

Implementation of Lighting Technique and Music Therapy for Improving Degree of Students Concentration During Lectures

ChangPyoung Han* , YouSik Hong**

*Professor, Dept. of Automotive Engineering, Sangji University, Wonju-si, Kangwon-do, Korea

**Professor, Dept. of Information and Communication SW Engineering, Sangji University, Wonju-si, Kangwon-do, Korea
e-mail : yshong@sangji.ac.kr

Abstract

The advantage of the distance learning universities based on the 4th Industrial Revolution is that anyone can conveniently take lectures anytime, anywhere on the web. In addition, research has been actively conducted on the effect of light color and temperature control upon student performance during online classes. However, research on how the conditions of subjects, lighting colors, and music selection improve the degree of a student's concentration during online lectures has not been completed. To solve these problems in this paper, we have developed automatic analysis system SW for the weak subjects of learners by applying intelligent analysis algorithm, have proposed and simulated music therapy and art therapy. Moreover, It proposed in this paper an algorithm for an automatic analysis system, which shows the weak subjects of learners by adopting intelligence analysis algorithms. We also have presented and simulated a music therapy and art therapy algorithms, based on the blended learning, in order to increase students concentration during lecture.

Keywords: Lighting Therapy, Lecture Concentration Analysis, Fuzzy Logic, Music Therapy

1. Introduction

Research papers published today show that if the color temperature of light is adjusted to the subject before the lecture begins, and the color therapy is performed during the 10-minute break, the student's concentration of the lecture improves by 25 ~ 35%. In addition, studies have shown that brain exercise, stress relief, and emotional colors of blue-light series are effective in improving performances in mathematics and science [1-3]. This principle is based on the study that brain waves are stabilized by maintaining the light that gives a sense of stability; stress is minimized and mental rotation is performed when calculating math and science problems. Researches have shown that brain exercise, stress relief, and emotional lighting are effective in improving math and science performance.

This principle is based on research that if the brain waves are stabilized, so that stress is minimized and comfort is maintained enough to feel stable, math problems are solved and brain rotation in science subjects is

accelerated [3-5]. In this paper, to study the learning effects of science and mathematics, we present a simulation for the optimal learning conditions, by using stress therapy and music therapy. However, depending on the user's taste, there are many differences in their favorite music or color. In this paper, therefore, optimal lighting therapy and music therapy were proposed and simulated to solve these problems. According to a recent study of herbal therapy based color therapy, it is said that blue light contracts the arteries and increases blood pressure, and is effective in the treatment of skin diseases, rheumatism, and various inflammations. Studies have shown that colors in green series has the effect of lowering blood pressure, the colors are also effective in the treatment of nerves, severe fatigue, neuralgia, headaches, and neuralgia.

On the other hand, studies have shown that yellow series colors have a psychological stimulating effect, giving pleasure for the treatment of neurasthenia or tuberculosis; and the red series colors are effective for the treatment of depression; and the purple series colors affect the heart, lungs, and blood vessels. In addition, recent studies have shown that music therapy increases breathing rate, heart rate, and blood pressure, as a result of fast tempos music. When music stops, the breathing and heart rates are slow down and blood pressure drops. Meanwhile, slow music is said to lower the heart rate. In addition, researches have been actively conducted on how lighting color and temperature control affect student's performance during online classes. In this paper, we proposed an optimal learning condition algorithm, using stress therapy and music therapy in order to effectively study science and mathematics.

Section 1 introduces the basic concept of smart learning, Section 2 describes the web-based SMART learning research using artificial intelligence, Section 3 explains the simulation results and future work plans. Finally, Section 4 will draw a conclusion.

2. Theory of Lecture Concentration Improvement

No matter how good the instructor is, it is not possible for the instructor to know the student's levels of understanding and the student's weak subjects. To solve this problem, we propose to develop a SW for student's concentration during lectures, an automatic analysis of weak subjects, and an automatic summary of lectures, by using a biometric sensor system of real-time bidirectional education based on blended e-learning (online learning + off-line learning) during lecture time[5-7].

We can use the lighting color temperature of 6,500K in daily life and 7,000K for reading books. We can raise the lighting temperature to 7,500K for studying subjects that require logic and concentration such as math and science. Bright yellow light is displayed at a lighting color temperature of 3,800~5,000K, which helps to learn subjects such as Korean, English, and society which require language-based understanding and memorization,

In addition, it has the effect of releasing fatigue, so it is also effective for learning subjects that require a deep state of concentration. Blue lighting is displayed at a color temperature of 6,000-7,000K. This light stimulates the brain to speed up of thinking, improve more attention and concentration, and help speed up of the mental rotation. Therefore, these blues are suitable for studying subjects such as mathematics and science that require logical thinking. Red lights are displayed at a color temperature of 2500 ~ 3000K. Since the red color enhances sensibility, it is suitable for learning a subject that requires artistic activity or creativity. It also helps reduce tension because it reduces mental fatigue. In this paper, we accurately determine competency-based learning by level, by proposing a smart E-Learning system using artificial intelligence.

Figure 1 shows the process of evaluating the student's understanding of the lecture based on the test score. In addition, we developed a technique that allows the instructor to analyze student's understanding of lecture that improves the existing learning problems, by using the real-time level learning system SW and related rules after the students log in.

Table 1. Input data using associated rules

Input data	
random variable 1	Student Score
random variable 2	Result Assumption
random variable 3	Absence Rate
random variable 4	Understanding Low, Med, High
random variable 5	Difficulty Low, Med, High

1. Degree supportability

$$\text{Supportability } (A \Rightarrow B) = \Pr(A \cap B)$$

Number of transactions between two events / Total transactions

Description: Concurrent occurrence rate of event A and event B

2. Degree of reliability

$$\text{Reliability}(A \Rightarrow B) = \Pr(A \cap B) / \Pr(A)$$

Number of two events happening / Number of two events happening

Description: The incidence rate of events A with events B included

3. Degree of improvement $(AB) = \Pr(AB) / \Pr(A) \cdot \Pr(B)$

Shows the ratio of transactions related to event B, under the transactions of event A

Can grasp the correlation of event $A \Rightarrow B$

In the case of students who passed the test with a score of 0.7 or higher on a fuzzy scale but lacked the basics of earning by units, instructors can use various intelligent fuzzy rules to measure student's weak subjects and lecture comprehension by considering reliability.

3. Computer Simulation

In this paper, to solve this problem, we proposed an algorithm to improve the understanding of lectures by using color therapy and music therapy. At the online college MOOC, the graduation rate for students is very low, with less than 10%. Since the instructor does not give a lecture to students, face to face like an offline course, in online class students can successfully complete the subjects only with their will and the ability to concentrate on the course. Especially, since online lectures by famous universities abroad are given in English; there are many cases students give up in the middle because they have difficulties in understanding the contents of the lecture. In addition, students who do not understand the contents of the lecture well and have poor grades cannot actively ask questions because they are embarrassed to ask questions frequently during the lecture. In this paper, to solve these problems we developed a bi-directional inquiry SW.

Virtual University : E-Learning Test			
Course Name : CS302Multimedia Processor Name : Alice			
E-mail : yshong@sangji.ac.kr Tel : 033-742-1121			
<input type="button" value="Submit"/>		<input type="button" value="Rewrite"/>	
student1	student2	student3	student4
high	medium	low	high
student5	student6	student7	student8
high	medium	low	high
student9	student10	student11	student12
medium	high	medium	high
student13	student14	student15	student16
high	low	high	medium
student17	student18	student19	student20
high	low	medium	high
Total Students :: 20			
Understood :: high : 10 medium : 6 low : 4			
2019-10-01 20:23:36	100	HIGH	100
2018-10-29 01:03:50	100	HIGH	100
2019-09-23 20:08:17	100	HIGH	100
	33	LOW	33
2010-07-12 13:28:41	100	HIGH	100
	33	LOW	33

Figure 1. Lecture understanding results

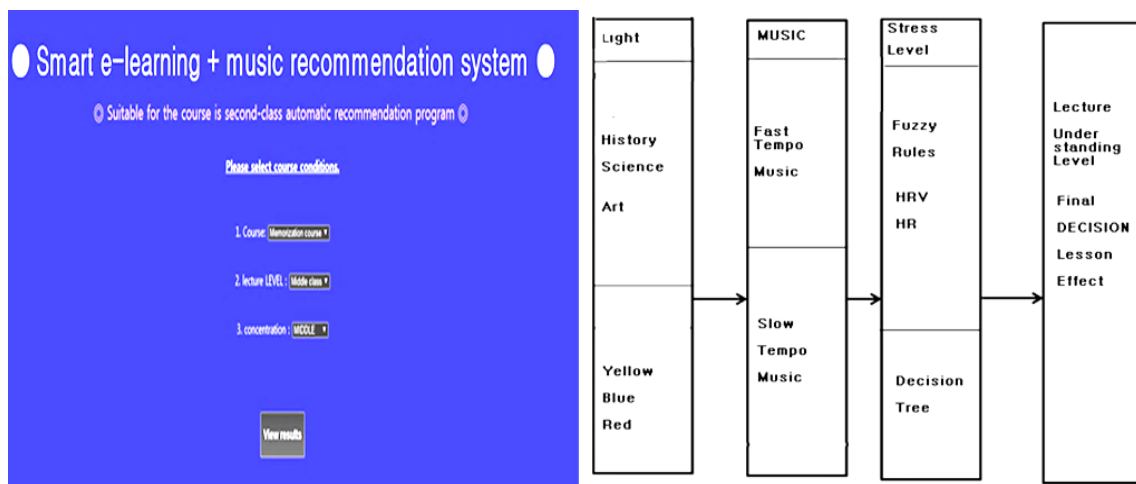


Figure 2. Smart eLearning-based music therapy and lighting therapy

Figure 2 describes the best lighting therapy for students, music therapy algorithms, and program execution screens for students who can improve their concentration in class using music therapy and color therapy. It illustrates the function of selecting the wrong types in DB and identifying the wrong types based on the wrong answer note SW.

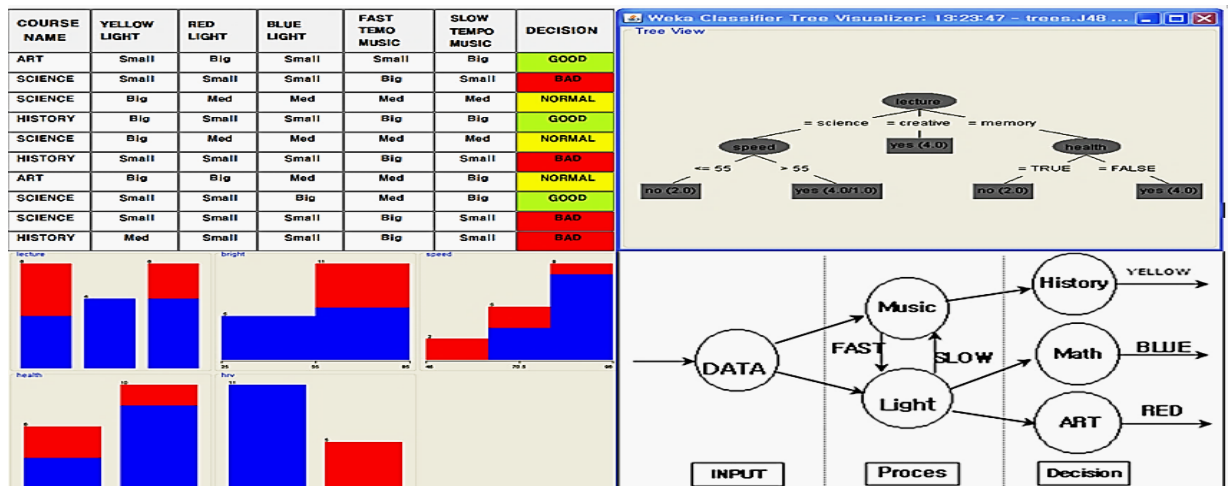


Figure 3. Simulation of lighting therapy to improve the concentration of lecture

Figure 3 shows the process of the lighting therapy simulation to improve the concentration of lectures. It was confirmed through simulation that, after 10 minutes of light treatment before class, the concentration of lecture in memorization classes can be improved by more than 20%, and the concentration of lecture in art classes by 20% or more. The data contents of simulation for the heart rate change, based on music therapy and lighting therapy, are as follows. Figure 3 illustrates the simulation process for lighting therapy to improve the concentration of lectures. Before the lecture, when lighting therapy was conducted for 10 minutes, it was confirmed through a simulation that the memorization class could improve the concentration of the lecture by more than 20 percent, the mathematics department by blue, and the art department by more than 20 percent. The data contents of simulation for the heart rate change, based on music therapy and lighting therapy, are as follows.

- (1) To improve students lecture concentration, we classify the study subjects into three groups : science subjects, art subjects, and memorization subjects. For a science subject, the classroom lighting is changed into blue, art subject, the classroom lighting is changed into red, For memorization subject, the classroom lighting is changed into yellow.
- (2) Music therapy and art therapy can increase student's understanding of lectures and reduce stress. For example, slower tempo music increases, the student's heart rate and fast music tempo music increases the student's heart rate.
- (3) However, no matter how good and healthy a student is, the heart rate, health condition, and the heart rate can increase or decrease according to the state of student's mental health. Therefore, it is difficult to measure the exact heart rate of a student.
- (4) Therefore, in this paper, we have analyzed the data of student's average heart rate; we also have adopted the association rules provided by the WEKA data mining tool, in order to measure the changes of student's heart rate, according to their understanding and concentration during lectures. In addition, we have analyzed a correlation between a light therapy and a heart rate of students, taking lectures based on music therapy and art therapy.

Rule: IF PA is t1 THEN C is B2 (Fu)

fact : PA is t1' (Fr)

Conclusion : HC is t2'

PA : Clinical Patient Status

HC: Inference Results

Fu, Fr : fuzzy number indicating uncertainty in the rule

```

RULE
IF Samp = Med And
Bmi = High And
S_time = High And
Age = Med And
Sex=male
then
Stress Level = CNF 80
    
```

```

RULE
IF Wrong_Answer = High
THEN UNST = SCORE CNF 70;
    
```

In this case, CNF 70 means that RULE is confident 70% . Therefore, if confidence is not expressed in the conventional way, it is always considered 100%. In this paper, using fuzzy rules, when students learn by levels, 'understanding' is classified as 'low, middlel, large', so that teachers can see the students' understanding during lectures in real time.

Conclusion Assuming the level of student’s understanding is 70 based on student performance, the reliability is 0.7. We can give confidence in the conditional statement itself.

If a confidence level of 60 for STAT = Low is given the student, the confidence in the conclusion is $0.8 \times 0.6 = 0.48$. Figure 2 shows a sample of 10 students (id: s1~s10) with the average of scores for each test analyzed. Teachers re-evaluated, in real time, understanding level of students by simulating the course (HIGH, MED, LOW).

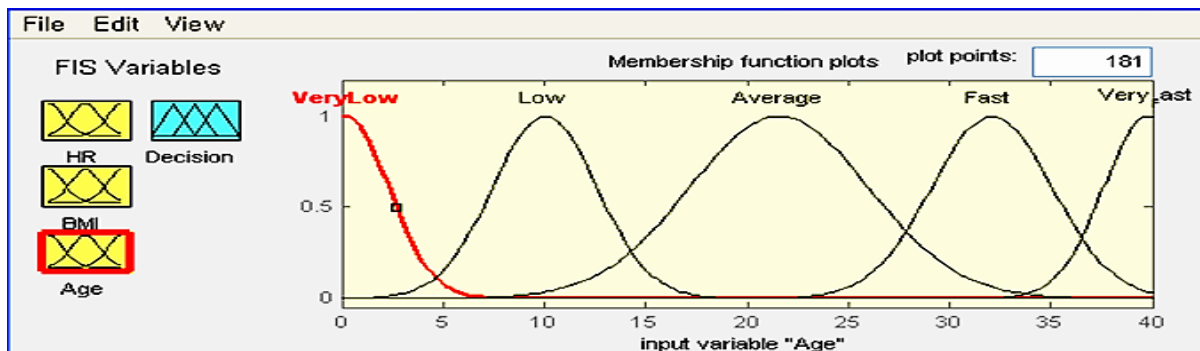


Figure 4. Automatic determination of student's understanding using fuzzy rules

Figure 4 shows the process of judging students' biological information (score, understanding, correct answer, incorrect answer, and weak subject) with an RFID student ID card, when attending a electronic virtual university system.

In this paper, when a teacher gives a lecture, the conventional method shows a very difficult problem in judging students who have understood the class and those who did not understand the class. In the existing method, more than 80% of students understand the content of the lecture while less than 30% of students understand the content of the lecture, together in the classroom. Therefore, in this paper, an algorithm for solving this problem is presented. In addition, this paper we show that our algorithm does not simply evaluate students’ score, but also offer a function to determine which part of the student, who have mastered a specific subject, is lacking.



Figure 5. Simulation of music recommendation

In figure 5, to improve the concentration of the lecture, by selecting three input conditions consisting of subjects, lecture level, and understanding, we show simulation results that output the lighting conditions and music conditions of the online lecture that can be most suitable for the student's study.

```

NumInputs=3
NumOutputs=1
[Input1]
Name='HRV'
Range=[0 250]
NumMFs=3
MF1='SLOW':trapmf,[-80.9 -27.1 7.22 59.8544973544974]
MF2='Med':trapmf,[40.0694708994709 63.3994708994709 98.3994708994709 132.599470899471]
MF3='FAST':trapmf,[85 236 322 324]
[Input2]
Name='BMI'
Range=[0 40]
NumMFs=3
MF1='Small':trapmf,[-0.531 -0.475 3.51 18.8888888888889]
MF2='Big':trapmf,[22.3838624338624 35.3138624338624 44.0338624338624 44.0338624338624]
MF3='Med':trimf,[13.1 23.3 31.7989417989418]
[Input3]
Name='Exercise'
Range=[0 10]
NumMFs=3
MF1='Small':trapmf,[-2.96 -0.145502645502645 1.03 3.77]
MF2='Medium':trimf,[1.44179894179894 5 7.53]
MF3='Big':trapmf,[4.43835978835979 7.65835978835979 10.1719576719577 11.5883597883598]
[Output1]
Name='Decision'
Range=[20 100]
NumMFs=3
1. Course:
  <select id='f1'>
    <option value='1'> Choose </option>
    <option value='2'>Memorization course</option>
    <option value='3'>Science subject</option>
    <option value='4'>Art subject</option>
  </select>
2. lecture LEVEL :
  <select id='f2'>
    <option value='1'> Choose </option>
    <option value='2'>High class</option>
    <option value='3'>Middle class</option>
    <option value='4'>Low class</option>
  </select>
3. concentration :

```

```

<select id="f3">
  <option value="1"> Choose </option>
  <option value="2"> HIGH </option>
  <option value="3"> MIDDLE </option>
  <option value="4"> LOW </option>
</select><p>
<button onClick="check()"><h3>View results</button>
<script>
function check() {
  var f1 = document.getElementById("f1").value;
  var f2 = document.getElementById("f2").value;
  var f3 = document.getElementById("f3").value;
  var result
  if(f1==1 && f2==1 && f3==1 && f3==3 || f1==1 && f2==1 )
  var result="※ Please select all 3 questions!";}
  else if (f1==2 && f2==2 && f3==2)
    window.location.href = "1.html";}
  else if (f1==2 && f2==2 && f3==3)
    window.location.href = "2.html";}
  else if (f1==2 && f2==2 && f3==4)
    window.location.href = "3.html";}

```

4. Conclusion

Nowadays, in online universities, researches have been actively carried out how the selection of lighting color and music affect the improvement of student's concentration during lectures and student's performance during lectures. To improve the problem of reducing lecture concentration in this paper, we have presented our performance of computer simulations using music therapy and art therapy, by developing an algorithm for improving student's concentration during lectures and a SW algorithm based on self-directed learning.

In the 21st century, anyone can easily have an access to the internet and take 24-hour online courses everywhere. Especially, giving lectures for online courses, it is very difficult for the lecturer to determine which subjects the students had repeatedly taken or in which subjects the students had failed, if the students' levels of learning are not taken into consideration for the students even with the same grades

In order to solve these problems, we proposed in this paper an algorithm for an automatic analysis system, which shows the weak subjects of learners by adopting intelligence analysis algorithms. We also have presented and simulated a music therapy and art therapy algorithms, based on the blended learning, in order to increase students concentration during lectures

Acknowledgement

This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(grant number: 2018R1D1A1B07043)

References

- [1]<https://www.zdnet.co.kr/view/?no=20190225170917>
- [2] Sumie Matsuura. "Personal Color Systems," Fashion & Textile Research Journal Volume 6, No.5. 2004
- [3] Oh, HeeSun. "Research of Personal Color". Journal of Fashion Business Vol 3. No2
- [4] Lee JongHee. "Child's Color Psychology Analysis using Fuzzy Reasoning Rule", Korean Journal of Fuzzy Logic and Intelligent Systems - Busan & Gyeongnam Branch Conference Proceedings, 2004.
- [5] A Study on the Points of Learner's Perspective in Remote Education on the Internet, Volume 6, Volume 3, 2006 of the Journal of the Korea Creative Content Association
- [6] Hong You-sik, Intelligent Education System, Journal of the Korean Association of Internet Broadcasting and Communications, Vol.13,2013

- [7] Han, AhReum. "Study on Emotional Processing Utilizing Fuzzy Inference Rules", Korea Institute of Maritime Information and Communication Sciences Conference Proceedings, 2006.
- [8] U.S. Department of Education, Office on Planning, Evaluation, and Policy Development
- [9] Hong You-sik, Min Joon-young, Intelligent Virtual University, Journal of Information Processing, Vol.20, No.5 2013
- [10] The effect of mindfulness meditation programs with Kang Hye-yoon, Nam Jung-hyun, and fragrance therapy on depression, stress and psychological well-being. Research on Art Psychotherapy, pp.219-236.2013
- [11] Effects of Kang Hee-sook, Choi Se-young, and group art activities on the self-respect and communication of children in local children's centers. Research on Art Psychotherapy, pp.167-190.2012
- [12] H.O. Won, "The Effects of the Neurofeedback Programs on the Function and Stress of High School Students", Journal of Child Care, Vol. 3, No. 14, pp. 315 - 323, 2008.
- [13] P.N. Friel, "EEG Biofeedback in the Treatment of Attention Deficit/Hyperactivity Disorder", Alternative Medicine Review, Vol. 12, No. 2, 2007.
- [14] M. Galina, Brain Music Treatment Introduction to QEEG and Neurofeedback, 2nd Edition, Elsevier Press, 2009
- [15] Kim, ByungJoo, "Music Recommendation System for Personalized Brain Music Training Research with Jade Solution Company", International journal of advanced smart convergence Vol.6, No.2, pp. 9 - 15, 2017
- [16] Lee, Kwan Hyeong, "A Study on the Desired Target Signal Estimation using MUSIC and LCMV Beamforming Algorithm", International journal of advanced smart convergence Vol.9, No.1, pp. 177 - 184, 2020