Hansun Brief

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The AlphaGo Shock and South Korea's Education Reform: Implementing Deep Learning[1]

〈Contents〉

Tae-wan Kim
President, Korean Institute for Future Education
Lydia Kim (Translation, Hansun Foundation Intern Fellow)

This issue's Hansun Brief contains core information from Hansun Foundation's recently published policy paper, "Strategies for the Future of South Korea's Education". Tae-wan Kim, president of the Korean Institute for Future Education and a co-writer for the policy paper, emphasizes the importance of deep learning. For more information about the strategies for South Korea's future education, consult Hansun's policy paper.

1) This work is a translation of the original document "알파고 쇼크와 대한민국 교육개혁: 심층학습의 실현" published March 30, 2016.

The presence of AlphaGo has shaken up our society. There has been an increased interest in artificial intelligence (AI), only a vaguely familiar concept that seemed to have little practical application to everyday life. The replacement of human-held occupations by AI has been a frightening prospect. As a response to the lack of a control tower, the government has established a strategic council on science and technology to oversee national efforts to overhaul the research and development (R&D) sector. This council supposedly plays the control tower role, but coordination among the government's departments has been difficult, and many of the issues require consultation with the president, which has lead to the criticism that the council has not been effectively fulfilling its role.

South Korea's strategic council, made in response to the AlphaGo Shock, reminds us of the American response to the Sputnik Shock in which the Soviet Union successfully launched the world's first satellite. The US declared that it would land its first astronaut within the next ten years and strengthened its elementary and middle school mathematics and science curricula ever since. Looking at the development of the American space industry now, this education reform had been a response to the governmental crisis 60 years ago. It is important to recognize the achievements brought by setting a specific goal, erecting an institution like NASA, and implementing education reforms.

The South Korean government has been neglectful or lax about new shocks, but overlooking the AlphaGo Shock in terms of education by regarding it as an exclusively scientific issue is wrong. The public has agreed on the need for education reform, but opinions have been divided on how to change what. AlphaGo is an exemplary incident that informs us on how to execute this change. It is a time to reevaluate the nation's education system and procedures for reformation.

1. The Need for Deep Learning

Today's society places an emphasis on advancing technology's mechanical and automatic functions. Certain students have no problem adapting to these changes, but those who cannot keep up will face employment challenges. Employment is increasingly selective with technological advancements taking up mechanical and automatic functions, and what were left of labor jobs have been taken up by foreign workers. An improvement in the quality of products and services has added to employment challenges. According to the National Statistics Office (KOSTAT), as of March 2016, 12% of those of the age 15 to 29 are unemployed.

The 6Cs required for the 21st century are communication, collaboration, critical thinking, creativity, character, and citizenship (Fullan and Langworthy, 2014). South Korea's teacher-oriented classrooms do not encourage these skills. Lectures are often simply "info dumps" that emphasize rote memorization for the sake of passing assessments. It is questionable how effective this teaching method is in encouraging critical thinking or the application of learned material.

Educating 21st century leaders requires a pedagogic reform. The new education model should build on surface learning, which emphasizes knowledge acquisition, to allow for deep learning, which emphasizes problem-solving skills (Fullan and Langworthy, 2014). In other words, the most important task for South Korea's education reform is transforming surface learning to allow for deep learning.

2. The Significance of Deep Learning According to the Taxonomy of Education Objectives

Learning is typically divided into three domains: the cognitive or thinking domain, the affective or feeling domain, and the psychomotor or kinesthetic domain. The cognitive domain covers intellectual and academic objectives. The affective domain consists of objectives that describe emotions, attitudes, values, and beliefs. The psychomotor domain deals with physical and motor skills, which are developed in the arts and sports.

Benjamin Bloom first introduced this taxonomy of classification in 1956, and it has been countlessly revised, improved, and employed by many scholars since. This taxonomy complements the western and eastern traditions' divisions of intellectuality, morality, and physicality. In western cultures, the concept of education is typically referred to as education and training, as training is considered to occur naturally and simultaneously with education. In eastern cultures, *hakseup* (學習) means learning and familiarizing. However, South Korea's current assessment-driven education not only disregards experimentation and practice, but also neglects empathy and social skills.

Simple knowledge acquisition is no longer enough; the skillset needed for the 21st century is critical thinking and applying knowledge to practice. Attaining these skills requires deep learning through cognitive, affective, and psychomotor domains. In other words, education of the 21st century should emphasize the previously neglected high-level critical thinking problem-solving skills of the cognitive, affective and psychomotor domains.

2-1. Cognitive Domain: Complex Problem Solving, Critical Thinking Skills

In the cognitive domain, deep learning signifies complex problem solving, critical thinking skills. Problem solving skills evolve from remembering, understanding, applying, analyzing, and evaluating to creating. Unfortunately, it is possible to succeed today's lecture-oriented classrooms without going beyond remembering and understanding information. It goes without saying that there is very little possibility of producing creative individuals in these environments. It is only natural that creative students must be able to also apply, analyze, evaluate, and create from what they have learned.

Table 1 shows the intersection between the dimensions of knowledge (factual, conceptual, procedural, and meta-cognitive) and the dimensions of the cognitive process (remembering, understanding, applying, analyzing, evaluating, and creating). Lecture-style classrooms only allow for remembering and understanding surface-level factual and conceptual knowledge. It is important that students develop more complex problem solving, critical thinking skills through deep learning.

Table 1. Taxonomy of the Cognitive Domain

The Knowledge Dimension	The Cognitive Process					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge List	List	Summarize	Classify	Order	Rank	Combine
Conceptual Knowledge	Describe	Interpret	Experiment	Explain	Assess	Plan
Procedural Knowledge	Tabulate	Predict	Calculate	Differentiate	Conclude	Compose
Meta -Cognitive Knowledge	Appropriate use	Execute	Construct	Achieve	Action	Actualize

Source: Forehand, M.(2012), Bloom's Taxonomy: From Emerging Perspectives on Learning, Teaching, and Technology. The University of Georgia.

For example, the French university entrance

exam baccalauréat asks: Am I what the past has made of me? Does what we say only consist of what we consciously think? Do we only accept scientifically proven facts as truths? Is calculation a product of reason? Is defending rights the same as defending interests? What in me drives my actions? Responding to these prompts requires higher-order critical thinking that involves both subjective and objective approaches.

2–2. Affective Domain: Building Social Skills

In the affective domain, achieving deep learning is building social skills. Students should learn to understand their own values and to identify and cooperate with others. Individual emotions should develop into values and belief systems. The affective domain ultimately covers the objective that people cooperate harmoniously by understanding and synthesizing individual belief systems.

Through deep learning, simple emotions and reactions should develop into personal values and belief systems. Therefore, the affective domain should aim to develop complex social skills that not only involve emotions but also the communication, comparison, and harmonization of values and beliefs with others.

Table 2 explains the affective domain's objective of as receiving, responding, valuing, organizing, and internalizing values. In other words, the most complex step, which requires internalizing values, is developing personality and character. Deep learning refers to type of education that can develop these skills. Such social and ethical capabilities will develop global citizens.

Table 2. Taxonomy of the Affective Domain

Process	Skill Objective
Receiving	Awareness, willingness to hear, selected attention
Responding	Active participation on part of the learners Attends and reacts to particular phenomenon
Valuing	Evaluating value of a particular object, phenomenon, or behavior
Organization	Prioritizing values by contrasting different values, resolving conflicts between them and creating a unique value system
Internalizing Values	Value system that controls their behavior

Source: Atkinson, S. P. (2012), Enabling Learning: Educational Technologies and Social Change, Updated: Taxonomy Circles–Visualizations of Educational Domains

2–3. Psychomotor Domain: Improving Motor Skills

In the psychomotor domain, deep learning is achieving improved motor skills through repetitive training. Skills include physical and coordination abilities that require neuromuscular training. The taxonomy of the psychomotor domain is still debated, but Harrow's classification, proposed in 1972, is the most widely used today. It ranges from the simplest to the most complex movements. Table 3 shows this range of reflex, fundamental, perceptual, psychical, skilled and non-discursive communication abilities. Each ability is illustrated with an example in Table 3.

Table 3. Taxonomy of the Psychomotor Domain

Process	Skill Objective Examples
Reflex movements	Actions elicited without learning in response to some stimuli
Fundamental movements	Walking, running, jumping, pushing, pulling
Perceptual abilities	Responding to visual, auditory, kinesthetic, or tactile stimuli
Physical ability	Flexibility, muscular exercise
Skilled movements	Movements and techniques acquires by sports or dance
Non–discursive communication	High–skill aim, ballet

Source: Harrow, A. (1972). A Taxonomy of Psychomotor Domain: A Guide for Developing Behavioral Objectives. New York: David McKay.

In this domain, repetitive training leads to psychomotor achievement. Education should be in

the form of professional training and engagement with the arts and sports.

3. Pedagogic Models that Encourage Deep Learning and the Implementation of Subjective Evaluation Methods

Most Korean classrooms follow a lecture style that is not so conducive to developing critical thinking problem-solving skills, social skills, or complex physical movements. To achieve deep learning, John Dewey proposes learning by doing, and Kilpatrick proposes project-based learning.

Scholars have defined project-based learning in various ways, but there are three common qualities: 1) a student-oriented education in which students 2) collaborate 3) to solve real-life issues and tasks.

As opposed to the traditional teacher-oriented "chalk and talk" classroom that favors memorization, project-based learning helps students acquire skills and techniques. Therefore, project-based learning encourages deeper understanding, social and communication skills, creativity, effective use of technology, refined writing skills, and clear expression and delivery of values and evaluations. Project-based learning inherently requires subjective evaluations, which would gradually bring about change in evaluation methods.

Project-based learning aside, there have been other methods to implement deep learning. While schools are making the effort to experiment with learning communities, flipped classrooms, and Havruta education, the government has been pushing forward with STEAM and SMART education. STEAM and SMART education programs are mostly present in the US and Canada, and learning community programs are found in Japan, South Korea, Vietnam, and other Asian countries. Havruta is an education model specific to Israel, in which class time emphasizes discussions and debates. South Korea's education reform should strive to implement the principles of these programs.

4. Strengthening Coding Education

AlphaGo is an AI developed by Google in London to play the board game Go. Recognizing the importance of coding early on, England in 2014 and the US in 2015, have implemented coding courses as required elementary, middle, and high school education. South Korea has announced that coding will become mandatory at elementary and middle schools starting 2018. Because South Korea is later in the game to implement coding education, it is important to push forward with a more active and strengthened program.

The key to coding education is teaching algorithm-building, thus thinking capabilities. Making machines capable of deep learning requires humans to be capable of even more advanced deep learning. The point of deep learning is for students to build the capacity to think critically and collaborate with others to solve problems. Applying deep learning into practice requires a reform in teaching and evaluation methods that encourage deep learning.