction with practice and assessment, and "bridging", or encouraging learners to reflect on past experiences or make connections between prior knowledge and current content.<sup>[70]</sup>

## Factors affecting learning

[edit]

Main article: Evidence-based learning

## Genetics

[edit]

Main article: Heritability of IQ

Some aspects of intelligence are inherited genetically, so different learners to some degree have different abilities with regard to learning and speed of learning.<sup>[*citation needed*]</sup>

## Socioeconomic and physical conditions

[edit]

Problems like malnutrition, fatigue, and poor physical health can slow learning, as can bad ventilation or poor lighting at home, and unhygienic living conditions.<sup>[74][75]</sup>

The design, quality, and setting of a learning space, such as a school or classroom, can each be critical to the success of a learning environment. Size, configuration, comfort—fresh air, temperature, light, acoustics, furniture—can all affect a student's learning. The tools used by both instructors and students directly affect how information is conveyed, from the display and writing surfaces (blackboards, markerboards, tack surfaces) to digital technologies. For example, if a room is too crowded, stress levels rise, student attention is reduced, and furniture arrangement is restricted. If furniture is incorrectly arranged, sightlines to the instructor or instructional material are limited and the ability to suit the learning or lesson style is restricted. Aesthetics can also play a role, for if student morale suffers, so does motivation to attend school.<sup>[76][77]</sup>

## Psychological factors and teaching style

[edit]

Intrinsic motivation, such as a student's own intellectual curiosity or desire to experiment or explore, has been found to sustain learning more effectively than extrinsic motivations such as grades or parental requirements. Rote learning involves repetition in order to reinforce facts in memory, but has been criticized as ineffective and "drill and kill" since it kills intrinsic motivation. Alternatives to rote learning include active learning and meaningful learning.

The speed, accuracy, and retention, depend upon aptitude, attitude, interest, attention, energy level, and motivation of the students. Students who answer a question properly or give good results should be praised. This encouragement increases their ability and helps them produce better results. Certain attitudes, such as always finding fault in a student's answer or provoking or embarrassing the student in front of a class are counterproductive. <sup>[78][79]</sup>*[need quotation to verify]*

Certain techniques can increase long-term retention:<sup>[80]</sup>

- The spacing effect means that lessons or studying spaced out over time (spaced repetition) are better than cramming
- Teaching material to other people
- "Self-explaining" (paraphrasing material to oneself) rather than passive reading
- Low-stakes quizzing

## Epigenetic factors

[edit]

Further information: Epigenetics in learning and memory

The underlying molecular basis of learning appears to be dynamic changes in gene expression occurring in brain neurons that are introduced by epigenetic mechanisms. Epigenetic regulation of gene expression involves, most notably, chemical modification of DNA or DNA-associated histone proteins. These chemical modifications can cause long-lasting changes in gene expression. Epigenetic mechanisms involved in learning include the methylation and demethylation of neuronal DNA as well as methylation, acetylation and deacetylation of neuronal histone proteins.

During learning, information processing in the brain involves induction of oxidative modification in neuronal DNA followed by the employment of DNA repair processes that introduce epigenetic alterations. In particular, the DNA repair processes of non-homologous end joining and base excision repair are employed in learning and memory formation.<sup>[81][82]</sup>

## General cognition-related factors

[edit]

This section is an excerpt from Development of the nervous system in humans § Adult neural development.<sup>[edit]</sup>

The nervous system continues to develop during adulthood until brain death. For example:

- physical exercise has neurobiological effects
- the consumption of foods (or nutrients), obesity,<sup>[83]</sup> alterations of the microbiome, drinks, dietary supplements, recreational drugs and medications<sup>[84][85]</sup> may possibly also have effects on the development of the nervous system
- various diseases, such as COVID-19, have effects on the development of the nervous system
  - For example, several genes have been identified as being associated with changes in brain structure over lifetime and are potential Alzheimer's disease therapy-targets.<sup>[86][87]</sup>
- psychological events such as mental trauma and resilience-building
- exposure to environmental pollution and toxins such as air pollution may have effects on the further development of the nervous system
- other activities may also have effects on the development of the nervous system, such as lifelong learning, retraining, and types of media- and economic activities
- broadly, brain aging

## Adult learning vs children's learning

[edit]

See also: Aging brain

[icon] **This section needs expansion.** You can help by adding to it. *(January 2023)*

Learning is often more efficient in children and takes longer or is more difficult with age. A study using neuroimaging identified rapid neurotransmitter GABA boosting as a major potential explanation-component for why that is.<sup>[88][89]</sup>

Children's brains contain more "silent synapses" that are inactive until recruited as part of neuroplasticity and flexible learning or memories.<sup>[90][91]</sup> Neuroplasticity is heightened during critical or sensitive periods of brain development, mainly referring to brain development during child development.<sup>[92]</sup>

However researchers, after subjecting late middle aged participants to university courses, suggest perceived age differences in learning may be a result of differences in time, support, environment, and attitudes, rather than inherent ability.<sup>[93]</sup>

What humans learn at the early stages, and what they learn to apply, sets humans on course for life or has a disproportional impact.<sup>[94]</sup> Adults usually have a higher capacity to select what they learn, to what extent and how. For example, children may learn the given subjects and topics of school curricula via classroom blackboard-transcription handwriting, instead of being able to choose specific topics/skills or jobs to learn and the styles of learning. For instance, children may not have developed consolidated interests, ethics, interest in purpose and meaningful activities, knowledge about real-world requirements and demands, and priorities.

## In animal evolution

[edit]

Animals gain knowledge in two ways. First is learning—in which an animal gathers information about its environment and uses this information. For example, if an animal eats something that hurts its stomach, it learns not to eat that again. The second is innate knowledge that is genetically inherited. An example of this is when a horse is born and can immediately walk. The horse has not learned this behavior; it simply knows how to do it.<sup>[95]</sup> In some scenarios, innate knowledge is more beneficial than learned knowledge. However, in other scenarios the opposite is true—animals must learn certain behaviors when it is disadvantageous to have a specific innate behavior. In these situations, learning evolves in the species.

## Costs and benefits of learned and innate knowledge

[edit]

In a changing environment, an animal must constantly gain new information to survive. However, in a stable environment, this same individual needs to gather the information it needs once, and then rely on it for the rest of its life. Therefore, different scenarios better suit either learning or innate knowledge. Essentially, the cost of obtaining certain knowledge versus the benefit of already having it determines whether an animal evolved to learn in a given situation, or whether it innately knew the information. If the cost of gaining the knowledge outweighs the benefit of having it, then the animal does not evolve to learn in this scenario—but instead, non-learning evolves. However, if the benefit of having certain information outweighs the cost of obtaining it, then the animal is far more likely to evolve to have to learn this information.<sup>[95]</sup>

Non-learning is more likely to evolve in two scenarios. If an environment is static and change does not or rarely occurs, then learning is simply unnecessary. Because there is no need for learning in this scenario—and because learning could prove disadvantageous due to the time it took to learn the information—non-learning evolves. Similarly, if an environment is in a constant state of change, learning is also disadvantageous, as anything learned is immediately irrelevant because of the changing environment.<sup>[95]</sup> The learned information no longer applies. Essentially, the animal would be just as successful if it took a guess as if it learned. In this situation, non-learning evolves. In fact, a study of *Drosophila melanogaster* showed that learning can actually lead to a decrease in productivity, possibly because egg-laying behaviors and decisions were impaired by interference from the memories gained from the newly learned materials or because of the

cost of energy in learning.[<sup>96</sup>]

However, in environments where change occurs within an animal's lifetime but is not constant, learning is more likely to evolve. Learning is beneficial in these scenarios because an animal can adapt to the new situation, but can still apply the knowledge that it learns for a somewhat extended period of time. Therefore, learning increases the chances of success as opposed to guessing.[<sup>95</sup>] An example of this is seen in aquatic environments with landscapes subject to change. In these environments, learning is favored because the fish are predisposed to learn the specific spatial cues where they live.[<sup>97</sup>]

## In plants

[edit]

In recent years, plant physiologists have examined the physiology of plant behavior and cognition. The concepts of learning and memory are relevant in identifying how plants respond to external cues, a behavior necessary for survival. Monica Gagliano, an Australian professor of evolutionary ecology, makes an argument for associative learning in the garden pea, *Pisum sativum*. The garden pea is not specific to a region, but rather grows in cooler, higher altitude climates. Gagliano and colleagues' 2016 paper aims to differentiate between innate phototropism behavior and learned behaviors.[<sup>32</sup>] Plants use light cues in various ways, such as to sustain their metabolic needs and to maintain their internal circadian rhythms. Circadian rhythms in plants are modulated by endogenous bioactive substances that encourage leaf-opening and leaf-closing and are the basis of nyctinastic behaviors.[<sup>98</sup>]

Gagliano and colleagues constructed a classical conditioning test in which pea seedlings were divided into two experimental categories and placed in Y-shaped tubes.[<sup>32</sup>] In a series of training sessions, the plants were exposed to light coming down different arms of the tube. In each case, there was a fan blowing lightly down the tube in either the same or opposite arm as the light. The unconditioned stimulus (US) was the predicted occurrence of light and the conditioned stimulus (CS) was the wind blowing by the fan. Previous experimentation shows that plants respond to light by bending and growing towards it through differential cell growth and division on one side of the plant stem mediated by auxin signaling pathways.[<sup>99</sup>]

During the testing phase of Gagliano's experiment, the pea seedlings were placed in different Y-pipes and exposed to the fan alone. Their direction of growth was subsequently recorded. The 'correct' response by the seedlings was deemed to be growing into the arm where the light was "predicted" from the previous day. The majority of plants in both experimental conditions grew in a direction consistent with the predicted location of light based on the position of the fan the previous day.[<sup>32</sup>] For example, if the seedling was trained with the fan and light coming down the same arm of the Y-pipe, the following day the seedling grew towards the fan in the absence of light cues despite the fan being

placed in the opposite side of the Y-arm. Plants in the control group showed no preference to a particular arm of the Y-pipe. The percentage difference in population behavior observed between the control and experimental groups is meant to distinguish innate phototropism behavior from active associative learning.<sup>[32]</sup>

While the physiological mechanism of associative learning in plants is not known, Telewski et al. describes a hypothesis that describes photoreception as the basis of mechano-perception in plants.<sup>[100]</sup> One mechanism for mechano-perception in plants relies on MS ion channels and calcium channels. Mechanosensory proteins in cell lipid bilayers, known as MS ion channels, are activated once they are physically deformed in response to pressure or tension. Ca<sup>2+</sup> permeable ion channels are "stretch-gated" and allow for the influx of osmolytes and calcium, a well-known second messenger, into the cell. This ion influx triggers a passive flow of water into the cell down its osmotic gradient, effectively increasing turgor pressure and causing the cell to depolarize.<sup>[100]</sup> Gagliano hypothesizes that the basis of associative learning in *Pisum sativum* is the coupling of mechanosensory and photosensory pathways and is mediated by auxin signaling pathways. The result is directional growth to maximize a plant's capture of sunlight.<sup>[32]</sup>

Gagliano et al. published another paper on habituation behaviors in the *mimosa pudica* plant whereby the innate behavior of the plant was diminished by repeated exposure to a stimulus.<sup>[18]</sup> There has been controversy around this paper and more generally around the topic of plant cognition. Charles Abrahamson, a psychologist and behavioral biologist, says that part of the issue of why scientists disagree about whether plants have the ability to learn is that researchers do not use a consistent definition of "learning" and "cognition".<sup>[101]</sup> Similarly, Michael Pollan, an author, and journalist, says in his piece *The Intelligent Plant* that researchers do not doubt Gagliano's data but rather her language, specifically her use of the term "learning" and "cognition" with respect to plants.<sup>[102]</sup> A direction for future research is testing whether circadian rhythms in plants modulate learning and behavior and surveying researchers' definitions of "cognition" and "learning".

## Machine learning

[edit]

[icon] **This section needs expansion.** You can help by adding to it. *(February 2020)*

Robots can learn to cooperate.

Main article: Machine learning

Machine learning, a branch of artificial intelligence, concerns the construction and study of systems that can learn from data. For example, a machine learning system could be trained on email messages to learn to distinguish between spam and non-spam messages. Most of the Machine Learning models are based on probabilistic theories where each input (e.g. an image ) is associated with a probability to become the desired output.



# Types

[edit]

# Phases

[edit]

## See also

[edit]

- 21st century skills – Skills identified as being required for success in the 21st century
- Anticipatory socialization – Process in which people take on the values of groups that they aspire to join
- Epistemology – Philosophical study of knowledge
- Implicit learning – in learning psychology
- Instructional theory – Theory that offers explicit guidance on how to better help people learn and develop
- Learning sciences – Critical theory of learning
- Lifelong learning – Ongoing, voluntary, and self-motivated pursuit of knowledge
- Living educational theory
- Media psychology – Area of psychology
- Subgoal labeling – Cognitive process

# Information theory

[edit]

- Algorithmic information theory – Subfield of information theory and computer science
- Algorithmic probability – mathematical method of assigning a prior probability to a given observation
- Bayesian inference – Method of statistical inference
- Inductive logic programming – learning logic programs from data
- Inductive probability – Determining the probability of future events based on past events
- Information theory – Scientific study of digital information
- Minimum description length – Model selection principle
- Minimum message length – Formal information theory restatement of Occam's Razor
- Occam's razor – Philosophical problem-solving principle
- Solomonoff's theory of inductive inference – A mathematical theory

- AIXI – Mathematical formalism for artificial general intelligence

## Types of education

[edit]

- Autodidacticism – Independent education without the guidance of teachers
- Andragogy – Methods and principles in adult education
- Pedagogy – Theory and practice of education

## References

[edit]

1. ^ Richard Gross, *Psychology: The Science of Mind and Behaviour* Archived 2022-12-31 at the Wayback Machine 6E, Hachette UK, ISBN 978-1-4441-6436-7.
2. ^ Karban, R. (2015). Plant Learning and Memory. In: *Plant Sensing and Communication*. Chicago and London: The University of Chicago Press, pp. 31–44, [1] Archived 2022-12-31 at the Wayback Machine.
3. ^ Lakoff, G., & Johnson, M. (2008). *Metaphors we live by*. University of Chicago press.
4. ^ Daniel L. Schacter; Daniel T. Gilbert; Daniel M. Wegner (2011) [2009]. *Psychology, 2nd edition*. Worth Publishers. p. 264. ISBN 978-1-4292-3719-2.
5. ^ OECD (2007). *Understanding the Brain: The Birth of a Learning Science*. OECD Publishing. p. 165. ISBN 978-92-64-02913-2.
6. ^ Sujan, M. A., Huang, H., & Braithwaite, J. (2017). Learning from incidents in health care: critique from a Safety-II perspective. *Safety Science*, 99, 115–121.
7. ^ Hartley, David M.; Seid, Michael (2021). "Collaborative learning health systems: Science and practice". *Learning Health Systems*. **5** (3): e10286. doi:10.1002/lrh2.10286. PMC 8278439. PMID 34277947.
8. ^ "Jungle Gyms: The Evolution of Animal Play". Archived from the original on October 11, 2007.
9. ^ "What behavior can we expect of octopuses?". *www.thecephalopodpage.org. The Cephalopod Page*. Archived from the original on 5 October 2017. Retrieved 4 May 2018.
10. ^ Learned helplessness at the *Encyclopædia Britannica*
11. ^ Sandman, Wadhwa; Hetrick, Porto; Peeke (1997). "Human fetal heart rate dishabituation between thirty and thirty-two weeks gestation". *Child Development*. **68** (6): 1031–1040. doi:10.1111/j.1467-8624.1997.tb01982.x. PMID 9418223.
12. ^ Sheridan, Mary; Howard, Justine; Alderson, Dawn (2010). *Play in Early Childhood: From Birth to Six Years*. Oxon: Routledge. ISBN 978-1-136-83748-7.
13. ^ Campbell, Cary; Olteanu, Alin; Kull, Kalevi 2019. Learning and knowing as semiosis: Extending the conceptual apparatus of semiotics Archived 2022-04-09 at the Wayback Machine. *Sign Systems Studies* 47(3/4): 352–381.
14. ^ Hutchins, E., 2014. The cultural ecosystem of human cognition. *Philosophical Psychology* 27(1), 34–49.

15. ^ Fuentes, Agustín (2017). *The International Encyclopedia of Primatology*, 3 Volume Set. Malden, MA: Wiley Blackwell. p. 712. ISBN 978-0-470-67337-9.
16. ^ "Non-associative Learning" (PDF). Archived from the original (PDF) on 2014-01-03 . Retrieved 2013-08-09.
17. ^ **a b** Pear, Joseph (2014). *The Science of Learning*. London: Psychology Press. p. 15. ISBN 978-1-317-76280-5.
18. ^ **a b** Gagliano, M.; et al. (2014). "Experience teaches plants to learn faster and forget slower in environments where it matters". *Oecologia*. **175** (1): 63–72. Bibcode:2014Oecol.175...63G. doi:10.1007/s00442-013-2873-7. PMID 24390479. S2CID 5038227.
19. ^ Wood, D.C. (1988). "Habituation in *Stentor* produced by mechanoreceptor channel modification". *Journal of Neuroscience*. **8** (7): 2254–8. doi:10.1523/JNEUROSCI.08-07-02254.1988. PMC 6569508. PMID 3249223.
20. ^ Shettleworth, S. J. (2010). *Cognition, Evolution, and Behavior* (2nd ed.). New York: Oxford.
21. ^ **a b** Galizia, Giovanni; Lledo, Pierre-Marie (2013). *Neurosciences – From Molecule to Behavior*. Heidelberg: Springer Spektrum. p. 578. ISBN 978-3-642-10768-9.
22. ^ Woolf, Clifford J. (2018-02-27). "Pain amplification-A perspective on the how, why, when, and where of central sensitization". *Journal of Applied Biobehavioral Research* . **23** (2): e12124. doi:10.1111/jabr.12124. ISSN 1071-2089.
23. ^ Bonne, Omer; Grillon, Christian; Vythilingam, Meena; Neumeister, Alexander; Charney, Dennis S (March 2004). "Adaptive and maladaptive psychobiological responses to severe psychological stress: implications for the discovery of novel pharmacotherapy". *Neuroscience & Biobehavioral Reviews*. **28** (1): 65–94. doi:10.1016/j.neubiorev.2003.12.001. ISSN 0149-7634. PMID 15036934. S2CID 23745725.
24. ^ Bransford, 2000, pp. 15–20
25. ^ J. Scott Armstrong (2012). "Natural Learning in Higher Education". *Encyclopedia of the Sciences of Learning*. Archived from the original on 2014-09-16.
26. ^ Plotnik, Rod; Kouyoumdijan, Haig (2012). *Discovery Series: Introduction to Psychology*. Belmont, CA: Wadsworth Cengage Learning. p. 208. ISBN 978-1-111-34702-4.
27. ^ Bangasser, Debra A.; Waxler, David E.; Santollo, Jessica; Shors, Tracey J. (2006-08-23). "Trace Conditioning and the Hippocampus: The Importance of Contiguity". *The Journal of Neuroscience*. **26** (34): 8702–8706. doi:10.1523/JNEUROSCI.1742-06.2006. ISSN 0270-6474. PMC 3289537. PMID 16928858.
28. ^ "Reflex Definition & Meaning | Britannica Dictionary". [www.britannica.com](http://www.britannica.com). Retrieved 2023-06-30.
29. ^ **a b** Pryor, Karen (1999-08-03). *Don't Shoot the Dog: The New Art of Teaching and Training* (Revised ed.). New York: Bantam. ISBN 978-0-553-38039-2.
30. ^ **a b** Chance, Paul; Furlong, Ellen (2022-03-16). *Learning and Behavior: Active Learning Edition* (8th ed.). Boston, MA: Cengage Learning. ISBN 978-0-357-65811-6 .
31. ^ Bitterman; et al. (1983). "Classical Conditioning of Proboscis Extension in Honeybees (*Apis mellifera*)". *J. Comp. Psychol.* **97** (2): 107–119. doi:10.1037/0735-

7036.97.2.107. PMID 6872507.

32. ^ **a b c d e f** Gagliano, Monica; Vyazovskiy, Vladyslav V.; Borbély, Alexander A.; Grimmonprez, Mavra; Depczynski, Martial (2016-12-02). "Learning by Association in Plants". *Scientific Reports*. **6** (1): 38427. Bibcode:2016NatSR...638427G. doi:10.1038/srep38427. ISSN 2045-2322. PMC 5133544. PMID 27910933.
33. ^ **a b** Lillemyr, O.F. (2009). *Taking play seriously. Children and play in early childhood education: an exciting challenge*. Charlotte, NC: Information Age Publishing.
34. ^ Whitebread, D.; Coltman, P.; Jameson, H.; Lander, R. (2009). "Play, cognition and self-regulation: What exactly are children learning when they learn through play?". *Educational and Child Psychology*. **26** (2): 40–52. doi:10.53841/bpsecp.2009.26.2.40. S2CID 150255306.
35. ^ **a b c** Grusec, Joan E.; Hastings, Paul D. "Handbook of Socialization: Theory and Research", 2007, Guilford Press; ISBN 1-59385-332-7, 978-1-59385-332-7; at p. 547.
36. ^ Paradise, Ruth (1994). "Interactional Style and Nonverbal Meaning: Mazahua Children Learning How to Be Separate-But-Together". *Anthropology & Education Quarterly*. **25** (2): 156–172. doi:10.1525/aeq.1994.25.2.05x0907w. S2CID 146505048.
37. ^ Lopez, Angelica; Najafi, Behnosh; Rogoff, Barbara; Mejia-Arauz, Rebeca (2012). "Collaboration and helping as cultural practices". *The Oxford Handbook of Culture and Psychology*.
38. ^ Bolin, Inge (2006). *Growing Up in a Culture of Respect: Childrearing in highland Peru* (2 ed.). Austin: University of Texas. pp. 90–99. ISBN 978-0-292-71298-0.
39. ^ Terry, W.S. (2006). *Learning and Memory: Basic principles, processes, and procedures*. Boston: Pearson Education, Inc.
40. ^ Baars, B.J. & Gage, N.M. (2007). *Cognition, Brain, and Consciousness: Introduction to cognitive neuroscience*. London: Elsevier Ltd.
41. ^ Lovett, Marsha; Schunn, Christian; Lebiere, Christian; Munro, Paul (2004). *Sixth International Conference on Cognitive Modeling: ICCM – 2004*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers. p. 220. ISBN 978-0-8058-5426-8.
42. ^ Chrisley, Ronald; Begeer, Sander (2000). *Artificial Intelligence: Critical Concepts, Volume 1*. London: Routledge. p. 48. ISBN 978-0-415-19332-0.
43. ^ **a b** Gage, Nicole; Baars, Bernard (2018). *Fundamentals of Cognitive Neuroscience: A Beginner's Guide*. London: Academic Press. p. 219. ISBN 978-0-12-803813-0.
44. ^ (Mayer 2001)
45. ^ (Paivio 1971)
46. ^ Augmented Learning Archived 2020-03-13 at the Wayback Machine, Augmented Learning: Context-Aware Mobile Augmented Reality Architecture for Learning
47. ^ Moore, M (1989). "Three types of interaction". *American Journal of Distance Education*. **3** (2): 1–6. CiteSeerX 10.1.1.491.4800. doi:10.1080/08923648909526659.
48. ^ Moore, M.G. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22–38). London and New York:

Routledge

49. ^ Hassard, Jack. "Backup of Meaningful Learning Model". Archived from the original on 29 October 2011. Retrieved 30 November 2011.
50. ^ Smolen, Paul; Zhang, Yili; Byrne, John H. (25 January 2016). "The right time to learn: mechanisms and optimization of spaced learning". *Nature Reviews Neuroscience*. **17** (2): 77–88. arXiv:1606.08370. Bibcode:2016arXiv160608370S. doi:10.1038/nrn.2015.18. PMC 5126970. PMID 26806627.
51. ^ **a b** "What is the difference between "informal" and "non formal" learning?". 2014-10-15. Archived from the original on 2014-10-15. Retrieved 2023-05-03.
52. ^ "Glossary". CEDEFOP. Retrieved 2023-06-24.
53. ^ Bell, J., and Dale, M., " Informal Learning in the Workplace" Archived 2013-01-21 at the Wayback Machine, *Department for Education and Employment Research Report No. 134*. London, England: Department for Education and Employment, August 1999
54. ^ **a b** "What is the difference between "informal" and "non formal" learning?". 2014-10-16. Archived from the original on 2014-10-16. Retrieved 2023-06-22.
55. ^ Kyndt, Eva; Baert, Herman (June 2013). "Antecedents of Employees' Involvement in Work-Related Learning: A Systematic Review". *Review of Educational Research*. **83** (2): 273–313. doi:10.3102/0034654313478021. ISSN 0034-6543. S2CID 145446612.
56. ^ **a b** Decius, Julian; Schaper, Niclas; Seifert, Andreas (December 2019). "Informal workplace learning: Development and validation of a measure". *Human Resource Development Quarterly*. **30** (4): 495–535. doi:10.1002/hrdq.21368. ISSN 1044-8004. S2CID 201376378.
57. ^ Dunst, Carl J.; Hamby, Deborah W.; Wilkie, Helen; Dunst, Kerran Scott (2017), Phillipson, Sivanes; Gervasoni, Ann; Sullivan, Peter (eds.), "Meta-Analysis of the Relationship Between Home and Family Experiences and Young Children's Early Numeracy Learning", *Engaging Families as Children's First Mathematics Educators, Early Mathematics Learning and Development*, Singapore: Springer Singapore, pp. 105–125, doi:10.1007/978-981-10-2553-2\_7, ISBN 978-981-10-2551-8, retrieved 2023-06-29
58. ^ Tangential Learning "Penny Arcade – PATV – Tangential Learning". Archived from the original on 2012-01-04. Retrieved 2012-01-31.
59. ^ J. Scott Armstrong (1979). "The Natural Learning Project". *Journal of Experiential Learning and Simulation*. **1**: 5–12. Archived from the original on 2014-10-19.
60. ^ Robert, Rath (2015-01-22). "Game Criticism as Tangential Learning Facilitator: The Case of Critical Intel". *Journal of Games Criticism*. **2** (1). Archived from the original on 2023-04-19. Retrieved 2018-06-08.
61. ^ Mozelius; et al. "Motivating Factors and Tangential Learning for Knowledge Acquisition in Educational Games" (PDF). *The Electronic Journal of e-Learning*. **15** (4 2017).
62. ^ Moreno, Carlos (2014). "Kiwaka | Kiwaka Story (by LANDKA ®)" (PDF). *LifePlay*. **3**.
63. ^ European Southern Observatory. "New App Kiwaka Features ESO Material". [www.eso.org](http://www.eso.org). Retrieved 2018-06-10.

64. ^ Landka (2014). "Kiaka Press Release" (PDF). [landka.com/documents/10/Kiwaka-PressRelease.pdf](http://landka.com/documents/10/Kiwaka-PressRelease.pdf). Archived from the original (PDF) on 2020-08-03. Retrieved 2018-06-10.
65. ^ "What is incidental teaching?". North Shore Pediatric Therapy, Illinois. 2017. Archived from the original on August 29, 2017. Retrieved August 29, 2017.
66. ^ Konetes, George (2011). *The Effects of Distance Education and Student Involvement on Incidental Learning* (PDF) (PhD dissertation). Indiana University of Pennsylvania. p. 115. ERIC ED535973 ProQuest 909895728. Archived from the original (PDF) on 2014-07-14. Retrieved 2014-07-12.
67. ^ "Bloom's Taxonomy". [www.businessballs.com](http://www.businessballs.com). Retrieved 4 May 2018.
68. ^ Perkins, D.N.; Salomon, G. (Jan–Feb 1989). "Are Cognitive Skills Context-Bound?". *Educational Researcher*. **18** (1): 16–25 [19]. doi:10.3102/0013189x018001016. S2CID 15890041.
69. ^ Committee on Developments in the Science of Learning with additional material from the Committee on Learning Research (2000). Chapter 3. Learning and Transfer. *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. The National Academies Press. doi:10.17226/9853. ISBN 978-0-309-07036-2. Archived from the original on 2013-04-26.
70. ^ a b Perkins, D.N.; Salomon, G. (1992). "Transfer of Learning". *International Encyclopedia of Education*. **2**.
71. ^ Rogers, Agnes L. (1916). "The Bearing of the New Psychology upon the Teaching of Mathematics". *Teacher's College Record*. **17** (4): 344–352. doi:10.1177/016146811601700413. S2CID 251487440.
72. ^ Schwartz, Daniel L.; Bransford, John D.; Sears, David (2005). "Efficiency and innovation in transfer". *Transfer of Learning from a Modern Multidisciplinary Perspective*: 1–15.
73. ^ Ruger, Henry Alfred (1910). "The psychology of efficiency: an experimental study of the processes involved in the solution of mechanical puzzles and in the acquisition of skill in their manipulation". Science Press. **19** (2).
74. ^ Mangal, S.K. (2007). *Essentials of Educational Psychology*. PHI Learning Pvt. Ltd. p. 736. ISBN 978-81-203-3055-9.
75. ^ Aggarwal, J.C (2009). *Essentials Of Educational Psychology (Second ed.)*. Vikas Publishing House Pvt Ltd. p. 596. ISBN 978-81-259-2292-6.
76. ^ *New Teachers: Designing Learning Environments*, May 7, 2015 Archived March 28, 2016, at the Wayback Machine. Retrieved 2016-03-19
77. ^ *A Place for Learning: The Physical Environment of Classrooms*, Mark Phillips, May 20, 2014 Archived March 13, 2016, at the Wayback Machine. Retrieved 2016-03-19
78. ^ Mangal, SK (2002). *Advanced Educational Psychology (Second ed.)*. PHI Learning Pvt. Ltd. p. 536. ISBN 978-81-203-2038-3.
79. ^ Bhatia, H.R (1973). *Elements Of Educational Psychology*. Orient Blackswan. p. 558. ISBN 978-81-250-0029-7.
80. ^ The Science Of Learning Archived 2022-05-17 at the Wayback Machine – April 11, 2017 (podcast interview with Ulrich Boser)
81. ^ Li, X; Marshall, PR; Leighton, LJ; Zajackowski, EL; Wang, Z; Madugalle, SU; Yin, J; Bredy, TW; Wei, W (2019). "The DNA Repair-Associated Protein Gadd45?

- Regulates the Temporal Coding of Immediate Early Gene Expression within the Prelimbic Prefrontal Cortex and Is Required for the Consolidation of Associative Fear Memory*". *J Neurosci.* **39** (6): 970–983. doi:10.1523/JNEUROSCI.2024-18.2018. PMC 6363930. PMID 30545945. Erratum in: Li, X; Marshall, PR; Leighton, LJ; Zajackowski, EL; Wang, Z; Madugalle, SU; Yin, J; Bredy, TW; Wei, W (2019). "The DNA Repair-Associated Protein Gadd45? Regulates the Temporal Coding of Immediate Early Gene Expression within the Prelimbic Prefrontal Cortex and Is Required for the Consolidation of Associative Fear Memory". *J Neurosci.* **39** (6): 970–983. doi:10.1523/JNEUROSCI.2024-18.2018. PMC 6363930. PMID 30545945.
82. ^ Brito, David V.C.; Kupke, Janina; Gulmez Karaca, Kubra; Zeuch, Benjamin; Oliveira, Ana M.M. (2020). "Mimicking Age-Associated Gadd45? Dysregulation Results in Memory Impairments in Young Adult Mice". *J Neurosci.* **40** (6): 1197–1210. doi:10.1523/JNEUROSCI.1621-19.2019. PMC 7002144. PMID 31826946.
  83. ^ Dye, Louise; Boyle, Neil Bernard; Champ, Claire; Lawton, Clare (November 2017). "The relationship between obesity and cognitive health and decline". *The Proceedings of the Nutrition Society.* **76** (4): 443–454. doi:10.1017/S0029665117002014. ISSN 1475-2719. PMID 28889822. S2CID 34630498.
  84. ^ Spindler, Carolin; Mallien, Louisa; Trautmann, Sebastian; Alexander, Nina; Muehlhan, Markus (27 January 2022). "A coordinate-based meta-analysis of white matter alterations in patients with alcohol use disorder". *Translational Psychiatry.* **12** (1): 40. doi:10.1038/s41398-022-01809-0. ISSN 2158-3188. PMC 8795454. PMID 35087021. S2CID 246292525.
  85. ^ Wollman, Scott C.; Alhassoon, Omar M.; Hall, Matthew G.; Stern, Mark J.; Connors, Eric J.; Kimmel, Christine L.; Allen, Kenneth E.; Stephan, Rick A.; Radua, Joaquim (September 2017). "Gray matter abnormalities in opioid-dependent patients: A neuroimaging meta-analysis". *The American Journal of Drug and Alcohol Abuse.* **43** (5): 505–517. doi:10.1080/00952990.2016.1245312. ISSN 1097-9891. PMID 27808568. S2CID 4775912.
  86. ^ "Genetic 'hotspots' that speed up and slow down brain aging could provide new targets for Alzheimer's drugs". University of Southern California. Retrieved 15 May 2022.
  87. ^ Brouwer, Rachel M.; Klein, Marieke; Grasby, Katrina L.; Schnack, Hugo G.; et al. (April 2022). "Genetic variants associated with longitudinal changes in brain structure across the lifespan". *Nature Neuroscience.* **25** (4): 421–432. doi:10.1038/s41593-022-01042-4. ISSN 1546-1726. PMC 10040206. PMID 35383335. S2CID 247977288.
  88. ^ "Brain scans shed light on how kids learn faster than adults". UPI. Retrieved 17 December 2022.
  89. ^ Frank, Sebastian M.; Becker, Markus; Qi, Andrea; Geiger, Patricia; Frank, Ulrike I.; Rosedahl, Luke A.; Malloni, Wilhelm M.; Sasaki, Yuka; Greenlee, Mark W.; Watanabe, Takeo (5 December 2022). "Efficient learning in children with rapid GABA boosting during and after training". *Current Biology.* **32** (23): 5022–5030.e7. Bibcode:2022CBio...32E5022F. bioRxiv 10.1101/2022.01.02.474022. doi:10.1016/j.cub.2022.10.021. ISSN 0960-9822. PMID 36384138. S2CID 253571891.

90. ^ Lloreda, Claudia López (16 December 2022). "Adult mouse brains are teeming with 'silent synapses'". *Science News*. Retrieved 18 December 2022.
91. ^ Vardalaki, Dimitra; Chung, Kwanghun; Harnett, Mark T. (December 2022). "Filopodia are a structural substrate for silent synapses in adult neocortex". *Nature*. **612** (7939): 323–327. Bibcode:2022Natur.612..323V. doi:10.1038/s41586-022-05483-6. ISSN 1476-4687. PMID 36450984. S2CID 254122483.
  - o University press release: Trafton, Anne. "Silent synapses are abundant in the adult brain". *Massachusetts Institute of Technology via medicalxpress.com*. Retrieved 18 December 2022.
92. ^ Ismail, Fatima Yousif; Fatemi, Ali; Johnston, Michael V. (1 January 2017). "Cerebral plasticity: Windows of opportunity in the developing brain". *European Journal of Paediatric Neurology*. **21** (1): 23–48. doi:10.1016/j.ejpn.2016.07.007. ISSN 1090-3798. PMID 27567276.
93. ^ [www.apa.org https://www.apa.org/news/podcasts/speaking-of-psychology/lifelong-learning](https://www.apa.org/news/podcasts/speaking-of-psychology/lifelong-learning). Retrieved 2024-11-01. cite web: Missing or empty |title= (help)
94. ^ Buxton, Alex (10 February 2016). "What Happens in the Brain When Children Learn?". *Neuroscience News*. Retrieved 11 January 2023.
95. ^ **a b c d** <Aimee Sue Dunlap-Lehtilä. *Change and Reliability in the Evolution of Learning and Memory (PDF)* (PhD). University of Minnesota. Archived from the original (PDF) on 2013-11-13. Retrieved 2013-12-15.>
96. ^ Mery, Frederic; Kawecki, Tadeusz J. (2004). "An operating cost of learning in *Drosophila melanogaster*" (PDF). *Animal Behaviour*. **68** (3): 589–598. doi:10.1016/j.anbehav.2003.12.005. S2CID 53168227.
97. ^ Odling-Smee, L.; Braithwaite, V.A. (2003). "The role of learning in fish orientation". *Fish and Fisheries*. **4** (3): 235–246. Bibcode:2003AqFF....4..235O. doi:10.1046/j.1467-2979.2003.00127.x.
98. ^ Ueda, Minoru (2007). "Endogenous factors involved in the regulation of movement and "memory" in plants" (PDF). *Pure Appl. Chem*. **79** (4): 519–527. doi:10.1351/pac200779040519. S2CID 35797968. Archived from the original (PDF) on 2019-06-06 – via Semantic Scholar.
99. ^ Liscum, Emmanuel (January 2014). "Phototropism: Growing towards an Understanding of Plant Movement". *Plant Cell*. **1** (1): 38–55. Bibcode:2014PlanC..26...38L. doi:10.1105/tpc.113.119727. PMC 3963583. PMID 24481074.
100. ^ **a b** Telewski, FW (October 2006). "A unified hypothesis of mechanoreception in plants". *American Journal of Botany*. **93** (10): 1466–76. doi:10.3732/ajb.93.10.1466. PMID 21642094.
101. ^ Abramson, Charles I.; Chicas-Mosier, Ana M. (2016-03-31). "Learning in Plants: Lessons from *Mimosa pudica*". *Frontiers in Psychology*. **7**: 417. doi:10.3389/fpsyg.2016.00417. ISSN 1664-1078. PMC 4814444. PMID 27065905.
102. ^ Pollan, Michael (2013-12-16). "The Intelligent Plant". *The New Yorker*. ISSN 0028-792X. Retrieved 2019-06-06.

## Notes

[edit]



- *Mayer, R.E. (2001). Multimedia learning. New York: Cambridge University Press. ISBN 978-0-521-78749-9.*
- *Paivio, A. (1971). Imagery and verbal processes. New York: Holt, Rinehart, and Winston. ISBN 978-0-03-085173-5.*

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- *Ulrich Boser (2019). Learn Better: Mastering the Skills for Success in Life, Business, and School, or How to Become an Expert in Just About Anything. Rodale Books. ISBN 978-0593135310.*

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- Animal cognition
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## Human intelligence topics

## Types

- Collective
- Emotional
- Intellectual
- Linguistic
- Multiple
- Social
- Spatial (visuospatial)


**Abilities,  
traits,  
and  
constructs**

- Cognition
- Cognitive liberty
- Communication
- Creativity
- Fluid and crystallized intelligence
- *g* factor
- Intellect
- Intelligence quotient
- Knowledge
- Learning
- Memory
- Problem solving
- Reasoning
- Skill
- Thought (abstraction)
- Understanding
- Visual processing

**Models  
and  
theories**

- Cattell–Horn–Carroll theory
- Fluid and crystallized intelligence
- Multiple-intelligences theory
- PASS theory
- Three-stratum theory
- Triarchic theory
- Evolution of human intelligence

**Areas of  
research**

- Heritability of IQ
- Psychometrics
- Intelligence and environment / fertility / height / health / longevity / neuroscience / personality / race / sex
-  Outline of human intelligence / thought

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Learning

**Non-associative learning**

- Habituation
- Sensitization
- Classical conditioning

**Associative learning**

- Imprinting
- Observational learning
- Operant conditioning

**Insight learning**

- Abductive reasoning
- Deductive reasoning
- Inductive reasoning

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## Mental processes

### Cognition

- Association
- Awareness
- Cognitive flexibility
- Cognitive liberty
- Forecasting
  - affective
- Foresight
- Comprehension
- Consciousness
- Critical thinking
- Decision-making
- Imagination
- Intuition
- Problem solving
  - methods
  - strategies
- Prospection
- Amodal
- Color
  - RGB model
- Depth
- Form
- Haptic (Touch)
- Perception as interpretation
- Peripheral
- Social
- Sound
  - Harmonics
  - Pitch
  - Speech
- Visual
- Consolidation
- Encoding
- Storage
- Recall

### Perception

### Memory

## Other

- Attention
- Experiential avoidance
- Higher nervous activity
- Intention
- Ironic process theory
- Learning
- Mental fatigue
- Relational frame theory
- Mental set
- Thinking
- Thought suppression
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## Frequently Asked Questions

What are the key differences between general medical coding and oncology-specific coding?

Oncology-specific coding involves detailed knowledge of cancer diagnoses, treatment plans, and procedures unique to oncology. It requires familiarity with specific ICD-10-CM codes for various types of cancer, CPT codes for chemotherapy administration, immunotherapy

treatments, radiation therapy codes, and understanding the nuances of staging and tumor markers. Additionally, adherence to guidelines from organizations like the National Comprehensive Cancer Network (NCCN) is crucial.

**How do changes in oncology treatment protocols impact medical coding practices?**

Changes in oncology treatment protocols can lead to updates or additions in relevant ICD-10-CM and CPT codes. Coders must stay informed about new therapies such as targeted treatments or personalized medicine approaches that may require specific coding adjustments. Regular training and reviewing updates from sources like the American Medical Association (AMA) or Centers for Medicare & Medicaid Services (CMS) help ensure accurate representation of services provided.

**What strategies can be employed to minimize errors in oncology practice coding?**

To minimize errors in oncology practice coding, it is essential to maintain comprehensive documentation that clearly outlines diagnosis specifics, detailed descriptions of treatment regimens, and precise procedural notes. Utilizing specialized software tools that incorporate real-time code validation can reduce human error. Continuous education programs for coders about advancements in cancer care and regular audits of coded claims also contribute to accuracy and compliance with regulatory standards.

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