Learning from Failure: The Benefits and Consequences of Making Mistakes within the Learning Theories of Behaviorism, Cognitivism and Constructivism

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Abstract

All humans are, by nature, fallible. It is impossible for a human being to go through life without making mistakes. Specifically in the area of education, this author believes that mistakes are an essential part of meaningful learning experiences. Mistakes often provide enriching moments outside the immediate scope of the intended learning objective that engage learners and provide opportunities to explore impactful ideas that can last a lifetime. Heuristic learning can take place within all the models of learning theory, but each theory handles the consequences and benefits of failure and “trial and error” learning differently. The author will compare the influence of failure between each of the models of Behaviorism, Cognitivism and Constructivism. There will also be an exploration into the methods Instructional Designers may use to create a culture that allows learners the freedom and confidence to fail, the guidance to process errors and the ability to apply new concepts to future opportunities.

*Keywords*: Failure, errors, mistakes, heuristic, Behaviorism, Cognitivism, Constructivism.

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*“To make no mistakes is not in the power of man;* *but from their errors and mistakes the wise and good learn wisdom for the future.”*

* Plutarch (*Greek Philosopher, 46-120 A.D.)*

 Failure is often defined as the opposite of success, but is it possible to learn from our mistakes? Gerber (1998) stated “People make mistakes in many facets of their lives as they engage in a learning process. People learn not from making mistakes, but from correcting them, remembering how the mistake was corrected and knowing when they encounter a similar situation not to make the same mistake again” (p. 173). John Dewey (American Philosopher 1859-1952) took responsibility for his political position in World War I and acknowledged that he was wrong. J. Isaac uses Dewey’s actions to illustrate that “true intellectuals are distinguished by how they deal with their errors” (Isaac, 2007, p. 17). It is impossible to ignore the significance of learning from failure. In the context of this paper, error is a subjective judgment made by a human being on the expected actions of a learner. It can be a case of misguidance, inaccuracy, impossibility, a failure to provide the expected response, omission of something expected, or just simply incorrect.

 In this paper the author will elucidate the benefits as well as the consequences of making mistakes as they relate to the learner’s experience within the context of Behaviorist, Cognitive and Constructivist learning methodologies, including forays into Cognitive Information Processing, Interactional Theories of Cognitive Development, Discovery Learning, Inquiry-Based Instruction and Problem-Based Learning. Case studies for “Productive Failure” (Kapur & Bielaczyc, 2012) referenced in this paper range from experiments with pigeons, physics instruction, architecture, e-learning, politics, justice, organizational behavior and even bowling.

 What is an error? Much research exists for the categorization and classification of errors. Robert Glaser divides errors into two categories: “(1) *False inductions*, where the rules are stated, examples given and an error has occurred in response; and (2) *Errorful Learning*, where learning comes from mistakes occurring as a result of exploring blind alleys and negative instances” (Glaser, 1966, pp. 5-9). Norman’s Taxonomy (Norman, 1988) also defines two types of errors: (1) *Slips*, associated with inattention and lack of monitoring; and (2) *Mistakes*, which are higher level cognitive failures associated with consciously selecting poor goals and plans (Priem, 2010, p. 382). J.T. Reason takes Norman’s “*mistakes*” and further categorizes them into (1) *knowledge-based* and (2) *rule-based mistakes* (Reason, 1990). Priem (2010) even goes so far as to propose a possible taxonomy of error itself (Priem, 2010, p. 385)*.* Priem’s taxonomy is specific to e-learning and should be of interest to contemporary instructional designers.

 There are many reasons why educators and instructional designers might want to minimize errors. When errors occur, they can be disruptive, distracting and may even become a negative influence on the learning process. Instructors may also fear the lack of control over instruction – arriving at the desired goal may not be reached along a straight path. In the course of exploration and experimentation, students and instructors may experience frustration and emotional effects (Glaser, 1966, p. 11). It requires a large investment by the instructor to provide attention, guidance and specific constructive feedback in order for “incidental learning” (Gerber, 1998, p. 170) to take place.

 Errors can be instructionally beneficial in that they can provide “intellectually satisfying discoveries” (Glaser, 1966, p. 9). Exploiting the human instinct for curiosity adds an important element to the learning process (Gerber, 1998, p. 175). Experiencing mistakes and dealing with their consequences allows the learner to own their experience and empowers them with the desire to continue. Equally as important, learning through mistakes ensures active engagement in the entire learning process.

**Behaviorism**

 Within the realm of Behaviorism, one could say that a failure can produce a weakening of undesirable (or inappropriate) operant behavior by presenting an aversive stimulus upon response (Driscoll, 2005, Figure 2.4, p. 45). The aversive stimulus is rather like a built-in error in this methodology. The operant still has a choice and is in control, but the mere fact that the response is aversive in nature seems to categorize it as an error. Unintended knowledge is possibly gained as well. Terrace (1963) wrote that during his discrimination experimentation with pigeons some “incidental learning” occurred (pp. 223,229).

 Because Behaviorism deals with manipulating stimuli in order to elicit a response, most research shows that the consequences of failure have been focused mainly on punishment, withholding reinforcement and corrective feedback (Glaser, 1966, p. 12). Other potential negative consequences of failure in the Behaviorist model include psychological harm, aversion, frustration, distress and even angry outbursts. The Behaviorist process of learning includes the concept of shaping. According to Driscoll (2005), shaping refers to the “reinforcement of successive approximations to a goal behavior (p. 46).” Progress continues as long as there is success in executing the desired behavior. Not attempting more difficult approximations (and failing along the way) will stunt the progress to the desired goal and shaping may have to start again at the point where the learner has repeatedly demonstrated success. By using Terrace’s (Terrace, 1963) discrimination learning experiments with pigeons as an example, Glaser (1966) confirms “only those birds that learned the discrimination with errors show (1) ‘emotional’ responses in the presence of S-, (2) occasional bursts of responses to the incorrect stimulus, and (3) less effective transfer to related discriminations (p. 10).” Driscoll (2005) uses the same pigeon experiment to illustrate that “almost errorless discrimination performance could be achieved with fading (p. 48).” Fields, Bruno and Keller (1976) also elaborate on the process of the fading (stages of acquisition) that occurred with Terrace’s experiment (p. 295).

**Cognitivism and Cognitive Information Processing**

 In Cognitivism, an “emphasis placed on the role of practice with corrective feedback” is used as an example of a factor that influences learning (Ertmer & Newby, 1993, p. 58). One assumes that a correction occurs because of an error. Feedback allows a learner to be guided toward a more “correct” outcome. This feedback is also a part of what is referred to as “scaffolding” (Driscoll, 2005, p. 257) and “Guided Learning” (Glaser, 1966, p. 11). Glaser goes on to say that “Richer learning, that is richer in associations, takes place when the associative history of the learner is employed to extend his learning; this is accomplished by mediators or thematic promptings which make positive use of existing knowledge and serve to guide learning.” To learn from their mistakes, Yerushalmi and Polingher (2006) guided students through a more active process of addressing their mistakes. They elaborate on methods for teachers to direct their practice to foster students’ learning in the context of their mathematics-based study.

 The negative side of failure in Cognitive models can be the realization of the limitations of a student’s working memory. Lannin, Barker and Townsend (2007) express the importance of examining the limitations of working memory during problem solving (p. 44). Cognitive Load (Driscoll, 2005, p. 136) is also a factor to consider. Sweller and Chandler’s (1994) Cognitive Load Theory (p. 185) states that the amount and frequency of information can interfere with the learning process and may be very difficult to assimilate. Time is also a factor that might deter the encouragement of exploration and experimentation. Instruction might tend to be less efficient because of circuitous routes toward the goal. Lastly, bad habits can result from improper or missing guidance. Another example of poor or missing guidance may even be a poor game of bowling (Hung, Chen, & Lim, 2009, p. 2)!

**Constructivism** (including Discovery Learning, Inquiry-Based and Problem-Based Learning)

 According to Jonassen and Rohrer-Murphy (1999), “All animals, including humans, interact with their environments and learn about their world through those interactions in order to fulfill some goal. Activity theory focuses on the purposeful actions that are realized through conscious intentions” (p. 65). The process of learning becomes the learning experience in itself. Kiss (2006) in her case study, showed that mathematicians can even discover hidden information in their arguments that were “so trivial that it seemed to be unnecessary to state them explicitly.” (p. 312). Sometimes referred to as heuristic, this type of learning refers to enabling a person to discover (or learn) something for him/herself. It is often considered a “hands-on” or interactive approach to learning. Examples of heuristic methods include trial and error, rule of thumb, intuitive judgments, common sense and guessing based on previous knowledge. These methods of learning inspire authentic ideas that allow for more personalized, deeper and meaningful experiences to be used in future experiences (Ertmer & Newby, 1993, p. 64). Mistakes can also extend the range of applicable reasoning (Lannin, Barker, & Townsend, 2007, pp. 46,57). In addition, the Constructivist model promotes collaboration, which enables the learner to receive constructive, specific feedback from peers as well as instructors, information that will have different (and perhaps even more) impact on the learner.

 In contrast, it is possible for the instructor and/or the learner to be overly selective about the information used to achieve the goal that might interfere with the entirety of the learning experience. Smith et al. (1993, p. 133) as cited in Priem (2010), acknowledges that teachers have a “practical interest in supporting some student understandings over others” (p. 390). Other negative effects of making errors in the Constructivist model are similar to that in the Cognitive model - less control over the material and a consideration for time efficacy. Lastly, it is possible that the conclusions drawn by the learner might be in conflict with the instructor’s ideas that might put into question the relevancy of the concepts (Ertmer & Newby, 1993, p. 66). The consequence of straying off topic may be the need to re-frame the structure of the lesson.

Table 1 *Comparison of benefits and consequences of errors made in each learning theory*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Sample Case** | **Desired Result** | **Error** | **Negative Consequence** | **Benefit** |
| **Behaviorism** | Press the green colored bar to deliver food | Pressing the green bar delivers food | Pressing the red bar delivers an electric shock | Pain and distress due to aversive electric shocks being delivered | Reinforces the desired behavior of pressing the green bar for food |
| **Cognitivism** | Finding your way to a restaurant using a map | Arriving at the desired restaurant | Coming across a one way (wrong way) street | Not getting to the desired restaurant in time, or missing it completely | Discovering a more interesting restaurant along the alternate route |
| **Constructivism** | Baking a lasagna based on previous knowledge of baking a cake | A delicious lasagna for dinner | Not having the oven at the correct temperature | Hungry guests that will not eat at the expected time | Discovering that all foods have specific cooking times. Another benefit: having more time to socialize with guests |

**Conclusion**

 In order to incorporate the opportunity for productive failure to occur into our instructional designs, the learner’s expectations need to be set. Jones (1977) states, “There is no doubt that a person’s perception of the likelihood of being successful influences the actual degree of success.” If the expectation is set to allow students to own their errors and wrestle with the concepts involved as they work their way to fuller understanding (Eggleton, 2001, p. 42), there will be less likelihood of frustration, stress, anxiety or cognitive overload. Educators and Instructional Designers need to “help students understand that the pursuit of excellence does not mean that anything short of perfection is failure (Keller, 1987, p. 5).”

 In addition to setting expectations, facilitators need to create an environment that is conducive to “inducing discoveries” (Glaser, 1966, p. 9). The learning space should provide a social culture that allows for and encourages positive and negative (constructive) feedback. Spychiger (2008) points out that feedback is not only an issue of social interaction, but also a “major topic of the pedagogical relationship (p.274).” The learning environment should also foster a genuine feeling of confidence and trust so learners may muster the courage to promote collaboration and risk failure in front of their peers in order to develop, grow and learn. If the learners are confident in their abilities, they will be motivated to delve deeper and try harder to find more creative problem-solving methods, even if it means making mistakes (Keller, 1987, p. 5).

 Placing opportunities that challenge a student in our designs can be problematic if placed at the beginning of the learning process. It is possible that the learners will not yet have acquired the necessary prior knowledge and also because they might be unable to see how everything fits together in the bigger picture (Kapur & Bielaczyc, 2012). To prevent obscurity and cognitive overload, Sweller and Chandler (1994) suggest procedures designed to reduce difficulty (p. 186). More systematically speaking, Kapur and Bielaczyc (2012) have come up with a three-part process that allows for productive failure design which includes *activities* engaged in by participants, *participation structures* used to engage with the problem, and *social surround* used to frame the problem-solving context (p. 49). They urge the designer to “create problem-solving contexts that involve working on complex problems that challenge but do not frustrate; provide opportunities for explanation and elaboration – participation structures used to engage with the problem; and provide opportunities to compare and contrast (p. 49).” It is important to include Gerber’s (1998) thought that as educators and designers of instruction, we need to offer opportunities for such activities to be “continuous, reflective, individualized and/or collective (p. 168).”

 As Diana Laufenberg says in her Ted Talk, our schools are embedded in the “culture of the one right answer.” (Ted Talks, 2010). This seems to be a very behaviorist view of learning. Educators want to reduce mistakes, not encourage them. If mistakes could be viewed more as a mismatch rather than a failure, it could help to prevent the student anxiety that often comes with more traditional, judgmental methods (Priem, 2010, p. 390). Tests are not only a way generate empirical data and assess knowledge. Tests can also be events that lead to opportunities to learn (Kapur & Bielaczyc, 2012).

 In conclusion, learners *need* to make mistakes. They need to process and learn from errors in order to experience a rich and meaningful learning experience that will deepen their understanding. Some may say that creating a “Fehlerkulture (a culture of mistakes)”, as Spychiger (2008) imagines, not only involves educators being creative, flexible, adaptive, patient, nonjudgmental and less critical, but could be a foundational pedagogy in itself (Priem, 2010, p. 391).

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