

# Structure of “Ventilation and Warming” in *Notes on Nursing* Written by Florence Nightingale in 19th Century: Introduction of Basic Physics to Nursing Students

Kazutoshi OGOH\*

*Miyazaki Prefectural Nursing University, Miyazaki 880-0929, Japan*

*E-mail: k-og@mpu.ac.jp*

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“Basic Natural Science” for freshmen at Miyazaki Prefectural Nursing University has a component including physics. Here students learn three principles of thermal transfer; conduction, radiation, and convection through a series of experiments. The purpose of these experiments is to understand the structure of a method for the caring of breathing and temperature of patients as written in “Ventilation and Warming”, the first chapter of F. Nightingale’s *Notes on Nursing*. Students can then apply this structure to retain fresh air in today’s hospital rooms, and can then appreciate studying real physics incorporated into fundamental knowledge for nursing practice.

**KEYWORDS:** convection, Nightingale, nursing, ventilation, warming

## 1. Introduction

Knowledge of basic physics (e.g. air and water pressure, body mechanics) is necessary for nursing practice, but most university nursing students (UNS) did not study physics in high school. Therefore, an important issue is how to motivate UNS in physics. This has led to include a physics module in a course entitled “Basic Natural Science” at Miyazaki Prefectural Nursing University (MPNU). F. Nightingale’s *Notes on Nursing* has been used as an essential reading material at MPNU since 1997. Sentences on caring for patients are selected and explained based on physics. UNS are then encouraged to study physics in a normal hospital setting with the first lesson of the course in 2013 being presented as a case study.

## 2. Learning process of the first lesson: “Ventilation and Warming”

### 2.1 Introduction

Freshmen at MPNU will first read the sentences in Table I, “Purpose”, and consider why the very first canon of nursing is to keep the air a patient breathes as pure as external air, without inconveniencing the patient. The aim is to help UNS understand the importance of breathing and the correct room temperature for patient recovery.

Table I. Sentences in “Ventilation and Warming”, the first chapter in *Notes on Nursing*

Purpose	The very first canon of nursing, the first and the last thing upon which a nurse’s attention must be fixed, the first essential to the patient, without which all the rest you can do for him is as nothing, with which I had almost said you may leave all the rest alone, is this: To keep the air he breathes as pure as the external air, without chilling him. <sup>[1]</sup>
Method	With a proper supply of windows, and a proper supply of fuel in open fire places, fresh air is comparatively easy to secure when your patient or patients are in bed. Never be afraid of open windows then. People don’t catch cold in bed.... Open the window above, not below.... An inch or two will be enough for two people in a moderately-sized bedroom in winter.... The worst place to admit air either into sick room or hospital ward, is at or near the level of the floor. Air admitted in this situation cools the floor and the lower strata of air; and if the patient is able to step out of bed, the cold air may give him a dangerous chill. <sup>[2]</sup>

## 2.2 Experiments

After reading Table I, “Method”, students then learn three principles of thermal transfer through a series of experiments. Conduction is understood by shaking hands with each other. Radiation and convection are realized by putting their hands near the flame of a candle from the sides and from above, respectively, as shown in Figure 1.

They can feel heat by putting their hands above the flame, but can also feel warmth with their hands at the sides. Students can now realize the convection phenomena that hot air moves upwards.

Another simple experiment is done by pouring hot water into a PET bottle, and then capping it. As the liquid and air in the bottle cool, a dent in the PET bottle forms due to the surrounding air.

Then, UNS learn that the volume of air decreases according to a fall in temperature, while the reverse density of air increases simultaneously.

Therefore, the UNS understand the structure of convection like this: Air at lower temperatures (higher density) drops, thus pushing air at higher temperatures (lower density) upwards. This air movement occurs in progression by the flame of the candle.

## 2.3 Discussion

Students now discuss the structure of the sentences in Table I, “Method”, based on the principles of thermal transfer. They can now understand air convection in a room, as shown in Figure 2 (not mentioned by F. Nightingale), and can explain it like this: “Hot air (**RED ARROWS**) moves upward due to the flames in an open fire place, travels along the ceiling, reaching the above opened window. Cold fresh air (**BLUE ARROW**) drops through the window mixing with the existing hot air. The fresh air at the proper temperature (**GREEN ARROWS**) sinks down to the patient below in bed.”

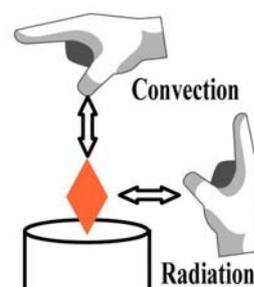


Fig. 1. Experiments on radiation and convection: Put your hands near the flame of a candle from its sides and one hand from above. In the previous case, you can feel the warmth without touching the flame, thus realizing radiation. In the latter case, you can feel more intense heat with your hand above the flame even though your hand is at the same distance. You can now realize hot air travels vertically with more intensity from the flame. You have now experienced the phenomenon of air convection. The truth of this phenomenon is that the surrounding air flows into the flame, thus pushing the heated air upwards.

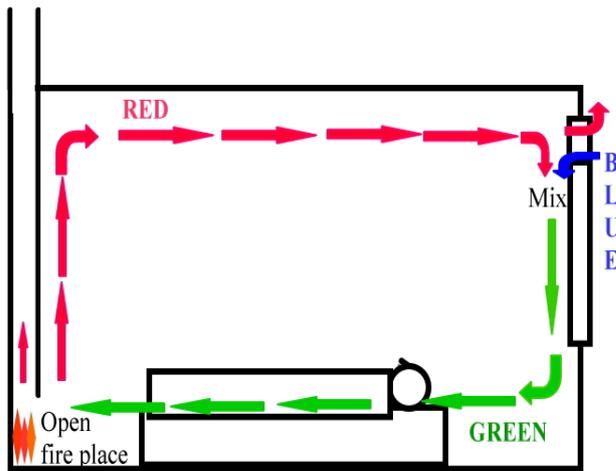


Fig. 2. Structure of the method in “Ventilation and Warming” in *Notes on Nursing*: Hot air (RED ARROWS) moves by flames in an open fire place, then travels along the ceiling, reaching the above opened window. Cold fresh air (BLUE ARROW) coming through the window then mixes with the existing hot air. The fresh air at the proper temperature (GREEN ARROWS) sinks down to the patients below in bed.

## 2.4 Application

Students try to apply this structure of air convection to keep air fresh and pure in today’s modern rooms with an air conditioner installed instead of an open fire place, as shown in Figure 3. The best students’ illustration works like this: “The window should also be opened above in today’s rooms, even in winter. The direction of airflow from the air conditioner should be down. Therefore, in today’s rooms, the airflow is the reverse of that in the 19<sup>th</sup> century rooms. Upward wind from a fan, which is set under the window, makes this air circulation more stabilized.”

## 2.5 Effect on students

Success in understanding the first lesson encourages UNS to study physics as a fundamental key for knowledge in nursing practice. In the recent past, more than 40% of the UNS have taken this course and have studied hard to achieve the program’s goals stated in Table II.

One month after the first lesson, students again try to explain the structure of the method in “Ventilation and Warming” in *Notes on Nursing* in regard to the air convection in today’s rooms. In 2013, all of forty seven UNS who took this course explained the first case correctly (Fig. 2). Fifteen out of the forty seven explained the second case incorrectly (Fig. 3); i.e. thirteen

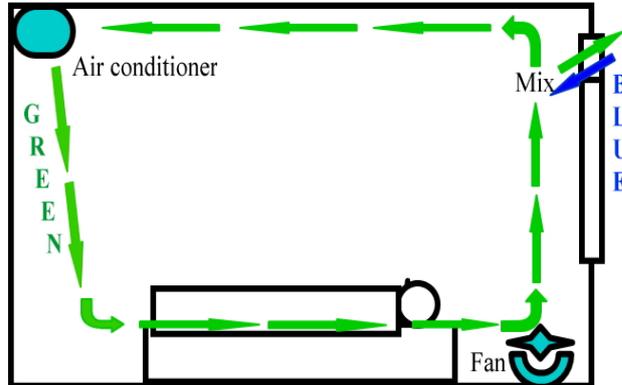


Fig. 3. Application of the air convection to today’s rooms: The window should also be opened above in today’s rooms in winter. The direction of airflow from the air conditioner should be down. Therefore, in today’s rooms, the airflow is the reverse of that in the 19<sup>th</sup> century rooms. Upward wind from a fan, which is set under the window, makes this air circulation more stabilized.

students’ illustrations showed the airflow from the air conditioner running along the ceiling, while two students’ illustrations showed the direction of the airflow correctly, but showed an open window near or at floor level. In a supplementary lesson of twenty minutes, the fifteen UNS reconsidered their illustrations and were able to realize the differences and similarities between the 19<sup>th</sup> century rooms and the rooms of today.

### 3. Whole programs of the physics module in the “Basic Natural Science” course

The knowledge of physics in Table II’s “Teaching Subjects” helps UNS to study basic professional and professional educational courses, including clinical nursing practice and research. A student’s typical remark from the 2013 class is as follows. “Hot air moves upward, cold air moves downward. We nurses should consider this and should change the position of window to be open or the direction of airflow from an air conditioner under various conditions.... After taking all the lessons of the physics module, I understand that a lot of ideas of physics are able to be applied to nursing.”

A decade before, when the chapter of “Ventilation and Warming” was first used for this lecture, not only thermal transfer but also heat itself were explained from molecular movements. It was obviously difficult for freshmen UNS to understand the sentences in Table I, “Method”, which considers molecular movements. Therefore, heat and molecular movements were shifted to the fourth through sixth lessons. The first through third phenomenal lessons helped the UNS to understand molecular movements.

Table II. The entire physics module in the “Basic Natural Science” course

Lesson	Chapter of <i>Notes on Nursing</i>	<i>Teaching Subjects</i>
1	“Ventilation and Warming”	Three principles of thermal transfer: conduction, radiation, convection
2	“Health of Houses”	Air and water pressure, siphon
3	“Observation of Sick”	Blood pressure, structure of manometer
4	“Light”	Radiant energy, infrared rays. Ionizing radiation: ultraviolet rays, X rays, gamma rays, etc.
5	“Noise”	Sound wave, supersonic wave, heat
6	“Cleanliness of Rooms and Walls” and “Personal Cleanliness”	Electricity, lightning conductor, ground, molecular structure of H <sub>2</sub> O, penetration through membranes
7	“Variety”	Body mechanics: pressure, center of gravity, support plane, leverage, shifting weight

### 4. Conclusion

Freshmen UNS at MPNU who have not studied physics in high school are encouraged to study physics as a key element in fundamental knowledge for nursing practice. They have experienced and now understand the sentences for the caring of patients written in F. Nightingale’s *Notes on Nursing* based on principles of physics learned through a series of classroom experiments.

### Acknowledgment

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### References

- [1] F. Nightingale: *Notes on Nursing* (Gendaisha Publishing Co., Ltd, Tokyo, 1974), Chap. 1, p. 7.
- [2] F. Nightingale: *Notes on Nursing* (Gendaisha Publishing Co., Ltd, Tokyo, 1974), Chap. 1, p. 8-10.