（課程博士・様式７）（Doctoral degree with coursework, Form 7）

学 位 論 文 要 旨

Summary of Doctoral Thesis

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Course：Join subject development major　　　　　　Name：MAM CHANSEAN

論文題目：カンボジアの生物教育における物理的アプローチによる教材開発

Title of dissertation：Development of Teaching Materials through Integration of Physical Approach for Biology Education in Cambodia

論文要旨：

Summary :

This doctoral dissertation aims (1) to produce biological experimental apparatus with the integration of physical approaches and other teaching materials related to biological contents, and (2) to use experiments as a method to teach biology in high school level.

This dissertation consisted of 9 chapters which Chapter 1 described the situation of biological education in Cambodia, the research purposes, the research methodology, and so on. Chapter 2 described the school quality assurance framework and the main problem of science education in Cambodia; and the following chapters address the problem described in chapter 1 and chapter 2.

Chapter 3 described the methods to select plant seeds for biological experiments. The seeds of 25 lettuce cultivars, 18 carrot cultivars, 5 radish cultivars, and 11 other vegetative cultivars were searched for their germination phenomenon in the dark and far-red wavelength irradiation. Carrot and lettuce cultivars were selected for the experiments, and especially “Furiru lettuce” is only photoblastic seed germination cultivar.

Chapter 4 titled “Methods for teaching light wavelength dependencies on seed germination and seedling elongation applicable for high school experimental class in developing countries” aims to introduce the methods to produce light emitting diode (LED) attached-experimental apparatus, and the experimental methods using this apparatus. An experimental box (190mm(W) x 260mm(L) x 115mm(H)) attached with 11 LED bulbs of the same wavelength was introduced. Each box was attached with white LED (major peak: 485nm), blue LED (477nm), green LED (527nm), orange LED (607nm), red LED (618nm), and far-red LED (690nm). Carrot and lettuce seeds of 10 cultivars each were used as plant materials. The result showed that the seeds of all carrot and lettuce cultivars germinated in dark conditions, except “Furiru lettuce”. Continuously irradiation of far-red wavelength suppressed lettuce seed germination, but it did not suppress seed germination of all carrot cultivars. Seedlings of both carrot and lettuce cultivars elongated the longest in dark condition, but the seedling elongations were inhibited the most by blue light irradiation.

Chapter 5 titled "Development of an LED-attached box for phytochrome response experiments on lettuce seed germination in senior high school biology" aimed to introduce the methods to develop an apparatus specified for phytochrome response experiments and the experiments using this experimental apparatus. A smaller LED-attached box with the combination of red (624nm) and far-red (690nm) was developed, and Furiru lettuce seeds were used. The result showed that Furiru lettuce seeds did not germinate in dark conditions or the last irradiation of far-red light, and the high germination rates were observed in the last irradiation of red light. Gibberellic acid (GA) and Abscisic acid (ABA) solutions were treated on lettuce seed to explain to students about seed germination phenomena.

Chapter 6 titled "The use of dwarf tomato cultivar for genetic and physiology study applicable for school education" aimed to introduce the methods to conduct biological experiments in high school. GA does not affect only seed germination but also on plant physical growth. GA_3 of 1mg/L, 10mg/L and 100mg/L were applied exogenously to dwarf and normal stem tomatoes. Moreover, the dwarf type tomato was crossed with the normal type tomato. The results of the experiments showed that 100mg/L GA_3 enhanced stem elongation of both dwarf and normal type tomatoes. The result of the cross followed Mendel's 1^{st} and 2^{nd} laws of inheritance. Normal stem was the dominant trait.

Chapter 7 titled "Genetics materials for experimental class of Mendel's 3^{rd} law using dihybrid crosses of lettuce cultivars in high school" aimed to introduce experimental methods and teaching materials for Mendel's Law of Independent Assortment. In chapter 6, while dwarf tomato was used for the educational materials of Mendel's 1^{st} and 2^{nd} laws, but using tomatoes to conduct experiments to study Mendel's 3^{rd} law was difficult because a big space is needed to keep approximately 100 tomato plants. Lettuce can be cultivated in small spaces. Reciprocal crosses between Furiru lettuce and Red sunstar, Sunny or Vitamin with red lobed leaf were performed. The segregation of F_2 populations was the same as the results of Mendel's dihybrid crosses with the ratio: 9: 3: 3: 1.

Chapter 8 titled "Genetics of photoblastic seed germination and seed color using lettuce cultivars for biological experiments in high school" aimed to introduce the experimental methods used to trace Mendel's law of inheritance. Furiru lettuce which is a photoblastic seed germination cultivar was crossed with 3 non-photoblastic seed germination cultivars. While the result indicated that violet flowers and black color seeds were dominant on yellow flowers and white seeds respectively, the genetics of photoblastic phenomena showed complicated inheritance.

Chapter 9 aimed to make a general discussion, conclusion and recommendation of the dissertation to contribute to development of biology education in Cambodia. The experimental apparatus developed in this study is useful for biological experiments in high schools. The experimental methods introduced in this study are suitable for the teachers and students. Teachers and relevant partners should consider developing this kind of experimental apparatus for their experimental classes in high schools.