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Extraction of learning point by visualization of skill

Shihoko Kamisato*, Yukihiro Mori*, Nobuhiro Yamashiro*, Kentaro Noguchi* and Yoshiteru Ishida**

*Information and comunication technology
Okinawa national college of technology
Nago 905-2192 Japan

**Department of Knowledge-Based Information Engineering
Toyohashi University of technology.
Toyohashi 441-8580 Japan

*(Tel : 81-980-55-4145) **
(Email: kamisato@okinawa-ct.ac.jp, ac104610@edu.okinawa-ct.ac.jp) (Email:ishida@cs.tut.ac.jp) ***
*(Email: ac094609@edu.okinawa-ct.ac.jp,knoguchi@okinawa-ct.ac.jp) **

Abstract: Experiments are a valuable tool in reinforcing important concepts in engineering students. In prece dence research, we considered the technical skill education imparted during engineering experiments and analy ze eye and arm movements of the teachers and students in the experiments. Purpose of this research is impro vement of engineering experiment by visualization of skills. We visualized the teaching materials movie of the teacher and student. Furthermore, it made clear a weak point of engineering experiment using principal comp onent analysis and protocol analysis. As a result it was able to make sure of having weak point consciousnes s with default setting of device and relation of connection of device.

Keywords: visualization, skill, experiments education, learning point, principal component analysis, protocol analysis.

I. INTRODUCTION

Experiments are a valuable tool in reinforcing important concepts in engineering students. Numerous trials for improvement of engineering experiment and training by linking experiment method with lectures are documented in literature [1]-[3]. There are some students who get the knack of experiment, but on the other hand there are many students who cannot get it. A student getting the knack of experiment arranges measuring device simply and understands the operation in a short time. But for most students the arrangement of measuring device is chaotic and moreover they need to get used to its operation. In precedence research, we considered the technical skill education imparted during engineering experiments and analyze eye and arm movements of the teachers and students in the experiments[4]-[6]. As a result the sign parameter was derived. The first was consciousness of experiment time. The second was the operation of experiment device. The third understand of experiment step [7]. Previously these parameters were not take into consideration in experimental education, however our research strongly supports inclusion of these parameter in improvement of educate method.

But a weak point of a student is not clear, and it is not the experiment improvement which considered it. Purpose of this research is improvement of engineering experiment by visualization of skills. We visualize the teaching materials movie of the teacher and student. Furthermore, it makes clear a weak point of engineering experiment using principal component analysis and protocol analysis.

II. VISUALIZATION OF VIEW TRANSITION

At first we did visualization of a point of student experiment for experiment improvement. The experiment intended for ten students and a teacher. Subject experiments using view camera and records view image. Using this image, it did visualization by showing stationary time and view transition of subject by directed graph. We compare a student with a teacher using the result and make clear the difference. A theme of experiment is electric instrument error measurement. Fig.1 shows the experiment conditions. Node of graph shows stationary time of a gaze point. An edge represents direction and number of times of view transition. It shows view transition graph of a teacher by fig.2. It shows view transition graph of a student by fig.3. As for the teacher, pattern along experiment procedures manual is found. For example, it makes sure with following step, measurement device → power

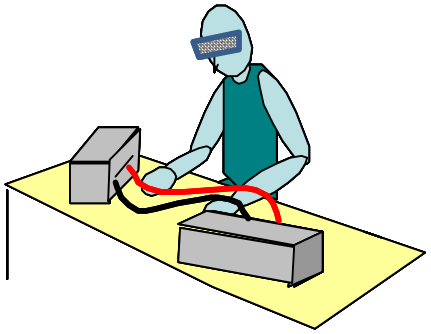
supply → measurement device → procedures text. On the other hand, as for the student, pattern is not established. In particular there is much movement to be useless in measurement device node neighborhood. On this account even if stationary time gets longer and compares a teacher, experiment time becomes long. From this thing, a weak point of a student understands that it is concerned with measurement device.

III. EXTRACTION OF WEAK POINTS

In this paper, it makes clear a weak point of a student in measurement experiment and reflects it in improvement.

1. Extraction by principal component analysis

In addition, we searched whether a student was conscious of a weak point. In addition, we searched whether a student was conscious of a weak point. Using questionnaire for experiment, it did self-evaluating about element of experiment such as wiring or operation of device. Table 1 shows abbreviation to use by question item and this report of questionnaire. The experiment of 8 themes was analyzed using principal component analysis.



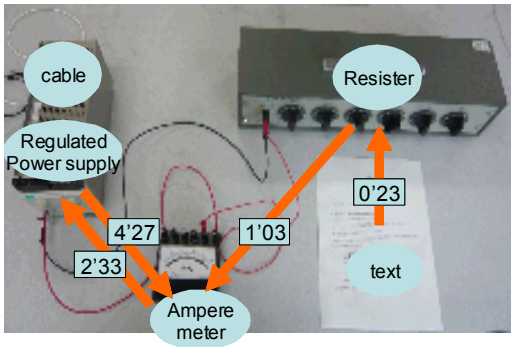


Fig.1 The condition of experiment

Table 1. Question item and symbol

Question	symbol
Experiment time	T
Preparations for lessons of experiment	P
Reconfirmation of text	R
Electric wiring of experiment	W
Operation of device	M
Understanding of principal	U
Understanding of text description	Tx
part	

Figure 4 shows contribution ratio of each principal component. In this research, it paid attention to it to the fourth principal component. In this research, we paid attention to the fourth principal component. Table 2 shows factor loading. The first principal component explains total 43%. In the first principal component, it is the point that electric wiring and operation device are watched by with interest.

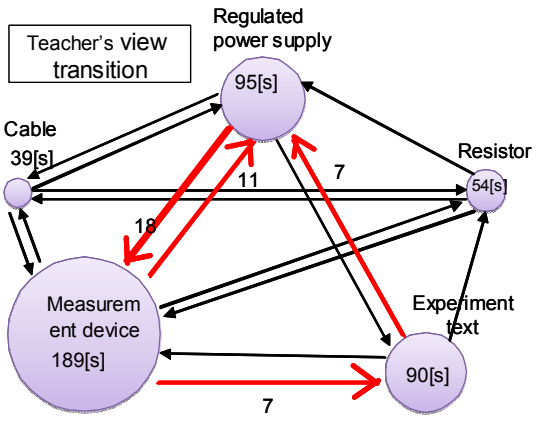


Fig. 2 Transition graph of a teacher

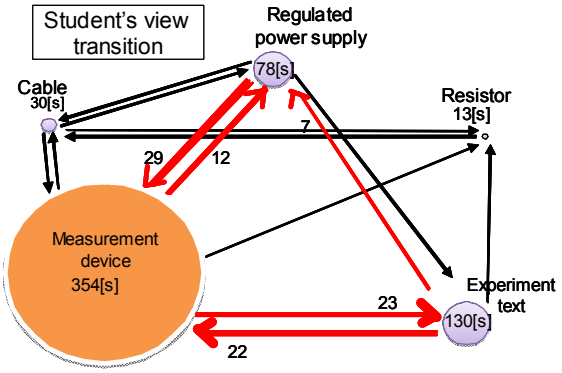


Fig. 3 Transition graph of a student

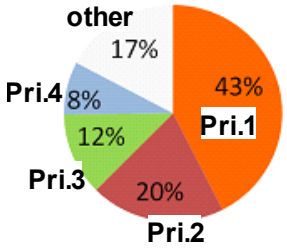


Fig. 4 Contribution ratio of each principal component

Table 2. Factor loading of principal component

Item / principal	Pri.1	Pri.2	Pri.3	Pri.4
Experiment time	-0.09	0.14	-0.09	-0.03
Preparations	-0.13	0.36	-0.39	0.78
Re-verification of text	-0.09	-0.76	-0.34	0.42
Electric wiring	-0.69	-0.31	-0.01	-0.13
Operation of device	-0.64	-0.17	0.06	0.16
Understanding of principal	-0.12	0.17	-0.07	-0.13
Understanding of text description	-0.27	0.81	0.57	-0.23

As a result it shows that there is difference whether a student is weak with it. From this thing, it is suggested by improvement of experiment that we should focus our attention on device operation and electric wiring. It was important that understanding of text was the fourth principal component from the second. It was related with reconfirmation of text. As a result of experiment, there is not good judgment with a little knowledge and experience at once. Therefore we think that device operation, electric wiring and text appear as the element which it is important of experiment.

2. Extraction by protocol analysis

Device operation and electric wiring understood the thing that it was important in improvement from view transition and result of principal component analysis. But concrete weak point and remedy are not clear. However, we cannot make clear a concrete weak points and remedies. Furthermore, detailed analysis becomes necessary. There we use protocol analysis in order to specify weak point in experiment. Protocol is a gesture in an action of subject and record of speech production. Analysis of protocol is used for a problem point in action and detection of the cause. It considers cause with the frequency. By this report, it classed the speech production protocol which it acquired.

Table 3. Job and abbreviation

job	abbreviation
Reads text	TXT
Electric wiring	WC
Device operation	SET
Record	REC
Reading of value	GM / TES

The speech production protocol was classed in action instructions, situation instructions and self speech production. The subject intended for five students of a beginner. It recorded a condition of the experiment which measured each subject. Subject sent own action in experiment on a voice and explained it. The analysis divided it into 22 steps as it was shown experiment to procedures text. Each step paid attention to it by the number of protocol manifestation. It shows abbreviation and job in table 3. It shows association of activity abbreviation and description representing step in table 3. As the situation which represented a weak point of experiment, it examined two situations. One is the situation which self speech production increases. The others are the situation that productive time gets longer. On these points, we take it as a weak point of subject. Fig.5 shows the thing which counted number of self speech production every step. This is average of five subjects. In the job that manifestation of protocol is found, a big thing of value is SET 1, WC1 and TES3. Furthermore, it shows the productive time which each step took by fig.6. This is difference of productive time of a student and a teacher by each step. This calculates average every step.

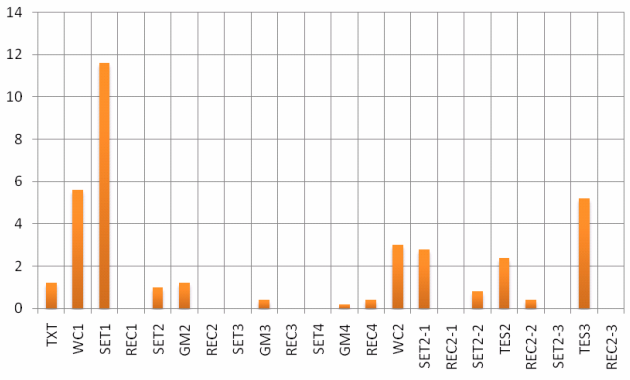


Fig. 5 The number of speech production every step

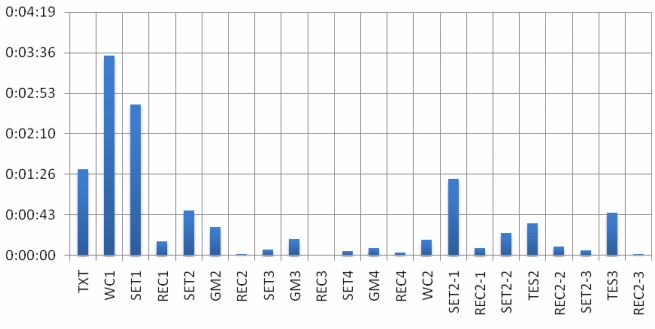


Fig. 6 Difference of productive time of a student and a teacher by each step

Work having difference of time is SET 1 and WC1. As a result it can suppose that the first electric wiring and instrument setup is the job which is a weak point with a lot of subject.

3. Consideration about learning point

We specified a weak point of a student. But it has to look for concrete cause for improvement. We focused our attention on protocol in electric wiring job of subject. At first, as for the confirmed weak point, speech production explaining relation of connection of device is not found. The second draws up circuit with layout completely the same as circuit diagram. The third identifies circuit diagram every one place of electric wiring. In the subject that electric wiring was not a weak point, the speech production which explained relation of connection was found. In addition, the circuit which it drew up was not the same as layout of circuit diagram. As a result they suggest that they use circuit diagram in order to make sure of relation of connection. This inclination was not found in case of weak point electric wiring. To the student who is inexperienced in experiment, it is important that confirmation of device connection. Furthermore, when learning effects rise by supporting it on default setting of device, it is expected.

IV. CONCLUSION

Purpose of this research is improvement of engineering experiment by visualization of skills. We visualized the teaching materials movie of the teacher and student. Furthermore, we identified a weak point of a student using principal component analysis protocol analysis. As a result it was supposed that the first electric wiring was the job which was a weak point with a lot of subject. In particular inclination was found to the student who was inexperienced in experiment. Necessity to support the weak point by learning before the fact was suggested.

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