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Development of Subject-Convergent Teaching-Learning Materials for Core Principles of Support Vector Machines

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Abstract

To cultivate talented people with creative and convergent thinking skills to live in the era of the 4th industrial revolution, the national curriculum of Korea is gradually emphasizing convergence education and software education. To meet the demands of the times, this paper suggests subject-convergent teaching-learning materials for educating core principles of Support Vector Machines, especially targeting elementary learners. Based on analysis of the national curriculum, achievement standards of three subjects are integrated. After printable worksheets for traditional face-to-face classes had developed, they were transformed to online interactive worksheets for non-face-to-face classes. The teaching-learning materials are expected to promote the growth of the learners' academic motivation and knowledge.

Keywords: Artificial Intelligence Education, Convergence Education, Elementary Education, Support Vector Machines

1. INTRODUCTION

The Software education is becoming more important competency for students in line with the recent social changes called the 4th Industrial Revolution [1]. Artificial Intelligence education, beyond software educations, is expanding its subject areas not only to problem-solving abilities but also to development of learners' various competencies [2]. In 2015, the Ministry of Education in Korea announced the 2015 Revised National Curriculum with an aim to nurture a creative and integrative learner. However, current national lever elementary curriculum only guarantees 17 lesson hours of software education for 6th graders [3]. Besides, elementary learners need supplementary materials and intriguing examples to understand abstract principles. The purpose of this paper is to develop subject-convergent teaching-learning materials that elementary school learners can easily and interestingly explore the core principles of artificial intelligence, especially Support Vector Machines(SVM).

2. MATERIALS AND METHODS

2.1 Analysis on the Curriculum

According to 'The National Strategy for Artificial Intelligence (2019)', the Korea government emphasize the importance AI education for primary school students [4]. 2015 Revised National Curriculum presents achievement standards for each subject. Achievement standards are core and ultimate objective of the subjects, which decide contents and assessments of individual classes. Among them, three achievement standards for elementary learners are chosen for teaching core principles of Support Vector Machines.

Table 1. Selected achievement standards for subject-convergent education

| Subject	Part	Achievement Standards	Association
Practical Studies	Technology Application	Find examples of software applications and understand their impact on our lives.	AI education, software education
Mathematics	Figure	Understand the vertical and parallel relationships of straight lines through activities to find right angles or straight lines that do not meet each other around the classroom and life	decision boundary and margin of SVM
Social Studies	Natural Environment and Human Life	Investigate the geographical characteristics of our town and explore its impact on the lifestyle of the people in the town.	localization, overall theme

2.2 Development of Worksheets for Face-to-face Class
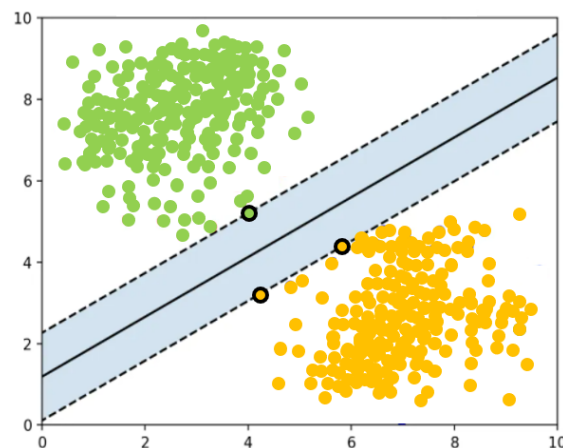
Figure 1. Basic concept of Support Vector Machines using Decision Boundary

Support Vector Machines are machine learning algorithms of artificial intelligence that are mainly used to classify data. There may be two or more types of data, but to make the classification by a line rather than a face, it is assumed that there are only two types of data. In other words, the decision boundary, not the hyperplane, was chosen as the main element of the teaching-learning materials.

Artificial intelligence needs at least three support vectors to find out decision boundary. Learners can experience this process by applying concept of parallel lines and vertical lines from mathematics. On the other hand, social studies emphasize knowledge and interest about local elements. Oreum was the local element of the Jeju region, where the morphological similarity with the support vector machine could be clearly found. To induce learners to actively participate in learning, it is necessary to provide visual connections [5].
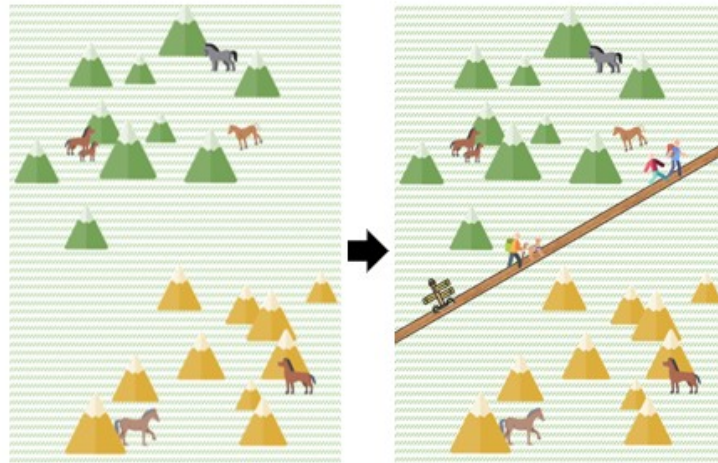
Figure 2. Jeju Oreum trail representing decision boundary of Support Vector Machines

### 2.3   Development of Worksheets for Non-face-to-face Class

Demand of non-face-to-face online teaching-learning methods and materials is rapidly increasing due to recent pandemic. Even if the situation of COVID-19 stabilizes, distance classes are likely to persist and research on non-face-to-face teaching-learning materials is needed to achieve the purpose of education and improve the learning achievement [6].

Utilized development tool, LIVEWORKSHEETS (www.liveworksheets.com), is an online platform for transforming images of printable worksheets to interactive online worksheets. By sharing URL, students can do the worksheets themselves and send their answers to the teachers or correct the answers.

3. RESULTS

3.1   Developed Teaching-Learning Materials

Three subjects are mainly integrated for teaching Support Vector Machines. First, Support Vector Machines are related to an achievement standard of practical studies in that it is a principle of artificial intelligence. According to Support Vector Machines, it is important to establish a decision boundary with support vectors, which classifies new input data into the correct category. This process is invisible and abstract for elementary learners.
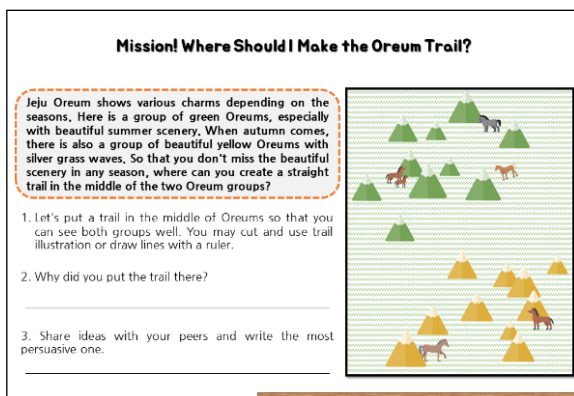
Figure 3. Printable worksheet for face-to-face class

For suggesting comparable situation and linking with social studies, learners are demanded to search for exact location of a trail between two groups of Oreum. Oreum is a proper name of relatively low mountains created by volcanic activities in Jeju island. In this case, Oreums are data points and the trail separating them represents decision boundary in Support Vector Machines. First, learners find at least three support vector Oreums. Then they need to apply mathematical principles of vertical and parallel to find out the trail decision boundary, using two triangle-shaped rulers. They also learned how to measure the length between parallel lines, and the length means margin in Support Vector Machines.

Figure 4. Online worksheet for face-to-face class

The only difference between printable and online worksheets is the way of drawing decision boundary. The former provides opportunity to put the trail at any angle, but the latter offers certain dots on each side and learners link two of them. Learners can type their answers in the blanks and send them to teachers, pressing 'Finish!' button.
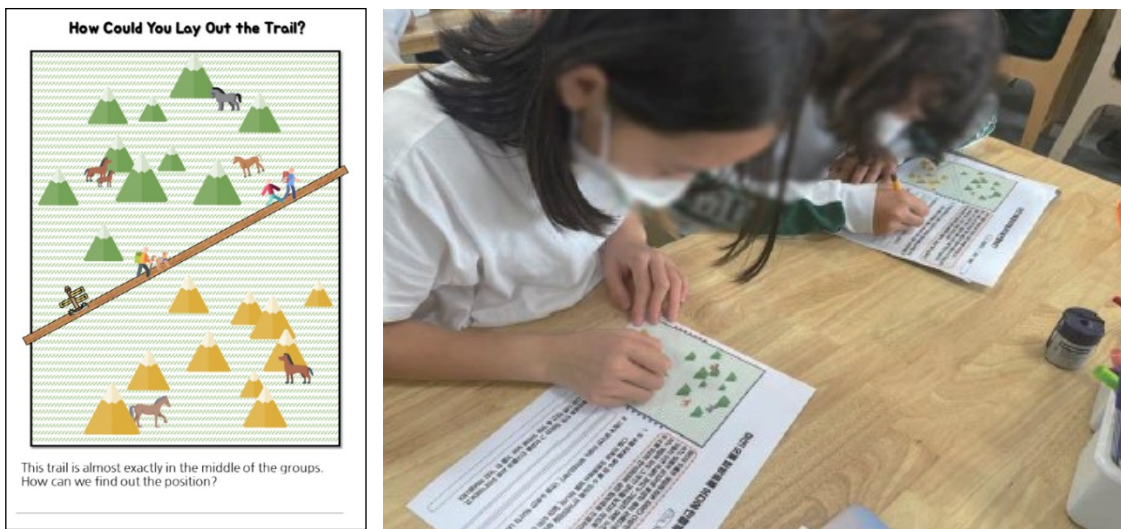

Figure 5. Intended location of the decision boundary

After the individual and group works, learners examine a trail suggested in a follow-up worksheet and teachers explain related notions and core principles of Support Vector Machines. If the learners struggle to comprehend the principles, additional physical or artistic activities can be introduced to enhance the learners' understanding. This implies possibility of extended subject-convergence.

4. CONCLUSION

Software education helps improve computing thinking ability, which is a core competency required in the future society [7]. The importance and weight of artificial intelligence education and convergence education in the national level curriculum are consistently increasing. However, in the actual educational field, subject segmental classes are often conducted and software classes are vastly insufficient, due to several constraints such as lack of lesson hour. Continual efforts and studies are necessary for education authorities and teachers to cultivate creative and integrated thinking ability of elementary learners.

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