

When types of concepts different from languages are to be learned, yet other notions of approximate learning should be defined.

Important Scientific Research and Open Questions

Although PAC learning is surely the prominent representative among the possible scenarios of approximate learning, it is not the only choice. It would be valuable to have criteria at hand that suggest, in a concrete application situation, which of the notions would be the appropriate one to pick, if any.

Cross-References

- ▶ [Formal Learning Theory](#)
- ▶ [Grammar Learning](#)
- ▶ [Language Acquisition and Development](#)
- ▶ [PAC Learning](#)
- ▶ [Statistical Learning Theory and Induction](#)

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Aptitude

A measure of an individual's potential to learn music. Tests have been developed by researchers such as Edwin Gordon to measure music aptitude.

Cross-References

- ▶ [Abilities to Learn: Cognitive Abilities](#)
- ▶ [Learner Characteristics and Online Learning](#)

Aptitudes and Human Performance

- ▶ [Ability Determinants of Complex Skill Acquisition](#)

Aptitude-Treatment Interaction

YU-CHU YEH

Institute of Teacher Education, Research Center for Mind, Brain and Learning, Center for Creativity and Innovation Studies, National Chengchi University, Taipei, Wenshan, Taiwan

Synonyms

[Attribute-treatment interaction](#)

Definition

Aptitude-treatment interaction (ATI) research is a research paradigm that attempts to examine how an outcome depends on the match between individuals' specific aptitude(s) and the treatment they receive. When a treatment and an individual's aptitude(s) are matched, the effect of the treatment is optimal. While an aptitude refers to any measurable personal characteristic that would have an impact on achieving goals in the designed treatment, a treatment refers to any manipulable situational variable. An interaction occurs when a treatment has an effect on one type of individual and a different effect on another.

Theoretical Background

The Goal of ATI

According to ATI, individuals differ in their readiness to profit from a particular treatment at a particular time, and individuals may adapt their situations to fit their own characteristics. Therefore, ATI offers a framework for interpreting aptitudes as personal readiness to profit from particular treatment situations. The goal of ATI is to find the interactions between alternative treatments and learners' aptitudes and therefore to create an environment in which the treatments match the aptitude of the learner, in other words, to achieve optimal learning (Cronbach and

Snow 1977). Notably, ATI methodology is designed to evaluate the degree to which alternative treatments have different effects on learners with different aptitudes and thus to determine whether particular treatments should be chosen or adapted to fit particular learners optimally (Snow 1991). Accordingly, ATI allows for the interactive creation and construction of knowledge, which in turn would enhance educators' ability to create more customized individual learning environments.

Development of ATI

The concept of ATI was first proposed by L. J. Cronbach in 1957. Cronbach encouraged psychologists to observe the experimental effects for participants of varied characteristics and to conduct investigations to find aptitude-treatment interactions (ATIs). However, R. E. Snow is thought of as the pioneer who conceptualized and investigated how combinations of aptitudes interacted to produce differential educational outcomes. Based on his studies, Snow proposed "aptitude complexes," which emphasize that aptitudes should not be treated as isolated variables and that the interactions of different aptitudes can produce differential educational outcomes.

Two dissertations supervised by Snow in 1976 provided important support for the concept of aptitude complexes. The first study used ninth-grade students as participants and found significant ATIs between four teaching approaches and three aptitudes: namely, ability, anxiety, and conformance. The second study included participants from high schools and found that combinations of conative and personality factors interacted with the ability level and the treatments involving high or low structure. By the late 1980s, the existence of different aptitude complexes had been supported by many studies. Though most of the evidence of this complex interaction between aptitudes and treatments was indirect, this orientation became the theoretical precursor to later studies on strategy training (Ackerman 2003).

Application of ATI

An ATI research design allows for a complex analysis of interactions between personal aptitude and the effects of experiential learning transformation. ATI has been employed to enhance learning in many fields, such as general classroom instruction, instructional multimedia, special education, teacher training, and medical

studies. To date, most ATI studies have been conducted to determine whether the effects of different instructional methods are influenced by learners' individual aptitudes. In this line of research, many studies have examined the concept of aptitude complexes. Aptitude complexes have emerged from the recognition that different aptitude combinations sometimes interact with the same treatment contrasts. For example, empirical studies of college students and adults found that three aptitudes – self-concept, interest, and motivational trait – were correlated with domain knowledge and ability measures (Ackerman 2003). Therefore, aptitude complexes can be determined from extant assessment measures, and aptitude complexes play an important role in determining the level of effort toward knowledge and skill acquisition.

In the area of multimedia instruction, ATI also plays a major role in delivering the basics for the development of "adaptive instructional systems." Related ATI studies suggest that web-based learning could be significantly enhanced by adapting presentation and instructional methods to styles in the wholist-analytic dimension (Cook 2005). Moreover, a study employing an ATI approach and focused on motivation training found that a combination of attention and relevance strategies improved motivation to learn, especially for those students with low levels of pre-motivation (Astleitner and Koller 2006).

To date, many ATI studies have been employed in the field of special education for students who are either gifted or in need of assistance. Some of the origins of the popularly used individual education plans (IEPs) in special education are derived from ATI theory and practice. In addition, ATI research and ATI methodologies have been used in teacher training for special education and in the delivery of individualized career planning workshops (Merz and Szymanski 1997).

ATI studies were also found in general teacher training research. For example, a study was conducted to examine whether teacher traits would interact with the designed treatments and therefore influence preservice teachers' improvement of teacher behaviors during a computer-simulated training session. The findings suggest that important ATIs occur during computer-simulation training; more specifically, positive personal traits – including critical-thinking dispositions, judicial and legislative thinking styles,

critical-thinking skills, and intrapersonal intelligence – influence how preservice teachers learn and adapt to information, feedback, and teaching practices (Yeh 2007).

Comparatively, only a few ATI studies have been conducted in the medical field. During the medical treatment period, the most important question is what treatment is best or better for whom, when, and why? ATI offers a research paradigm for understanding exactly how outcome depends on the match or mismatch between patients' specific characteristics and the treatments they receive. Therefore, ATI research offers invaluable insights into the multifaceted package of care typically delivered in complementary and alternative medicine/integrative medicine (Caspi and Bell 2004).

Research Design of ATI

The most commonly used methods for ATI research are standard experimental design, regression discontinuity design, and change curves (or growth curves) design. These methods allow the researcher to explicitly test the possibility that one or more aptitudes moderate or mediate outcome/outcomes through an interaction with one or more treatments (Caspi and Bell 2004).

1. Standard experimental design: This is the most commonly used design in ATI research. In such a design, participants are randomly assigned to two or more groups that receive the same treatment, and the outcome is assessed with respect to different levels of an aptitude or a set of aptitudes.
2. Regression discontinuity design: This design is especially appropriate for ATI research when randomization is not feasible. In this design, participants are assigned to conditions based on a cutoff score of a certain aptitude measure taken prior to the treatment. The assignment variable must be an ordinal, interval, or ratio variable.
3. Change curves (or growth curves) design: This design focuses on analyzing how participants change in an outcome variable over time. The main advantages of this approach are that (1) growth curves preserve the data at the individual level; and (2) growth-curve analysis does not necessarily require suitable control conditions, which are crucial to demonstrating treatment effects in comparative trial designs.

To ensure the occurrence of ATI, alternative treatments and the inclusion of two psychological variables are suggested. To be differentially effective for various types of participants, the alternative treatments should demand different abilities for successful performance. Moreover, ATI is more likely to occur when two psychological variables are included in the experimental design where one psychological variable correlates substantially with success in one treatment and the other correlates substantially with success in the other treatment (Cronbach and Snow 1969).

Important Scientific Research and Open Questions

ATI studies contribute to the construction of theories for effective instruction, medical treatment, and adaptive learning. For ATI findings to be meaningful and feasible, however, ATI research should be driven by plausible hypotheses based on data-based theories rather than simply being a hit-or-miss fishing exploration fueled by spurious statistical associations (Caspi and Bell 2004). Moreover, personal characteristics abound in correlations, and aptitude complexes play an important role in knowledge construction and skill acquisition (Ackerman 2003). Therefore, when employing ATI, aptitude complexes should be considered and multiple aptitudes and higher order interactions should be analyzed. The tendency to oversimplify or to reduce complex relationships into simple paired relationships should be overcome in order to fully benefit each individual learner. In addition, incorporating e-learning and neuroscience into educational and psychological studies has become a new paradigm. Determining how to integrate e-learning and neuroscience into ATI research to develop new theories and to understand the underlying brain functions during learning is worth trying. Such related findings will shed light on the development of ATI research.

Cross-References

- ▶ [Adaptation to Learning Styles](#)
- ▶ [Adaptive Blended Learning Environments](#)
- ▶ [Adaptive Learning Systems](#)
- ▶ [ARCS-Model of Motivation](#)
- ▶ [Attitudes and Learning Styles](#)
- ▶ [Critical Thinking and Learning](#)
- ▶ [E-learning](#)
- ▶ [Learning Style\(s\)](#)