Importance of Psychomotor Development for Innovation and Creativity

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Abstract

Innovation and creativity have been on the top of desired learning outcomes for over a century. Many research efforts have been dedicated to creativity and creative behavior in education. Most of these research efforts have demonstrated and emphasized the importance of the development of the cognitive and affective domains in fostering creativity in educational settings. Minimum effort, however, has been directed toward the role that psychomotor domain skills play in the development of creativity. This paper discusses the importance of the development of the psychomotor domain in fostering creativity. To demonstrate this, the creative realization process is studied. The creative realization domains are redefined to identify the virtual and perceptual realities, in addition to physical reality, as valid domains of the realization process. Bloom's learning domains and educational objectives are also discussed and aligned with the objectives of the realization process. When we consider the different reality domains, the importance of the psychomotor domain becomes clear for educational disciplines that are not limited to perceptual domain realization. To illustrate the concepts presented in the paper, several examples are included.

Introduction

Innovation is the action of creating new ideas, products, or processes. Creativity is the ability to produce and perform such innovative actions. Therefore, innovation as an action results from creativity as a human attribute. Due to its importance as a human ability, creativity has been studied extensively for many years. Several educational movements directed the move toward incorporating the development of creativity in teaching and learning (Treffinger, Isaksen & Firestien, 1983), including learner-centered education (Rugg & Shumaker, 1928), humanistic and affective education (Combs, 1962), and process education (Cole, 1972).

Early studies of creativity viewed creativity as a rational cognitive domain process. These studies focused on cognitive abilities, creative thinking, and creative problem solving (Wertheimer, 1945; Torrance, 1974). Another group of studies addressed the affective aspect of creativity by focusing on the attributes of creative individuals (Patrick, 1935; Skinner, 1968). A third group of creativity studies shared the process thinking with the cognitive group and the affirmative conception of creativity with the affective group by emphasizing the human desire for fulfillment and self-actualization (Maslow, 1959). Aspects of creativity having to do with the psychomotor domain, however, have not been addressed in any of these studies. This paper discusses the effect of the development of the psychomotor domain on creativity, in some fields of education.

Realization and Reality Domains

Two realities have emerged since the beginning of human life on earth, physical reality and the human perception of it. Since every individual perceives physical reality in his or her own way, the need to share perceptions caused the natural introduction of the third domain of shared realities known as the virtual domain. Therefore, by expanding the definition of reality to go beyond what is physical and include the other two domains, the following three domains of reality can be identified (El-Sayed, 2011):

1. **Physical reality**: represented by the physical universe that can be recognized with the senses such as seeing, hearing, touching, smelling, and tasting.
2. **Perceptual reality**: represented by individual perceptions or paradigms of other realities.
3. **Virtual reality**: represented by shared perceptions of other realities.

By examining all three realities, it can be stated that:

- The **perceptual domain** is where individual realization is being formulated (developed and validated). While perceptual reality is unique and may be subjective, for each individual, their perception *is* reality.
- The **virtual domain** is where collective and shared perceptions are being formulated (developed and validated).
- The **physical domain** is where physical reality is being actualized (developed and validated).

Considering that there are three realities, the concept of realization can be expanded to include all three domains of reality. Within each domain there are interacting elements or objects specified by:

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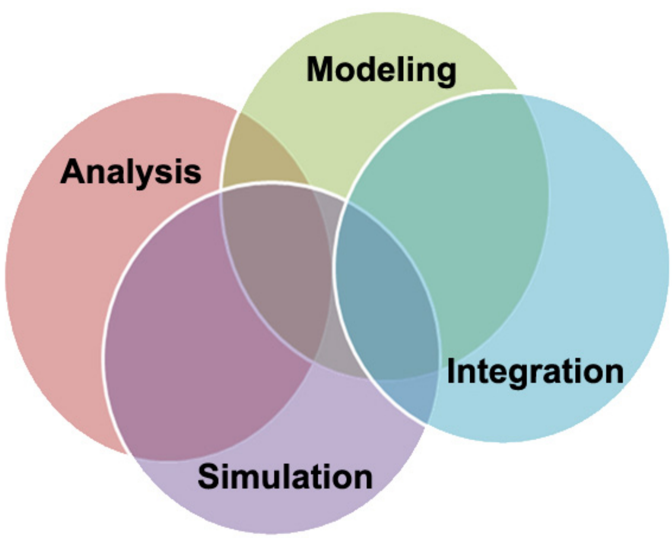
- **Forms** (shapes and substances)
- **Functions** (purpose and performance)
- **Interactions** (actions and reactions) with other objects through fields of activities (interaction fields).

The transfer between the three reality domains is made more explicit through mapping. The two main elements for mapping are modeling and simulation. The process of mapping objects and their environment between different realities through the use of modeling and simulation requires deconstructing and reconstructing using:

- **Analysis** (for deconstruction)
- **Integration** (for reconstruction)

Both analysis and integration use modeling and simulation to different degrees. As shown in Fig. 1, analysis is performed mostly through simulation somewhat through modeling, while integration is performed mostly by modeling and less often by simulation. It is also obvious that both analysis and simulation are logical and analytical in nature while modeling and integration are more holistic and creative in nature.

Figure 1 Different realization processes



Realization Activities

There are three main objectives when interacting with any reality:

1. **To understand it** (know it)
2. **To utilize it** (use it)
3. **To improve it** (alter it)

These three objectives are interconnected and overlapping because, in order to utilize or alter a reality, one must understand it. Similarly, utilizing or altering reality brings about a better understanding of it. In addition, these three objectives create the following distinct activities that humans participate in when interacting with reality:

1. **Research**: aiming at understanding reality
2. **Problem solving**: aiming at utilizing reality
3. **Design**: mainly aiming at improving or altering reality

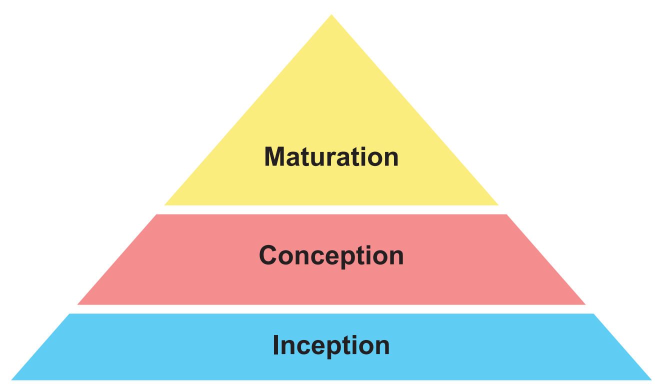
These activities can be performed in any reality or across all three realities.

Creative Realization Process

Understanding the reality domains and realization process is vital for studying the processes of innovation and creativity. Creativity is an innovative form of realization aiming at altering reality. The following three phases, as shown in Fig. 2, are the main phases of a creative realization process:

- **Inception**: idea genesis, development, and validation
- **Conception**: concept specification, development, and validation
- **Maturation**: creation specification, development, and validation

Figure 2 Creative realization processes



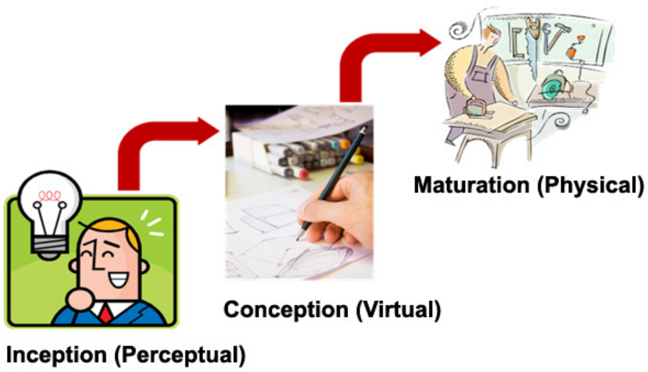
Depending on the creative outcome, these three phases cross different reality domains. Such an interaction is demonstrated by the following example of a product development process.

Example 1

Creative product development process

From Fig. 3, it is clear that the perceptual domain is the source of all creative ideas and inceptions. The perceptual domain is also the leading domain at work during conception and maturation phases. Depending on the final outcome of the creative activity the virtual and physical domain may also be engaged in the process.

Figure 3 Creative product development



Based on the understanding of the realization concepts discussed, it can be stated that a creative realization process could cover all three reality domains. A creative realization process begins with an idea initiated using skills within the perceptual domain to conceptualization and development taking place using skills from the virtual or physical domains. Therefore, knowledge and skills are needed when dealing with any of the three domains. Depending on the field, the lack of knowledge and skills in any of these domains could slow down or stop the creative process unless there is external compensation. The following example of an engineering design process demonstrates such a consequence.

Example 2

The need for manufacturing knowledge and skills in engineering design

Engineering design, requires a mapping process in the perceptual domain during inception, further processing in the virtual domain during conception, and finally, work in the physical domain as product production requires manufacturing knowledge and skills. Unless the inventor has all of the needed manufacturing knowledge and skills, the full creative realization process will not be completed. It is, however, possible to complete the creative process without these skills, if the inventor is part of a team and the needed manufacturing knowledge and skill can be provided by another team member.

Bloom's Educational Objectives

Bloom classified educational objectives into the following three domains with different levels of objectives in each (Anderson & Krathwohl, 2001):

- **Cognitive** (thinking skills)
- **Affective** (values and emotions)
- **Psychomotor** (movement skills)

Bloom classified the following skills or objectives under the cognitive domain:

Cognitive (thinking skills)

1. **Knowledge** – information gathering without necessarily understanding, using, or altering it
2. **Comprehension** – understanding the gathered information without necessarily relating it to anything else
3. **Application** – using the general concept gained through comprehension to solve a problem
4. **Analysis** – disassembling something down into its fundamental elements
5. **Synthesis** – creating something new by integrating different elements
6. **Evaluation** – differentiating the subtle differences in objects or methods

Bloom classified the following skills or objectives under the affective domain:

Affective (values and emotions)

1. **Receiving** – Awareness and willingness to receive
2. **Responding** – Willingness to actively participate in responding (motivation)
3. **Valuing** – Attaching different worth or value to a particular object or action
4. **Organizing** – Setting priorities, comparing, relating, and synthesizing different values
5. **Internalizing** – Behaving based on internalized value system

Bloom classified the following skills or objectives under the psychomotor domain:

Psychomotor (movement skills)

1. **Perception** – Guiding motor activity using sensory cues
2. **Set** – Getting ready to act mentally, physically, and emotionally
3. **Guided Response** – Starting to learn complex skills through imitation and trial and error
4. **Mechanism** – Gaining confidence and proficiency in learning complex skills
5. **Complex Overt Response** – Performing complex movement skillfully

6. **Adaptation** – Modifying movement patterns to fit specific requirements
7. **Origination** – Creating new movement patterns

Realizational and Educational Objectives

Both teaching and learning are perceptual domain exchanges between teachers and learners. These exchanges are usually shaped by the educational objectives. Mapping Bloom's cognitive domain of educational objectives with the three main realization objectives discussed previously it is clear that:

1. **Knowledge** and **comprehension** can be aligned with **understanding realty**
2. **Application** and **analysis** can be aligned with **utilizing realty**
3. **Synthesis** and **evaluation** can be aligned with **altering realty**

Clearly, Bloom's cognitive domain of educational objectives is aimed at developing the knowledge and skills required to deal with the reality of any field of study. These objectives are also well aligned with the natural progression to a higher or enhanced level of realization, as shown in Fig. 4, beginning with understanding and ending with the altering of reality. Bloom's highest objective of evaluation can only be reached with refined realization within the perceptual domain. Similarly, when dealing with a reality, each of the objectives in the affective and psychomotor domains can be mapped into three ascending levels as shown in Fig. 5, and Fig. 6 respectively.

Figure 4 Progression of cognitive domain educational objectives

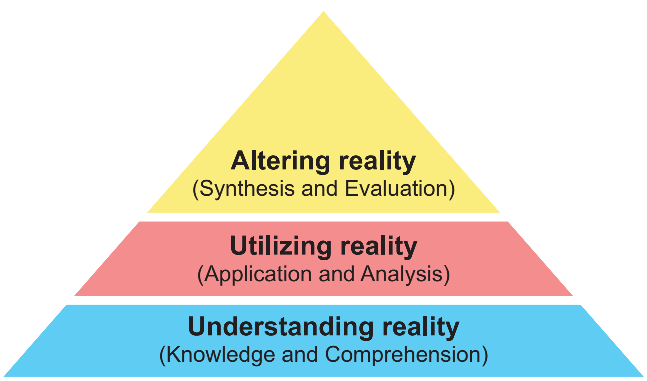
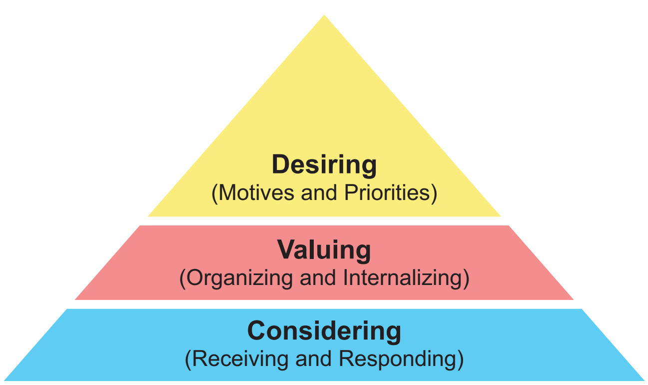


Figure 5 Progression of affective domain educational objectives



Educational Objectives and Creativity

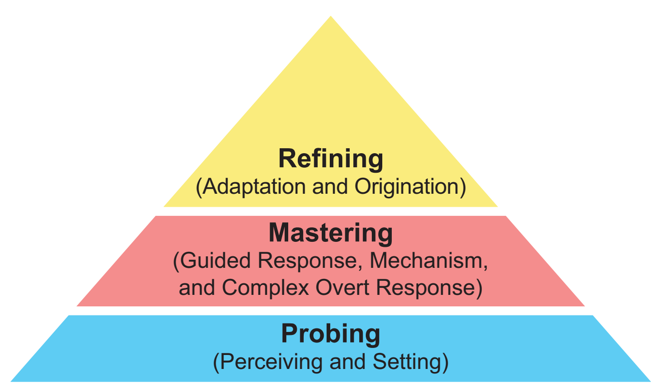
To reach a level of creativity in problem solving or utilizing reality, a learner should at least reach the upper half of the development of the cognitive domain as shown in Fig. 4. To value pursuing a creative solution, the learner should reach the upper half of the affective domain as shown in Fig. 5. Similarly, in some disciplines, such as engineering, surgery, arts, cooking, etc., in preparing to reach the skill level needed to initiate and develop a creative solution, the learner should reach at least the upper half of the pyramid of psychomotor domain development as shown in Fig. 6. Therefore, in view of the educational objective discussed, in order to foster the development of creativity, some educational programs need to include development in the psychomotor domain as well as in the cognitive and affective domains.

For disciplines that deal with the physical or virtual realities as fields of practice, the educational program should not focus exclusively on development of cognitive domain skills. Unless the field of practice is completely cognitive, development of cognitive domain skills alone in the classroom may not be sufficient to foster creativity. The following engineering case study supports this result.

Case study

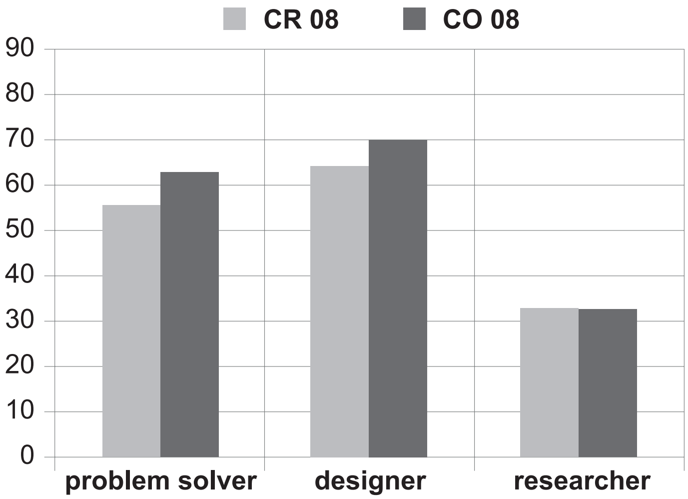
This survey of engineering alumni is used to assess the roles of classroom and cooperative education learning experiences (El-Sayed, El-Sayed, & Beyerlein, 2010). This survey focused on the large increase in ability as problem solvers, designers, and researchers for each experience.

Figure 6 Progression of psychomotor educational objectives



The results are shown in Fig. 7.

Figure 7 Setting accounted for a large increase in ability



Due to increased motivation and synergistic psychomotor skills with other workers, both problem solving and design are reported higher in the real-life learning environments than the classroom, as shown from Fig. 7.

Conclusion

Because of the focus on cognitive domain development, educational processes usually provide knowledge in a segmented logical sequence and analytical style. Consequently, most educational programs accentuate analysis and simulation over the creative practices of modeling and integration. For this reason, in addition to the relative ease of developing and assessing analytical skills, most educational programs rarely include creativity as a learning objective or outcome.

To foster creativity and innovation in education, it is imperative to include creativity as an educational objective. To achieve the required creativity outcomes, however, it is essential to understand the domains of reality in the particular field of practice concerned, and the knowledge, skills, and attitudes needed to attain creative realizations. Since classroom teaching and learning are mostly perceptual domain exchanges, shaped mainly by the teacher's perceptual reality and the learner's style of learning, it is necessary for the teacher to know what is required of a person in order to be creative in the field of practice concerned, and to know how to deliver instruction in a manner that is synchronous with the learner's learning style. It is also necessary to assess the learner's performance in each reality domain, in addition to the development of the cognitive, affective, and psychomotor domains needed for creative realization in the field of practice.

For some educational fields, the development of the learner's psychomotor domain is necessary for fostering creativity, specifically fields with practices in other realities in addition to the perceptual. In other words, unless the field of practice involves use of the cognitive domain skills exclusively, the educational program will not fully achieve the creativity objectives by focusing only on cognitive development. Psychomotor abilities not only facilitate the learner's practices but also motivate the learner to try different alternatives. A median level of mastery in the psychomotor domain skills can lead to a lower level of frustration, a higher level of motivation, and ultimately a higher desire and ability to innovate and create.

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