An Analysis of Emotional Fluctuation and Its Causes in the Productive Practice for Engineering Undergraduates: Based on the Case of an Engineering Major in China

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Abstract

Productive practice is a significant teaching link for engineering undergraduates in China. Through the analysis of prior literatures and observation, this paper puts forward an assumption that engineering students, as the main body of productive practice, express undulating feelings and emotions with days during the process of practice. In view of this assumption, and considering the previous researchers' results that emotions have influence on students' academic achievements and can predict their achievements, this paper intends to test and study undergraduate students' emotional fluctuations in the productive practice and analyze related causes. Practice record diaries, interview, frequency statistics and changing curves have been used to collect and analyze students' emotional expressions. These emotional expressions could be divided into two types: positive emotional words, such as happy, exciting, confident, inspired, satisfying, and well-informed, and negative emotional words including boring, tired, monotonous, confused, whiny, waste-of-time, among others. This paper is a result of a tracking investigation of undergraduate students from an engineering major in the summer semester. It demonstrates that the students' emotional fluctuations are affected by time change, practice contents, accommodation and transportation arrangements, weather conditions and subjective initiative of the students. The paper also discusses the measures that could be taken to better the students' emotions, so as to optimize productive practice effect.

Introduction

Along with the profound changes of human society, economy, science and technology since the 21st century, newer and higher requirements are constantly proposed for engineering and technical personnel's quality through the integration and complexity of engineering. There is an urgent need for the modern higher engineering education reform and development to foster high-quality engineering and technical personnel with innovative spirit and practice ability. This will be needful in satisfying the requirements of the social high-speed development. In the same sense, the curriculum arrangement of engineering majors in undergraduate level practical teaching mainly consists of cognition practice, productive practice, graduation practice, curriculum design and graduation project, among others.[1] Being the significant component of practical teaching process carried out by engineering universities, productive practice is recognized as the effective measure for consolidating and deepening the professional basic theory, boosting engineering students' abilities to link theory with practice and to deal with practical problems, as well as optimizing the students' engineering practical abilities.

Productive practice is a course which closely integrates classroom teaching and productive practice teaching with the practical ability training as the main line in the professional course setting. Generally, it is arranged for engineering undergraduates in the summer holiday at the end of the 6th semester, taking about 2-3 weeks (1 month for individual major) in

professional-related factories or enterprises. During the practice, students are organized into relevant units to visit workshops, laboratories and other sites. They listen to special lectures, and participate in alumni exchange meetings as well. For some non-confidential industries, short-term hands-on links may be arranged for the students, in which factory workers directly teach students on actual operation and production processes.

Colleges and universities have increasingly focused on the effect of productive practice of engineering students with the growing emphasis on nurturing practical abilities. A great number of scholars have conducted researches on productive practice, proposing targeted recommendations which are based on the analysis of productive practice status, problems and unfavorable factors[2-6]. These researchers largely believe that the factors that influence the effect of productive practice are the objective and external factors such as the difficulty of connecting productive practice places, lack of enterprise enthusiasm, short time of productive practice, shortage of funds for productive internship, and limitation of practice contents. Still, the study on engineering students, as the main body of productive practice, is not deeply considered.

YUAN Quan[7] has established that the practice enthusiasm of students is not high, and that the practice quality has declined over time. The students are usually full of inquisitiveness and expectation of the factory practice when mobilized before departure. Nonetheless, their enthusiasm goes down in varying levels after the first day of internship, which is caused by (a) work efficiency and safety considerations that lead to less communication and interaction with other factory workers as well as less hands-on opportunities; (b) non-photographing of technical information of secret places that lead to low enthusiasm among the students, thus their practical reports are downloaded from the Internet, among other information. The authors of this paper agree with YUAN's opinion that the emotions of students will change during the productive practice. However, according to the previous observation, the authors endeavor to suggest an assumption that this change do not just decline but undulation with time. This is because students experience various changes of living environment and learning styles, which may bring about their emotional fluctuations.

Other relevant researches have affirmed that the emotional undulation of students can exert influences on their academic achievements. Many scholars who study the related field have built and adopted the theoretical models, including control-value theory [8,9]and structural equation model[10]. They have used the Achievement Emotions Questionnaire[11] in investigating, testing and explaining how the students' emotional changes influence their academic achievements. These scholars' results point out that: positive emotions have positive influence on students' academic achievements whereas negative emotions have negative effects; the academic emotions can forecast school-work achievements; the positive academic emotions can positively predict academic achievements while the negative emotions can directly and negatively predict the achievements.

By analyzing the prior literatures, it is noticeable that these researches mentioned above are mostly carried out from the macroscopic perspective. However, they lack in the field of influence exerted by the emotional fluctuations of undergraduates in the specific studying process to the effectiveness of study. Still, these researches and their results can provide the basis of assumption and precondition support. In view of the assumption that the students' emotions will undulate during the practice, and considering the predecessors' research results that emotions have influence on the students' academic achievements and can predict the achievements, the authors argue that the undergraduate students are the principal part of

productive practice. Thus, the emotional fluctuation of students is regarded as one of the important subjective factors that influence the effectiveness of productive practice. This paper will, therefore, collect daily emotional words of undergraduate students during the process of productive practice, describe and test the fluctuations of the students' mood by curves reflected by these emotional vocabularies, analyze the corresponding causes of these observed aspects through practice arrangements, practice diaries and interviews, and aim at making appropriate recommendations to strengthen the factors that result in positive mood but weaken the factors that lead to negative mood so that productive practice could be improved.

Methodology

A total number of 63 undergraduate students from an engineering major of a typical technical and engineering university, who enrolled in 2011 and participated in the productive practice in 2014, have been selected as the research sample. The productive practice conducted in the summer vacation at the end of the 6^{th} semester was composed of off-campus internship and on-campus internship. In the off-campus practice, 63 students were divided into two teams respectively into two different cities.

Table 1 Arrangements and Contents of Productive Practice

City	Place	Days	Contents	Amount
City A Team A	Place 1	5	visit workshops, laboratories and other sites, listen to special lectures	30
	Place 2	5	visit workshops, laboratories and other sites, listen to special lectures	
City B Team B	Place 1	8	visit workshops, laboratories and other sites, listen to special lectures, participate in alumni exchange meetings, group workshop internship	33
	Place 2	2	visit workshops, laboratories and other sites, listen to special lectures	
Beijing	on-campus	2	listen to special lectures	63
		3	oral defense, complete the summary reports	

Productive practice guidelines containing practice sites introductions, arrangements, contents, issue lists and daily feedbacks were specially designed for every student. In the feedback part, there was a standard A4 sheet of paper with horizontal lines used in recording the daily practice logs of each student. To acquire timely and accurate practice situation and result, all the students were required to handwrite practice diary every evening after supper, and to underline three vocabularies referring to their daily mentality, emotions and feelings at the bottom of the paper. Lead teachers were assigned to check the feedback records at ten o'clock every night. After 12 days, a total of 2,268 relevant words were collected. Except for the non-emotional vocabularies, 2,001 vocabularies that are beneficial to the research were extracted, accounting for 88.2% with efficiency. These collected terms were referred as the emotional vocabularies. They were, then, sub-divided into two contrary parts: the positive emotional words and the negative emotional words. Accordingly, the positive emotional vocabularies included curious, expecting, delighted, happy, interesting, inspired, surprising,

comfortable, exciting, impressed, proud, grateful, satisfactory, adaptive, confident, enriched, and well-informed, and so on. The negative emotional vocabularies included tired, fatigue, boring, confused, nervous, agitated, regretful, inanimate, monotonous, whiny, exhausted, and a waste-of-time, among others.

Using descriptive indexes (frequency, percentage), the positive emotional words and negative emotional words were analyzed. With the frequency as the ordinate, practice time as abscissa, emotion changing curves have been drawn.

The interview method was adopted to deeply and thoroughly study the causes of students' emotional changes. After reading and analyzing all the emotional words, this paper arranged the interviews on the emotional fluctuations that were reflected by the curves and the difference between the two teams; with one teacher from every practice team as well as two selected students from every team. Through questioning the overall evaluation of productive practice and students' performance, the experience and feelings of students in the whole practice process and in the "mood swing days (when most positive emotional vocabularies or most negative emotional vocabularies appeared)", and asking for suggestions for improving the effectiveness of productive internship, the entire process of the practice could be comprehensively understood. It could also aid in achieving a profound analysis on causes of students' cognitive changes as well as their psychological changes.

Results and Discussions

Engineering Undergraduates' Emotional Fluctuation during the Productive Practice

(1) Statistics and Analysis of All Emotional Words

According to the statistics of all the positive and negative emotional vocabularies generated during the productive practice period (as illustrated in Figure 1), this study discovered that the positive emotional words exceeded the negative emotional words in numbers. However, these two categories were conversely interconnected. On the first, third, fifth, seventh and tenth days, the students were in a positive mood, whereas on the second, fourth, sixth and ninth days, they were in a negative state.

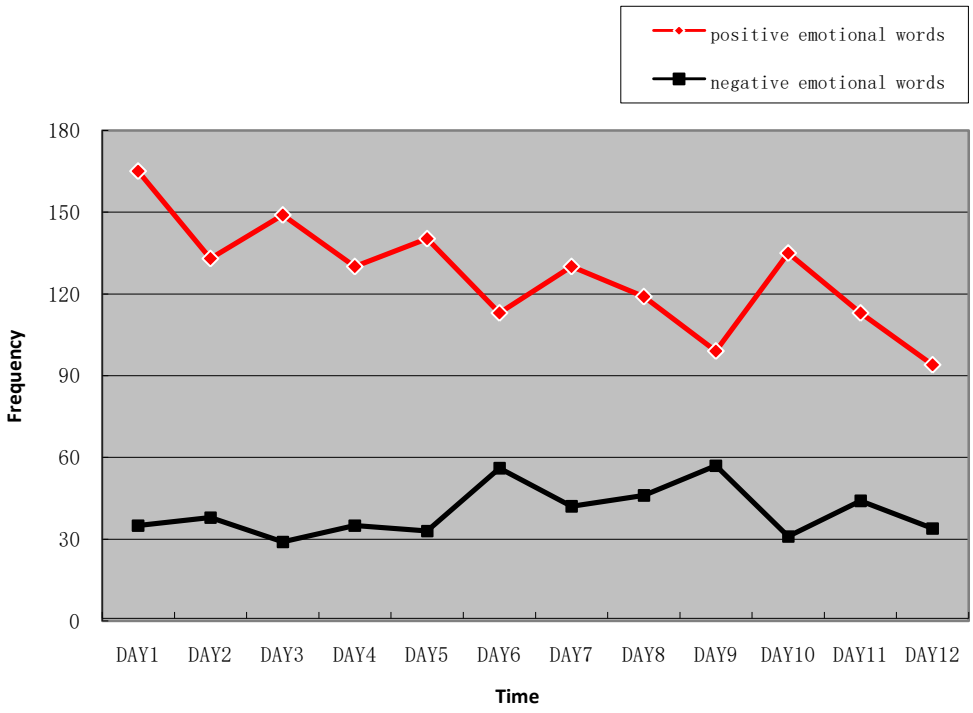


Figure 1: Frequency of All Students' Emotional Words during the Productive Practice

Comparison diagram (Figure 2) of Team A and Team B depicted that students from both teams were in a good emotional state on the first, third, fifth, seventh and tenth days, conforming with the overall indication. Specifically, on the first and third days of practice, students enjoyed the best conditions. Words, including expecting, curious and yearning tended to appear 50 times during the first day of practice, and words like happy, delighted and enjoying appeared 37 times. These vocabularies demonstrated that students embraced the practice mentally at the beginning of the productive practice. Whether viewed from the general perspective or individual conditions of the two teams, all the students were in a better state on the third day as well. This paper, by referring to the productive practice logs and schedules, found out that the visiting was permitted on the third day. Through visiting, students were able to catch plenty of material objects in sight and have more direct feelings. Due to this, the students tended to be on the high ropes and full of curiosity. According to the contents of the interviews, two teachers also agreed with the fact that visiting could help in grabbing attention of the students because the students liked visits, as compared with participating in seminars and alumni associations. Students tended to obviously display depressed emotions on the eleventh and twelfth days of the productive practice.

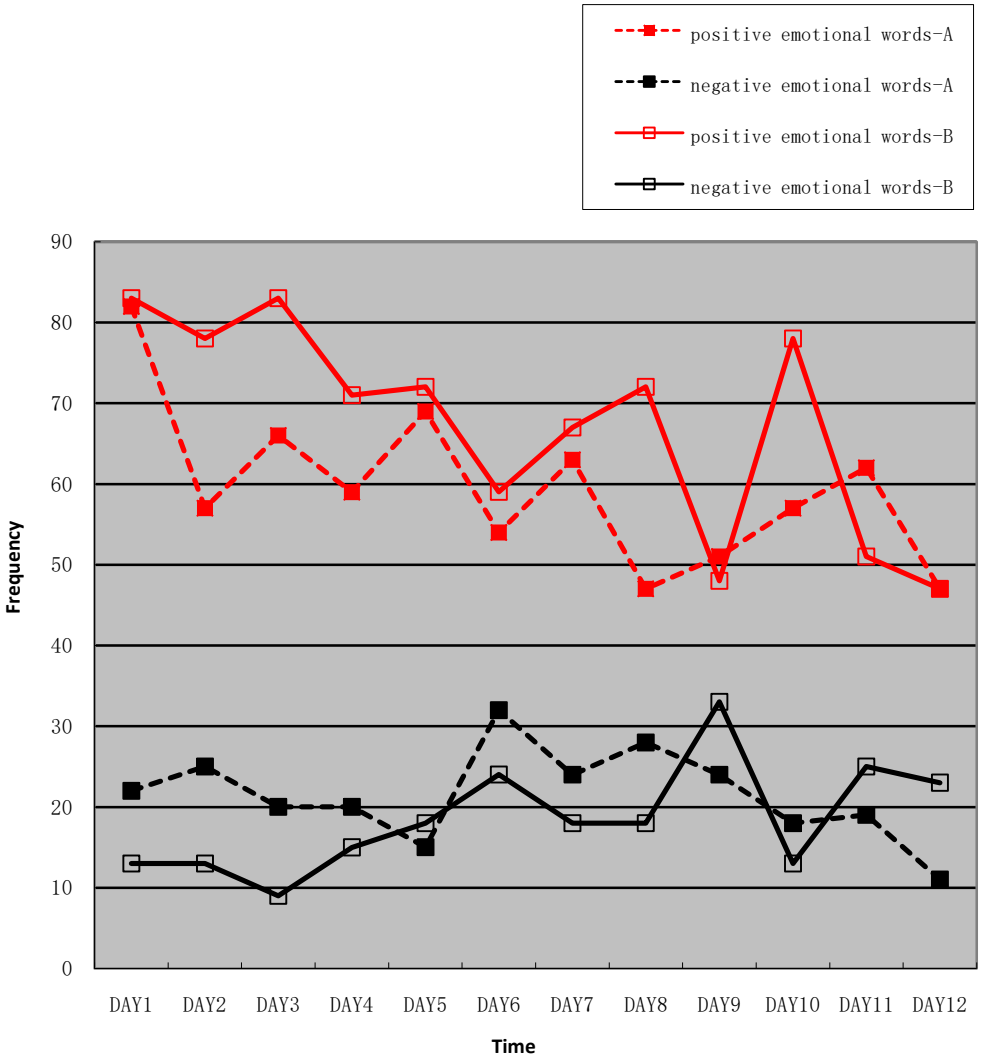
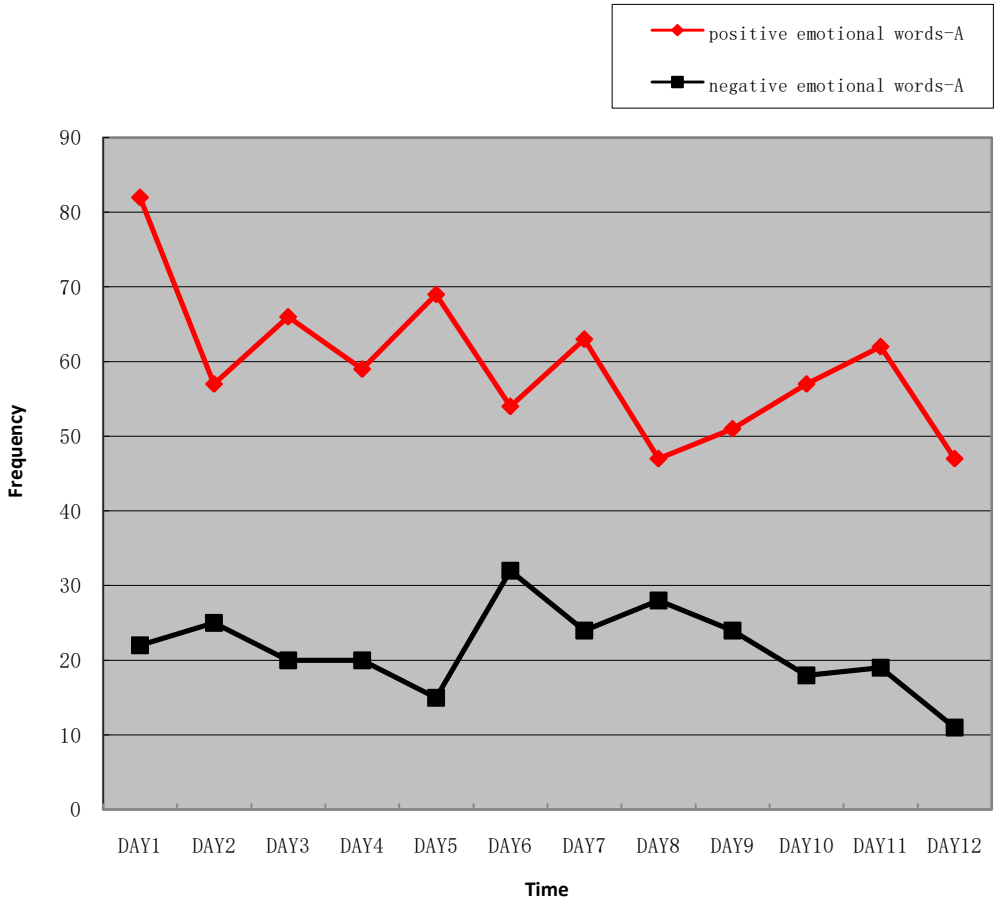


Figure 2: Comparison of Emotional Words Frequency on Each Day between the Two Teams

Undergraduates in Team A (as illustrated in Figure 3) showed positive status and condition on the fifth day apart from on the first and third days. They also tended to display an extremely negative status on the sixth day as well as on the eighth day. The word “fatigued” appeared 18 times on the sixth day, meaning that more than half of the students were in the mentioned state. As for Team B (as illustrated in Figure 4), the positive emotional vocabularies appeared more frequently as compared with Team A in the first eight days. This indicated that the entire status of students in Team B was better than that of students in Team A. However, this team reached its low on the ninth day. Afterwards, on the tenth day, the status was reversely promoted to an emotional peak. The specific reasons for the peak shall be introduced and discussed in the following interviews. Viewed from a general perspective, students mostly reached the fatigued period after half of the productive practice was conducted. The tired and exhausted feelings might be physically and mentally displayed among the students.



DAY 1: positive--curious, yearning--feelings of freshness at the beginning

DAY 3: positive--happy, fruitful--the first visit after lectures of two consecutive days

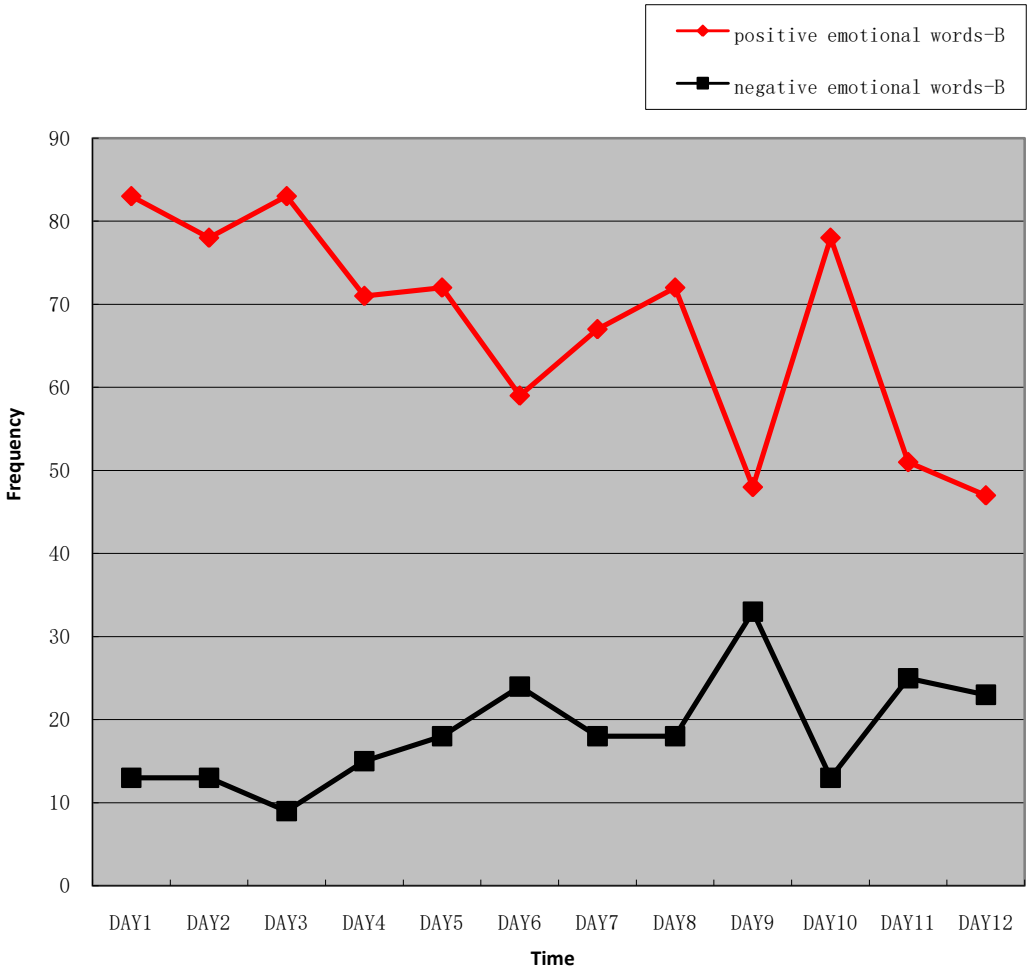
DAY 5: positive--happy, fruitful--the lecturer's rich experience, clear explanation and authority contributed to an active interaction

DAY 6: negative--fatigued--the house moving task and the defective living conditions

DAY 8: negative--hot, fatigued--hot weather, meals and transportations by self-settlement

DAY 11: positive--happy, impressed--because of the quite old lecturer worthy of respect

Figure 3: Frequency of Emotional Words on Each Day in Team A



DAY1: positive--curious, yearning--feelings of freshness at the beginning

DAY3: positive--happy, fruitful--the first visit after lectures of two consecutive days

DAY6: negative--fatigued--entered the fatigued period after half of the practice was conducted

DAY 8: positive--happy, shocked--visited a test bed, observed the ignition testy; had a recruitment and employment session; participated in alumni exchange meetings

DAY9: negative--fatigued, disappointed--visited a test station with three–hour driving; poor conditions and visiting contents;

DAY10: positive--happy, fruitful--visited the workshop and test cabinet in the headquarters all day

Figure 4: Frequency of Emotional Words on Each Day in Team B

(2) Statistics and Analysis of Emotional Words Appearing with the Highest Frequency on Each day

To carry out the overall analysis of undergraduate students' emotional and psychological changes during the productive practice, this paper achieved the statistics of students' emotional vocabularies with the maximum frequency in the period of the productive practice. For instance, 50 students stated the "curious" vocabularies, including curious, newness, expecting, among others. They also used 37 vocabularies concerning the meanings of "happy" and 26 vocabularies related to "harvest" on the first day. This paper merely achieved the statistics of the positive emotional vocabularies and negative emotional vocabularies with the

highest frequency on a daily basis as to effectively analyze the status of most students every day. As shown in Figure 5, about one third of students felt tired each day during the productive practice period, except for most students of Team A who felt extremely bad on the sixth day. Presumably, this trend was observed after the students went to the second place for practice with defective living conditions and house moving task. Most students in Team B also felt exhausted on the ninth day after taking a three-hour drive to the visiting site. Drawing from the interviews, the local conditions, weather conditions and arranged schedules had exerted certain influence on the results that students felt tired, exhausted and inanimate. Except for the students having negative feelings, half or more than half of them experienced favorable and positive feelings. In overall, students had an adequate condition and status for productive practice. However, there were less effective vocabularies in the on-campus practice. A majority of the students felt at ease and comfortable during the school practice because of the familiar conditions of the school, even though it was generally reflected that the special lectures in the on-campus practice were relatively boring.

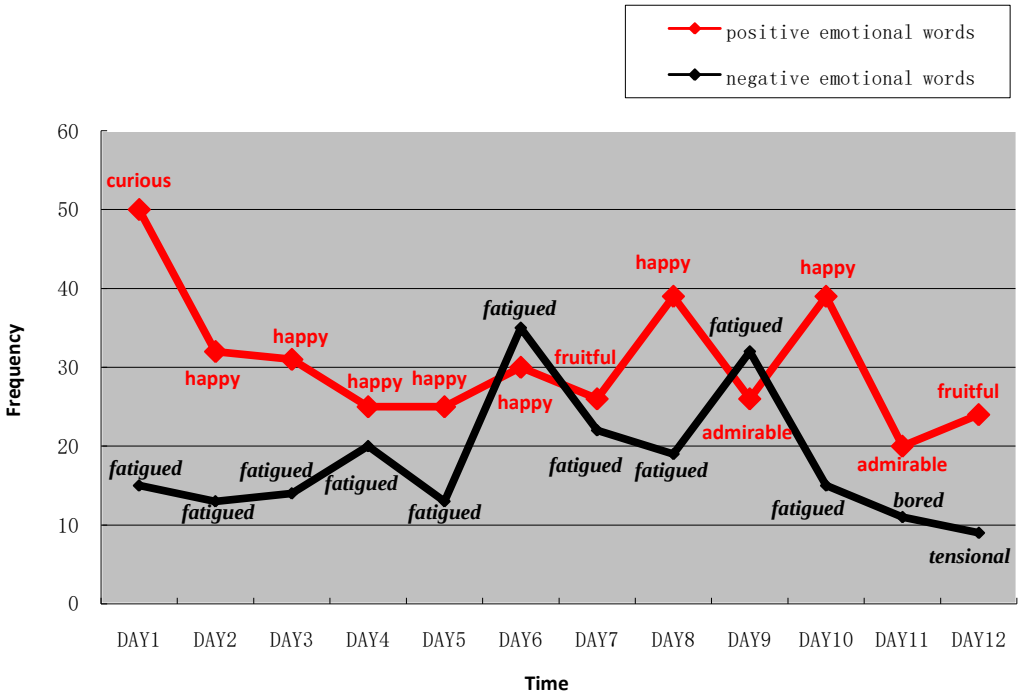


Figure 5: Frequency of Emotional Words Appearing with the Highest Frequency on Each day

Given the differences between the two teams in allocated times of each practice site and the external environments, this paper correspondingly drew the statistical diagrams of the most frequently observed emotional vocabularies during the productive practice for both of the teams. Through Figure 6 and Figure 7, the paper illustrated that students in Team A were in a worse status on the fourth, sixth and eleventh days of the practice. Likewise, students in Team B displayed the worse conditions on the sixth, ninth and eleventh day. As compared with Team A, Team B had more days wherein the quantity of positive emotional vocabularies exceeded 15 or 20. In addition, Team B had more days in which the quantity of negative emotional words was less than 10. Consequently, Team B had more days in terms of when the students were in a better state as compared with Team A, and had fewer days when the students were in a worse condition. In accordance with the contradistinctive statistics of all the emotional vocabularies of both teams during the productive practice (as illustrated in Figure 2.), the Team B's curve of positive emotional vocabularies was basically above Team A's curve, and likewise the negative emotional vocabularies curve of Team B was basically

under that of Team A except for the special days' data. All of the information mentioned above demonstrated that emotions of students in Team B were entirely better than those of students in Team A. Accordingly, the external environment and condition shall exert influence to the status of students in practice.

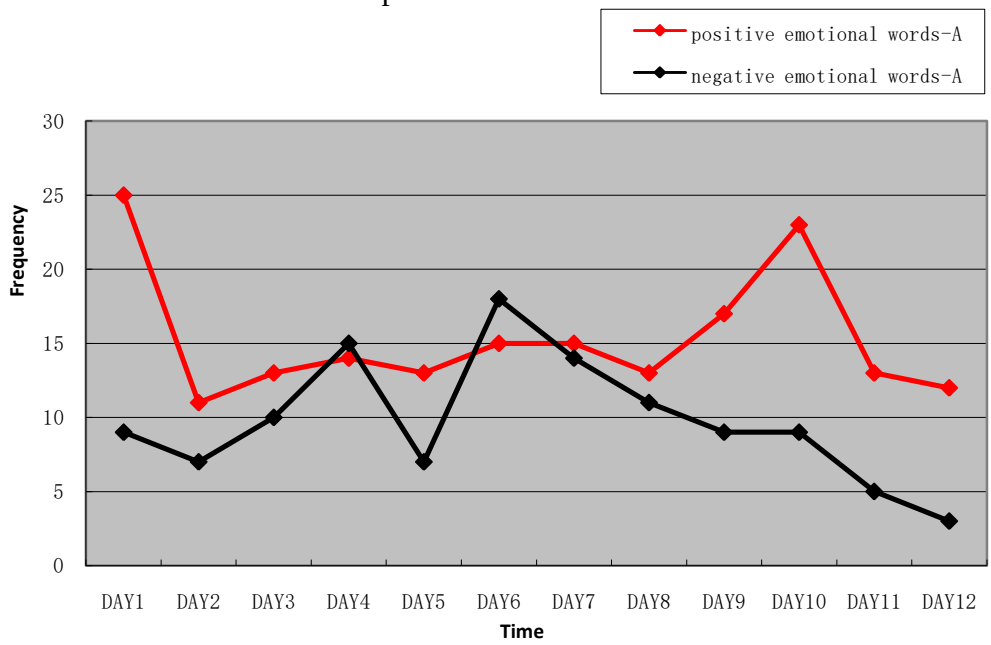


Figure 6: Frequency of Emotional Words Appearing with the Highest Frequency on Each day in Team A

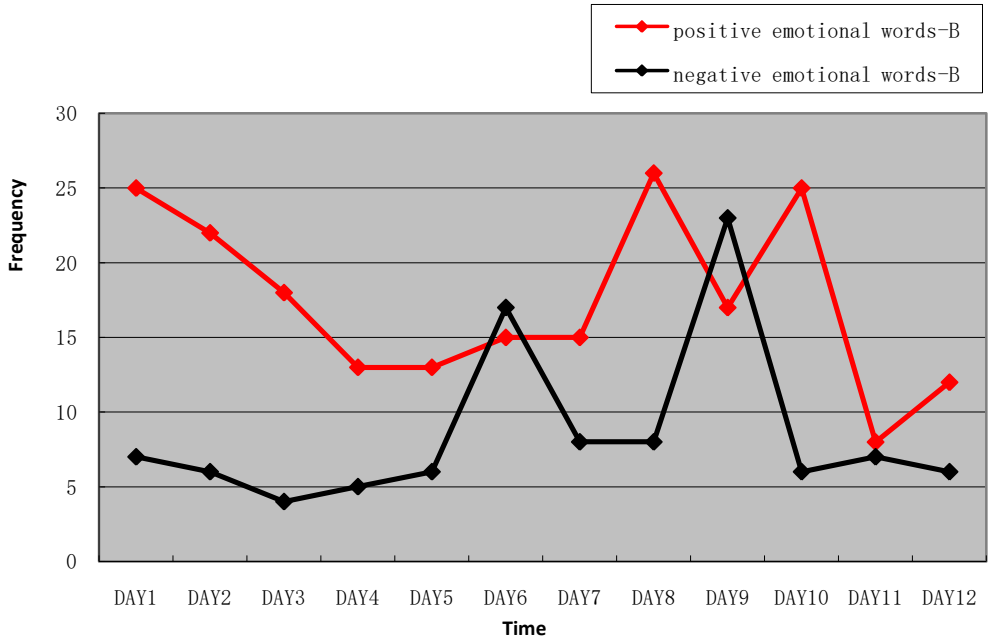


Figure 7: Frequency of Emotional Words Appearing with the Highest Frequency on Each day in Team B

Whether viewed from an individual perspective or from the overall perspective, except for when in a better or worse status, emotional states of students in both teams were relatively stable and sound. Nonetheless, this result shall be easily impacted by the external environment and conditions, practice forms and contents.

Causes of Emotional Fluctuation

The causes of students' emotional changes during the productive practice were specifically analyzed by integrating the students' practice logs, schedules as well as the contents of interviews. The causes were concluded in the following pages.

(1) Time factor was an objective reason for the students' emotional changes.

During the whole productive internship, on the first day, all the students showed freshness, curiosity, excitement and expectation in a good state. On the second day, they were in a declining state for lectures of two consecutive days. By the third day, they visited the site for the first time, with their moods and statuses at a high point. But as the productive practice developed gradually over time, they no longer felt fresh to the environment. For instance, on the eighth and ninth days, due to the familiar contents, physical and psychological exhaustion, they entered into the period of physical and psychological double fatigue and their statuses declined from stabilization. When they encountered a good lecture or visiting, their emotion rose to a higher point again, but when they encountered negative things and interactions, their emotions fell to a low point. In addition to these unpredictable occurrences and challenges, their emotions were more stable in other times, with slight changes according to the practice forms and contents. Overall, time factor was an objective reason for the students' emotional fluctuations in productive practice, showing some regularity.

(2) Practice contents and overall quality of lecturers were the main reasons for students' emotional changes.

This analysis based on the days with more positive emotional words for both Team A and Team B: the third day and the fifth day for both of the teams, the seventh day and eleventh day for Team A, as well as the eighth day and tenth day for Team B. This study revealed that the students were in a better mood basically because of visits which tended to stimulate more interests and emotions than special lectures and alumni exchanges. For instance, for both teams, different from the basic information introductions and special lectures on the first and second days, when students went on a visit on the third day, they expressed more intuitive feelings and harvest by seeing a lot of material objects. In this regard, they were in a good state with solid interests. On the eighth day, the students in Team B felt shocked for visiting a test station, and observing the ignition test run by monitoring. In the afternoon, an introduction to recruitment and policy closely related to future study and employment was conducted. This energized the students' interests. Furthermore, on the tenth day, the students from Team B were in a high mood because of the visit to the headquarters all day.

Moreover, due to the lecturer's rich experience, clear explanation and authority, students actively asked questions with good interaction, contributing to a good state. By conducting interviews with the leading teachers and reading students' diaries, it was indicated that the students in Team A were in a good mood on the fifth day because the lecturer performed extremely well. Many students also took down harvest and admiration to the lecturer in the practice diaries. In contrast, students generally revealed that a lot of off-campus practice lectures were boring, thus they were more likely to remain drowsy. Besides, lots of the students also felt that on-campus internship lectures were difficult to understand sometimes confusing. Students in Team A were in a slightly better state on the eleventh day than in the twelfth day because the lecturer on the eleventh day was quite old, thus many students were impressed.

Question：What do you think is the most favorable status of all students during the productive practice? Or which day do you remember as the day that all students were enthusiastic about the productive practice? (excerpts from the interview records)

Teacher in Team A: For example, there was an engineer giving a lecture on rocket. He had abundant practical experience and profound understanding of both the domestic and international situations. The speech he presented was clarified through integrated video analysis, various categories as well as through specific analysis in resolving practical problems. The engineer was kind and inclusive. He presented an authoritative and brilliant lecture. Students listening to the lecture were elevated mentally, and conducted an interactive questioning for over forty minutes. Thus, the question on whether students were motivated enough depended largely on the lecturer and contents. (excerpts from the interview records)

(3) Accommodation, route distance, weather and other external conditions would influence students' mood.

Through this analysis, it could be ascertained that the low mood among members in Team A and Team B for a few days was generally associated with accommodation, journey distance, weather and other external factors. For instance, undergraduate students in Team A experienced a bad state on the sixth day. This was because the hotel room conditions were relatively poor; three to four students per room. It was more crowded with inconvenient bathing and washing setups, and the rooms were also full of insects. Therefore, the students were extremely unsatisfied, thereby contributing to the negative mood. Team A students had negative emotions on the eighth day as well with fatigue and tiredness being epitome descriptions of their feelings. One-third of the students felt that it was too hot; hence they became tired during the visit and study. As illustrated in Figure 4, students in Team B were in a particularly poor state on the sixth day and ninth day, and especially on the ninth day. Through interviews and practice diaries, on the ninth day, the students were arranged to visit a certain test station with three – hour driving. Thus, they were generally exhausted. Getting to the destination, they found that the conditions were exceedingly poor and did not match their expectations. As a result, they were in an extremely bad state, with 27 (81.8%) of the students noting "tired" ,"lost" and other negative terms to describe their emotions.

Student in Team A： Every student got excited about the visits. Due to the bad weather conditions and physical fatigue, some students did not feel like walking further. The distance between the factories and the hotel was quite long. We got tired and were no longer enthusiastic about the contents of the lecture. (excerpts from the interview records)

Teacher in Team B: In the last two days, we had been to place C. It took more than 3 hours to arrive at the factory. Confidential information of visiting and the permitted period for visiting were also too limited for students to effectively acquire the intended knowledge. They were only allowed to visit the geological measurement site which they had already visited before. They felt absolutely disappointed and felt no harvest through this challenging trip. (excerpts from the interview records)

Students in Team B felt better than those in Team A in the entire productive practice. Through the interviews, the main reason was the dining, accommodation and traffic conditions for Team B being better than those for Team A. For instance, the dining and accommodation were arranged by the internship unit for Team B. It was double-bedded room

with air-conditioner and independent bathrooms as well as three meals provided freely by the internship cafeteria. Additionally, a special bus shuttle was provided for students from the unit to accommodation place. However, students in Team A lived in the hotel around the internship unit, and took care of their meals and transportations independently. Considering the costs, many students had worse dining and accommodation conditions, and had to take a bus or walk to the practice place.

Conclusions

As the necessary link of practical teaching process, productive practice aims at reducing the distance between theoretical study and practical operation. It enables students to feel the value and meaning of engineering practice more deeply, and enhances their hands-on operation abilities as well as their comprehensive practical abilities. According to the emotional words, changing curves and interviews, the realization degree of these goals is related to emotional volatility in a sense, and especially depends on the negative emotions which influence the effect of the productive practice. Through the presented analysis, we can draw out the factors that affect the students' emotion fluctuations, including the external environment and conditions, internship time arrangement, practice forms, internship contents, individual subjective initiative, and individual physique, among other aspects. The external environment and conditions, such as hot weather, long journey and tough conditions, have a great influence on the students' mood and state, which directly tends to affect the effectiveness of the practice.

The followings are recommendations for engineering productive practice reform based on the previous discussions and conclusions.

According to the law of emotional curves, it is definite that students have a physical and psychological fatigue period, even though this study fails to show whether the specific time is related to the major itself. Consequently, it is suggested that the psychological intervention ought to be added in the middle of the productive practice, with group counseling and mid-term inspections, among other practices, to remobilize the enthusiasm of students. This will help the students to quickly adjust.

The attracting levels of the forms and contents of productive internship will lead to students' emotional fluctuations. Generally, students are more interested in the visits as compared with lectures. However, the lecturers also play an important role in both the visits and the lectures. A good visit or an excellent lecture can still mobilize interests and promote positive emotions. It is, therefore, recommended for increasing the proportion of the visits, refining the visit contents, conducting explanation in the visit process, increasing hands-on contents as possible and adding job contents that students are interested in.

Students' practice effect and status can also be improved and promoted if the limited outlay shall not be over expended to optimize the productive practice conditions for the students. Particularly, accommodation and transportation conditions should be major concerns.

With the research on students' emotional state in the process of productive practice as the main line, the factors that affect emotional fluctuations which can strengthen the positive factors, weaken or eliminate the negative factors, and improve the effect of productive practice are concretely analyzed. This study is mainly based on the daily emotional vocabularies of the students as well as on the interviews conducted with the teachers and

students. In the future, psychological teachers can be further assigned to the practice team to record students' emotional changes on-site at any time, with more in-depth exploration of the emotional fluctuation and its causes as well as timely intervention. This will be helpful to achieve goals of the productive practice.

In addition, it is relatable that the general situation of engineering profession may not be represented well due to the small sample size and due to the fact that only a single major was considered in the study. Hence, the scope of study objects is expected to be further expanded. Moreover, productive practice, cognition practice, graduation practice, curriculum design and graduation project are all crucial components of the practical teaching process in engineering universities. In the future, researches on emotional fluctuations in other types of engineering practical ability enhancements and comparisons among them could be carried out.

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