**Educational Collaboration between Chemistry and Business Departments**

**- Participation in A new drug delivery drug planning contest-**

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**Abstract**

**This research aims to share a case study and the knowledge of how a single objective can be achieved through collaboration between students of the Department of Chemical and Biological Engineering and the Department of Business Administration through using and complementing each other's expertise in resolving two problems presented a request from society. The first one involved promoting cross-field integration in product development and the second, fostering women engineers.**

**The methodology is as follows. Fourth- and fifth-year students from both departments participated in the 38th Annual Meeting of the Japan Society of Drug Delivery System (DDS) Student Research Project Contest, "Let's Create Your Laboratory," wherein essays and online presentations were held as part of the contest. The students in Chemicals mainly developed the product development plan, while the students in Business analyzed the target markets for the product development plan designed by the former and named the products. The product names are "Hahu Hahu Protect," a sunscreen hand cream, "Koroppe-tai," a mouthwash that allegedly kills viruses in the mouth through chemical sensations; and "Colorful Pee," a supplement for cancer detection.**

**The two teams were awarded the Grand and Third prizes in the high school division. The other the team was conferred with the President's Award in the university student division, and this team were also awarded a prize in the National Institute of Technology in 2022. Although the research fields are dimensionally opposite, it was clear that joint education can achieve effective results.**

**This form of collaborative education demonstrates a high degree of originality. First, this joint education program led to a fusion of different fields. The second is that it led to the rare inclusion of female researchers, not common in KOSEN. Third, a mixed-gender student group worked on the project. The joint research by faculty members and students from different fields and of both genders, ideas that could not have been generated by each of them singly became possible to generate and with success.**

**Keywords:** *different field collaboration, drug, women engineer, chemical, business*

**Introduction**

Markets in developed countries are becoming saturated, and consumer preferences are diversifying. Globalization and the dramatic development of information technology have made sharing information with other countries easier. Consumers can obtain more information and gain access to products and services domestically and internationally through the Internet. Companies therefore attempt to shorten product life cycles in response to these consumers. To speed up product development, "it has become necessary to engage in multifaceted communication with the market from the technology development and product planning stages.” Cross-cultural integration in product development plays an important role in this process, where two disciplines, chemistry and engineering, which are responsible for product development and business administration, respectively, are responsible for market expansion strategies.

In addition to the fusion of different disciplines, the diversity of human resources responsible for development and strategy is also important. For example, in 2022, Nara Women's University was the first women's university to establish a new engineering department, signifying the importance of the perspectives of female researchers sought by the industry. Innovations can emerge by shifting development from a male-centered perspective to one including female perspectives. Companies too have expressed a desire for female engineers (Yanagisawa, 2022). In terms of the percentage of women enrolled in university undergraduate programs, engineering has the lowest percentage at 15.8% The majority of technical colleges have engineering departments where the ratio of male to female students is only 21.8% (National Institute of Science and Technology Policy, 2022).

However, the Ube National College of Technology is one of only four among fifty-one schools in Japan to have a management-related department. The ratio of female students in the Department of Management and Information Science usually is around 70 to 80% every year. The Department of Materials Science and Engineering, one of the departments of chemistry and biology, is also one of only 21 schools in Japan, and the ratio of female students in the Department of Materials Science and Engineering is approximately 20 to 30%.

Therefore, it is necessary to provide education that takes advantage of the characteristics of our school to meet the social demand for the fusion of different fields and the development of female researchers and engineers. Participation in academic contests can deepen students' interest in research and promote their understanding of the usefulness of product development through the fusion of different fields.

**Contest Overview and Selection Process**

The Japan Society of Drug Delivery System (DDS) is an organization for presenting ideas utilizing DDS technology under the theme of medicine and pharmaceutical sciences. DDS enables drugs to work in targeted places and at targeted times in the body. This project is like a "dream plan" to cure unresolved diseases and to improve human health.

On June 30, 2022, the 38th Japan Society of DDS Annual Meeting and Student Research Project Contest, "Create Your Laboratory, Create Your Pharmaceutical Company," was held. This project was for two sections: one for college students and one for high school students. In the college student section, students first make a audio/video presentation and submit it. After a selection process, they present their ideas for solving current medical issues using DDS in a web presentation contest. High school students submit an essay on " Learn about DDS Technology and Propose Your Idea," and if selected, they present their idea in the same contest.

This contest does not involve actual product development but new ideas. The contest is an opportunity to develop creativity by thinking independently and formulating a plan based on the knowledge they have accumulated so far.

**Participants**

The participants were 12 students (4 fourth-year students, four fifth-year students, and four fourth-year students of the Department of Management and Information Sciences. 1 male student, 11 female students) and two faculty members (1 from the Department of Chemical and Biological Engineering and one from the Department of Business Administration). Both faculty members and students in the Department of Materials Science and Engineering are RAs (Research Assistants) in the "GEAR5.0 (Advanced Education for Advanced Implementation of Future Technology in Society)" project being promoted by the National College of Technology, Japan.

GEAR5.0 is a program started in 2020 at technical colleges to lead future technology realized by Society 5.0. GEAR5.0 is one of the projects for fostering "Society 5.0-type human resources for future technology," based on the changes in social and economic structure, technological advancement, and social, industrial, and regional needs realized by Society 5.0. Curriculum inspection (educational contents and methods) is conducted to ensure the quality of education at technical colleges in the Society 5.0 era.

The program was conducted as part of seminars for students from different fields in both departments.

**Work Process and Methods**

Students from both departments discussed the issue and used their respective specialties to divide the work. The process was as follows.

First, students from the Department of Chemical and Biological Engineering took the lead in proposing product development ideas based on existing technologies and presented them to students from the Department of Business Administration. The ideas were examined to see if they would be accepted by the market from a management perspective, and the three projects described below were selected.

Second, the students of the Department of Chemical and Biological Engineering devised the mechanism for the components of the specific product to be developed, while the students of the Department of Business Administration analyzed the target market for the product and devised a product name.

Third, the students prepared for their presentations. PowerPoint slides were prepared from the respective areas of responsibility, combined, adjusted, and practiced for the presentation.

The three projects were as follows

1. "Huff Huff Protect" sunscreen hand cream

This product is a hand cream with sunscreen added. Since Frequent hand washing and alcohol disinfection practices, which were common during the coronavirus pandemic, led to people having roughened hands and a demand for hand creams. Although hand creams contain moisturizing ingredients, their ingredients make the hands more susceptible to sunburn. Sunscreen creams, on the other hand, contain ultraviolet absorbents and ultraviolet triphosphates, which have low moisturizing capacity. Therefore, sunscreen is often applied after moisturizing cream is applied, or sunburn is ignored, resulting in blemishes. Therefore, there is a need for a hand cream that can moisturize and repair skin indoors and provide sun protection outdoors.

The capsule used in the hand cream is a mixture of gelatin and a caged compound, which is a component of soft capsules, and when exposed to a certain amount of ultraviolet light, the caged compound denatures, deforming the capsule and through a hole releases the sunscreen ingredient into the hand cream, resulting in a sunscreen effect.

　The caged compound is considered to be BODIPY (boron-dipyrromethene), but as it takes more than 30 minutes for BODIPY to react, the skin cannot make a hole in the capsule within a short period of time, from the moment it is exposed to ultraviolet rays to within 3 minutes (at UV index 3.0) when sunburn begins. Therefore, to speed up the reaction of the caged compound, a catalyst is also added to cause a secondary reaction, such as a psyllium reaction.

We named this product "Huff Huff Protect" because it is a half-and-half hand cream and sunscreen cream that both moisturizes and protects against sunburn. The main target is homemakers in their 30s to 50s who suffer from rough hands due to dryness caused by housework. The average price of hand cream popular among this group is about 1,105.2 yen, and the average price of sunscreen cream is 1,157 yen. Therefore, the selling price is set at 1,200 yen and it is hoped that most of the current sunscreen cream market will buy this Huff Huff Protect, which would then beget a sale of 67 billion yen, as estimated.

2. Mouthwash "Koroppe-tai"

It has been reported that popping-iodine, a commercial gargle, can remove 99.99% of coronaviruses and its effect can last for 6 hours (e.g. J. Dent. Res., 2021). However, the gargling time to remove the virus varies from 15 to 60 seconds, making it difficult to know when the virus can be removed entirely. In addition, no mouthwash has yet been developed providing information on when to gargle.

Taking this challenge, "Koroppe-tai," a mouthwash was developed, which tells the user when to gargle and the timing to remove viruses by producing a chemical sensation in the mouth.

　To live without masks, the mouthwash can be used and the term "Koroppe-tai," means "to gargle out the corona," to remove it altogether.

　The "Koroppe-tai" uses a popping-iodine solution, which can remove coronaviruses, and it boasts the highest share in the gargle market (48.85%, Intage, 2020). The company proposes a mouthwash containing a DDS compound capsule, such as the New Coronavirus Antigen Test Kit (Kobayashi Pharmaceutical Co., Ltd.), which causes an antigen-antibody reaction when it encounters the coronavirus, causing the capsule to crack and release the soothing component (methyl salicylate).

　The "Koroppe-tai" has two functions: to signal the end of gargling immediately after use and to signal the time for the next gargle; hence, the capsules to be mixed are a soft type (ingredient: gelatin) that breaks easily, and a hard type that breaks after 6 hours (ingredient: hydroxypropyl methyl methacrylate): hydroxypropyl methylcellulose).

The proposed "Koroppe-tai" will help reduce the stress caused by the coronavirus and live mask-free; it is expected to generate sales of more than 600 million yen in the Poppidone (Isodine) market.

3. "Colorful Pee," a supplement for cancer detection

Against the backdrop of the need for early detection of cancer, ColorfulPee proposes the development of a supplement to detect cancer in urine. If there is no cancer, the micelles (cancer test drug) contained in Colorful Pea are discharged from the body as is, but if cancer is present, the micelles disintegrate in the cancer cells, and the fluorodeoxyglucose-linked dye in the micelles is contained in the urine, resulting in red fluorescent urine. Currently used cancer test self-kits (Nematode N-Nose) are expensive and time-consuming to test. This product is a low-cost, easy-to-use cancer test against the backdrop of growing interest in dietary supplements (Fig.1).

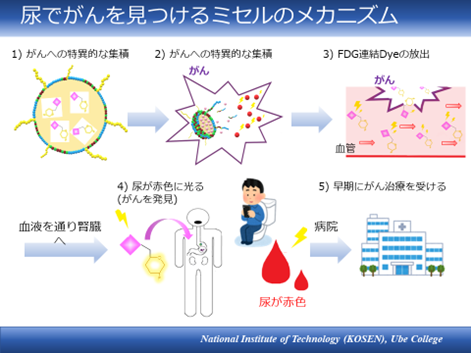


Figure 1: Slide explaining the mechanism of Colorful Pee by students.

Together, these three projects combined knowledge from the field of chemistry with knowledge of the market from business administration. It would have been not easy to conceptualize so many different ideas in a short period of time using knowledge from one single field.

**Results and Discussion**

The results of the DDS contest, which consisted of teams of students from different fields of management and materials science, are as follows:

First prize in the high school student division: Development of a mouthwash, "Koroppe-tai," which signals virus removal through the chemical sensation in the mouth (three students from the Department of Chemical and Biological Engineering and one student from the Department of Business Administration).

Third prize in the high school student division: "Huff Huff Protect," a hand cream with sunscreen effect (three students from the Department of Chemical and Biological Engineering and one student from the Department of Business Administration).

University student division: Development of "Colourful Pee," a supplement for easy detection of cancer; this project received the Conference Chairman's Award　(three students from the Department of Chemical and Biological Engineering and one student from the Department of Business Administration). The winner of the university student division was also honored with the 2022 National Institution of National Colleges of Technology Student Award (Fig.2).

These results were published in the PR Times on November 11, 2022, and the contest received exceptionally high evaluations.

A group of people holding certificates

Description automatically generated with medium confidence

Fig. 2: Photograph of the campus commendations

It would have been easier for the Department of Chemical and Biological Engineering or Department of Business Administration alone to develop and present ideas. The Department of Chemicals alone had a weak sense of the market, whereas the Department of Business alone needed help in developing product ideas. This was also the case for the faculty members. The results of various awards can be attributed to the fusion of different fields.

By competing with other high schools and universities instead of simply soliciting ideas, we were able to increase students’ motivation. The students learned from each other by listening to presentations from other groups and sharing their thoughts and impressions.

However, two major challenges must be addressed. First, owing to the different timetables of the two departments, there were instances when more than one communication between students was required. This could be resolved by facilitating interactions between the two departments, such as organizing an icebreaker activity, before the event.

Second, despite the majority of participants being female students, there were no groups of male students; therefore, it was not possible to clearly identify the presence or absence of original ideas from female students. From the following year onward, it may be necessary to devise ways to organize the groups in order to evaluate potential differences in "product development" between male and female students.

**Conclusions**

In this study, students from two departments—the Department of Chemical and Biological Engineering and the Department of Business Administration—were invited to participate in a contest sponsored by an academic society. The goal of the contest was to develop products that integrated different fields and fostered female researchers and engineers. As a result, all groups received awards. Selling products to consumers is challenging without product knowledge, and without knowledge of the market, developed products will not sell. This study deepened the students' understanding of the importance of these aspects to each other.

However, as this was the students' first time participating in the contest, the full effects of the comparison are still not evident. It is necessary to repeat the challenges annually to verify these results and further evaluate their impact.

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