# Raising Student Awareness in a Test Centered Environment

Yuko Shigeta*, Takumi Ogawa, Yoshiharu Nakamura, Rio Hirabayashi, Eriko Ando, Tomoko Ikawa and Shinya Hirai

*Department of Fixed Prosthodontics, School of Dental Medicine, Tsurumi University, Yokohama, Japan*

## Abstract

The purpose of this present study was to improve student knowledge on the semi-adjustable articulator. Following from the insights provided by Ryan and Deci's review of Organismic Integration Theory (OIT), we attempted to promote student interest in the semi-adjustable articulator. OIT was also utilized to provide guidance in assessing student motivation and its relation between the degree of student knowledge/interest. Finally, the study also aimed at establishing a rationale to evaluate and further develop our classroom practices at the institute. Through this process for raising student awareness, it was suggested that to observe the FGPs was useful to recognize the utility of a semi-adjustable articulator when a bridge at the molar region is made. Moreover, it was suggested that the student motivation helped promote their understanding. This highlights the need to support student motivation in our classroom. Finally, future studies on how professors perceive bureaucratic pressures from Ministry of Health, Labor and Welfare (MHLW) and within the institute could add additional insights to improving our educational practices in the classroom.

**Keywords:** Student awareness; Student motivation; Semi-adjustable articulator; Self-determination Theory; Organismic integration theory

## Introduction

Previous studies [1] report that any restoration provided should not interfere with mandibular function, transmit excessive force to the attachment apparatus or the temporomandibular joint, either in the intercuspal or eccentric jaw positions. However, the non-adjustable articulator mainly simulates the hinge motion of the mandible, holding the casts in centric relation. Thus, the occlusal inaccuracies produced by this type of instrument may have to be corrected intra-orally. This takes valuable chair time and the final restoration can be less than optimal [2]. Moreover, despite these corrective efforts, many inaccuracies are likely to remain unrecognized. These overlooked occlusal interferences can produce pathologic conditions, ranging from destruction of teeth and supporting structures and/or TMJ disturbances [2].

Hobo et al. [3] suggested an approach that avoids these setbacks. In their study, they described how multiple restorations (or FPD's) can be fabricated on a semi-adjustable articulator and a face-bow transfer, which minimizes tooth hinge axis errors. This is an approach further supported in British dental textbooks [4], which recommend the use of semi-or fully adjustable articulators for FDP fabrication. Accordingly, in 2008, the semi-adjustable articulator was introduced into our model training for undergraduate students. However, despite reviewing it in class, results from class and board exams indicated that student knowledge on the semi-adjustable articulator had not improved.

The purpose of this present study was to improve student knowledge on the semi-adjustable articulator. Following from the insights provided by Ryan and Deci's review of Organismic Integration Theory (OIT) [5], we attempted to promote student interest in the semi-adjustable articulator. OIT was also utilized to assess student motivation and its relation between the degree of student knowledge/interest. Finally, the study also aimed at establishing a rationale to evaluate and further develop our classroom practices at the institute.

## Theory overview

OIT is a sub-theory within the Self-Determination Theory (SDT) framework. SDT is comprised of five mini-theories, each of which addresses a particular aspect of motivation. As OIT specifically focuses on how extrinsically motivated behavior can shift from being externally regulated to being directed by a more autonomous form of extrinsic motivation [5], we felt it was a suitable for the classroom.

In its classification of extrinsic motivation, OIT outlines four forms along a continuum. Moving along this continuum from left to right, comparative levels of self-determination and autonomy increase [6]. This is a significant. We are more likely to internalize an extrinsic motive when it is experienced as autonomous. This transforms it into an endorsed value [7]. Furthermore, autonomous forms of extrinsic motivation render behaviors that are more robust [5].

These more autonomous extrinsic motivation forms are classified in OIT as identified regulation and *integrated regulation* [5]. An identified regulation reflects an individual's deliberate decision to adopt a goal or behavior because they recognize it as personally important [8]. An integrated regulation occurs once the regulatory process is assimilated into the individual's sense of self [5]. This latter form is the most autonomous type of extrinsic motivation and is experienced as fully self-determined [5]. While it shares similarities to intrinsic motivation, as Deci et al. [8] state,"…intrinsic motivation is characterized by interest in the activity itself, whereas integrated regulation is characterized by the activity's being personally important for a valued outcome". Hence student behavior that has developed into an integrated regulation is performed because it is perceived as part of what they are and, for that reason, that behavior is maintained. On the contrary, student behaviors tied to intrinsic reasons are performed for their enjoyment and stimulation [5].

Conversely, when extrinsic motivation is experienced as controlling, it impedes the internalization of the extrinsic motive [7,9].

**Corresponding author:** Yuko Shigeta, Department of Fixed Prosthodontics, School of Dental Medicine, Tsurumi University, Yokohama, Japan, Tel: +81455808417; Fax: +81455739599; Email: shigeta-y@tsurumi-u.ac.jp

OIT classifies this impoverished level of internalization as externally regulated and introjected regulation.

Behaviors associated with the least autonomy are referred to as externally regulated behaviors [5], and are experienced with a sense of pressure to act a certain way [10]. They are performed either to fulfill an external demand, to achieve a form of compensation, or to avoid negative consequences such as disapproval [5] Introjected regulation is the next non-autonomous form of extrinsic motivation, and describes actions motivated by pressures to seek out approval, from either the self or others, in order to sustain feelings of worth [5]. While this motivation form is internally driven, the individual is being regulated by concerns over how they are being evaluated. Thus, this motivation form does not render experiences that feel truly self-determined [11].

### Features of the classroom

Japan's board exam is called the National Exam for Dentists (NED), and is held in February. Candidates who fail must wait an entire year before retaking the NED. A unique feature of the NED is a section of 30 compulsory questions, in which examinees are required to answer 80 percent of them correctly. Within this section of the test is a distinctively demanding element, where either one or two mandatory questions must be answered correctly. If an examinee misses one of these mandatory questions, they will fail the entire test. Thus, it is possible for a student to fail the entire NED, regardless of their overall performance. Thus, the pressure to study is very intense. Moreover, the university has a vested interest that a sufficient pass rate is achieved.

Currently Japan's population is in decline. As of 2008, the number of openings for universities equaled the number of high school graduates [12]. Japanese universities have to compete to meet their enrolment numbers. In an effort to make our university more attractive to students, instructors are encouraged to try and raise the NED pass rate. Thus the NED attains further significance, as there is a concern that a decline in the pass rate could directly lead to a drop in institute enrollment. Subsequently, the selected textbooks are specifically designed to prepare students for the NED. To ensure sufficient coverage within course duration, instructors strictly adhere to the text. This is evident in classroom practice, where a priority is placed on rote memorization.

Pelletier, Seguin-Levesque, and Legault [13] observed that pressure could have an adverse effect on classroom practices. The more teachers perceived pressure (complying to the curriculum, with colleagues, and performance standards) the less self-determined and more controlling they became in their teaching. We speculate that a similar dynamic may exist in our institute, where there is an emphasis on NED pass rates.

### Justification for OIT

Since OIT defines specific traits that depict autonomy supportive environments, we felt it could direct our classroom practice. Reeve [14] identified particular behaviors associated with autonomy support. They included providing a meaningful rationale for a behavior, minimizing performance contingent rewards and punishments, providing opportunities for participation, and those in leadership positions acknowledging negative feelings associated with difficult tasks. Some additional features of autonomy supportive environments include the provision of informational feedback [15] and shared decision-making [16]. From this, we modified our classroom review of the semi-adjustable articulator accordingly:

- Variations in condylar angle influence the occlusal surface. Due to time constraints, students only get the opportunity to make a bridge at the prescribed condylar angle (30 degrees).

We suspected this limitation may negatively impact student comprehension, regarding the full range of the semi-adjustable articulator. Therefore, we demonstrated different guiding paths on an FGP table, at 0, 30, 60 degrees of the condylar path angles. Furthermore, we accompanied our explanation with slides, demonstrating how an incorrect condylar angle setting could cause interference.

- A second slide presentation demonstrated a variation of angles in dentros patients. In 1999, Tani et al. [17] investigated the sagittal condylar path angle in Japanese adults. The condylar path angle showed twin peaks from 41-45 degrees and from 26-30 degrees. The sagittal condylar path angle shows a wide range of variation in dentros adults. Following this, we emphasized the importance of measuring the condylar angle and setting the appropriate angle for each patient.

- At this point, we compared the two articulators. We admitted that while it was easier to use a non-adjustable articulator to make a prosthesis, it was not ideal for measuring jaw motion. The non-adjustable articulator mainly simulates the hinge motion of the mandible, holding the casts in centric relation. Occlusal inaccuracies produced by this type of instrument may be corrected intra-orally. This takes valuable chair time and the final restoration is less than optimal. Many inaccuracies, however, remain unrecognized and these remain as occlusal interferences which frequently produce pathologic conditions, ranging from destruction of teeth and supporting structures and/or TMJ disturbances.

- While these modifications may appear standard, the need for their inclusion indicates the extent classroom practice is autocratic in Japan. This tendency exists in secondary education as well, where priorities emphasize test performance [18,19]. While the underlying reasons for this merit further investigation, they exist beyond this paper's scope (for a more thorough review of education practices in Japan [20]). Nevertheless, despite their subtlety, we felt that these modifications would be sufficient.

## Subjects and Methods

The subjects were 108 fourth year undergraduate students in Tsurumi University.

The study model was mounted via face bow transfer. The sagittal condylar path angle was set with anterior check bite. The upper study model was then replaced with the working model, and a bridge was made on it.

A questionnaire on a semi-adjustable articulator was provided to the students during a wax-up, which asked them to self-evaluate their knowledge and interest in the semi-adjustable articulator (Table 1).

| S.no | Questions |
| --- | --- |
| 1 | How well do you understand the potential the semi-adjustable articulator? |
| 2 | How well do you understand the role of the facebow? |
| 3 | How well do you understand the influence the condylar path angle has on the occlusal surface? |
| 4 | How well do you understand the difference between a prosthesis made on average value and semi-adjustable articulator? |
| 5 | In the future, would you want to use a semi-adjustable articulator in your clinic? |

**Table 1:** Questionnaire about semi-adjustable articulator.

Three FGP tables were made on a die of the upper right first molar, while the working model was mounted on a semi-adjustable articulator (Pro Arch, Shofu Inc.) by students who had completed their class project ahead of schedule. The FGPs were recorded and observed, when the condylar path angle was set at 0, 30, and 60 degrees.

Approximately two months later, we explained these findings to all students. To evaluate student knowledge/interest, the same questionnaire was re-administered after explaining the influence of condylar angle to occlusal surface configuration.

The first questionnaire for knowledge/interest was conducted during the wax-up. Results revealed that student knowledge/interest was low. Therefore, approximately one month later, students received our modified version of the Learning Self-Regulation Questionnaire [21] (Table 2).

There were 3 groups of items, and those in each group pertained to the heading. Using a 7 point Likert scale, students indicated how true each reason statement was for them (Table 3).

## Statistical Analysis

Cronbach α was calculated to verify modified questionnaire reliability. Pearson's test was utilized to conduct a simple correlation between student knowledge/interest and the resultant score. Statistical significance was defined as $p < 0.05$. Statistical analysis was carried out with SPSS 12.0 (SPSS Inc., Chicago, USA).

## Results

### Prior to OIT intervention

**Sagittal condylar path angle:** The sagittal condylar path angle ranged from -3 to 60 degrees with an average angle of 33.0 ± 7.84 degrees (Figure 1). The used dentition model has 30 degrees on the



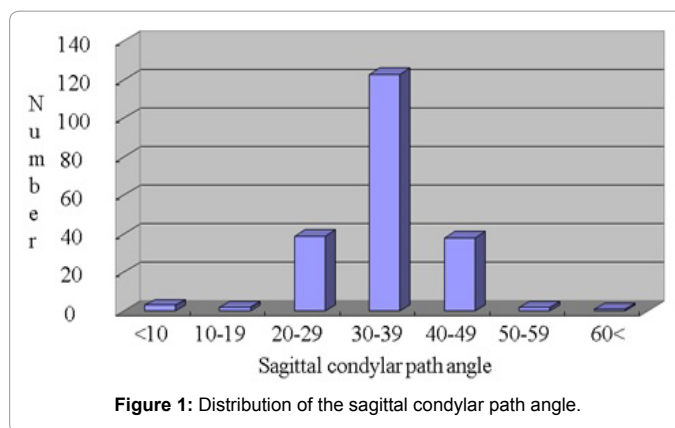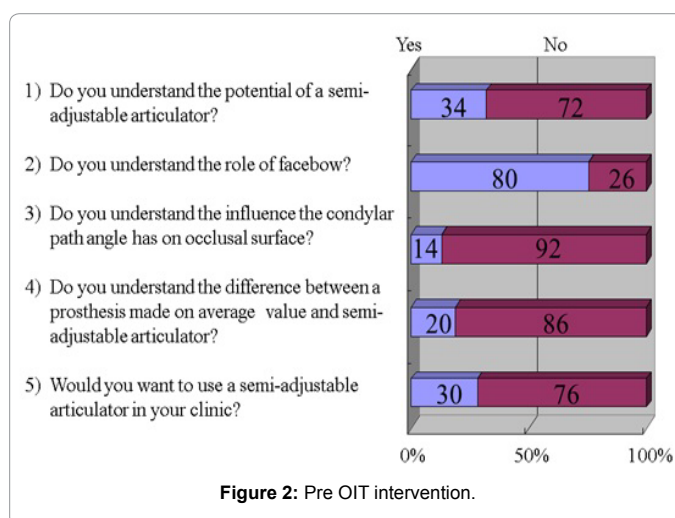**Figure 1:** Distribution of the sagittal condylar path angle.



**Figure 2:** Pre OIT intervention.

condylar angle. However, many students set an incorrect condylar angle. Thus, they needed an explanation on how the condylar angle influences occlusal surface. We based the condylar angle for simulation on the FGP table from this result.

**Degree of knowledge/interest for a semi-adjustable articulator before observing the FGPs:** Figure 2 shows the results of questionnaire on semi-adjustable articulators.

**Recorded FGPs:** Figure 3 shows the recorded FGPs when the condylar path angle was set at 0, 30, and 60 degrees. The distal-buccal cusp on the lower first molar passed between the mesial- and the distal-buccal cusp on the upper first molar in our model during lateral excursion. Using Figure 3b, we explained that to avoid cuspal interference, an appropriate condylar path angle must be provided at the intercuspal or eccentric jaw positions as well as during movement. In addition, we provided the data on condylar path angle in dentulous adults [22] to our students.

**Results of the re-administered questionnaire, post OIT influences on classroom:** Figure 4 shows the results of the re-administered questionnaire. Via observing FGPs, the knowledge/interest for semi-adjustable articulators improved.

**Verification and reliability of the modified learning self-regulation questionnaire:** The mean and standard deviation were calculated for each of the 14 items on the questionnaire. The ceiling effect and floor effect were investigated. From this data, we verified the

| | I am likely to utilize a semi-adjustable articulator: |
|---|---|
| 1 | Because I feel it's a good way to increase my skills. |
| 2 | Because others would think badly of me if I didn't. |
| 3 | Because learning to use a semi-adjustable articulator is an important part of becoming a good dentist. |
| 4 | Because I would feel bad about myself if I didn't study this approach. |
| | The difference between a prosthesis made on average value and a semi-adjustable articulator is significant: |
| 5 | Because I will get a bad grade if I don't follow what my teacher suggests. |
| 6 | Because my teacher seems to have insight on which articulator works best for the patient. |
| 7 | Because I am worried that I am not going to perform well in the class if I don't follow what my teacher suggests. |
| 9 | Because the semi-adjustable articulator would serve me well in the clinical setting. |
| | The reason I will use a semi-adjustable articulator in the future is |
| 10 | Because it's exciting to use such a promising device. |
| 11 | Because I would feel proud if I could become proficient at it. |
| 12 | Because it's a challenge to make a prosthetisis that is perfect for the patient. |
| 13 | Because it's interesting to use the semi-adjustable articulator to find out what the best path is. |
| 14 | Because I want patients to think that I am a good dentist. |
| 15 | Because I will get money if I use it. |

**Table 2:** Modified version of learning self-regulation questionnaire

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| not at all true | | | somewhat true | | | very true |

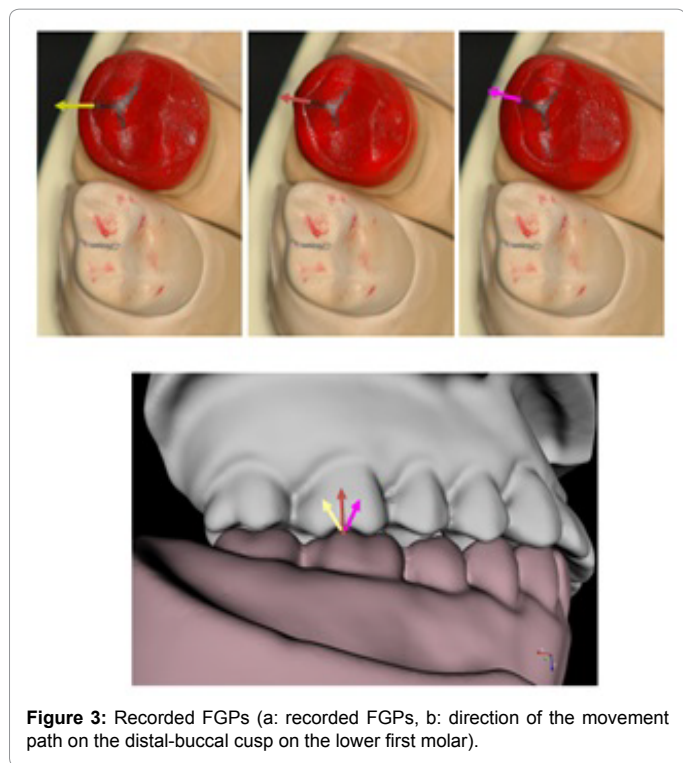**Table 3:** Seven point Likert scale.

**Figure 3:** Recorded FGPs (a: recorded FGPs, b: direction of the movement path on the distal-buccal cusp on the lower first molar).



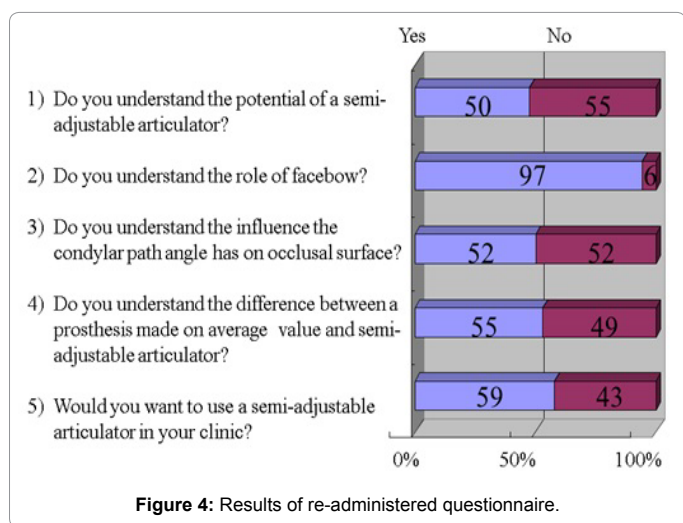**Figure 4:** Results of re-administered questionnaire.

|  | N | Frequency | Minimum | Maximum | Average | Standard Deviation | Ceiling effect |
|---|---|---|---|---|---|---|---|
| Gender | 106 | 1 | 2 | 1.49 | 0.502 | 1.99 | 0.99 |
| 1-a | 106 | 1 | 7 | 5.18 | 1.217 | 6.40 | 3.96 |
| 1-b | 106 | 1 | 7 | 3.26 | 1.658 | 4.92 | 1.61 |
| 1-c | 106 | 3 | 7 | 5.76 | 1.019 | 6.78 | 4.74 |
| 1-d | 106 | 1 | 7 | 2.78 | 1.621 | 4.40 | 1.16 |
| 2-a | 106 | 1 | 7 | 3.02 | 1.707 | 4.73 | 1.31 |
| 2-b | 106 | 1 | 7 | 5.35 | 1.360 | 6.71 | 3.99 |
| 2-c | 106 | 1 | 7 | 3.76 | 1.642 | 5.41 | 2.12 |
| 2-d | 106 | 2 | 7 | 5.25 | 1.196 | 6.45 | 4.06 |
| 3-a | 106 | 1 | 7 | 3.41 | 1.535 | 4.94 | 1.87 |
| 3-b | 106 | 1 | 7 | 4.37 | 1.623 | 5.99 | 2.74 |
| 3-c | 106 | 2 | 7 | 5.63 | 1.214 | 6.85 | 4.42 |
| 3-d | 106 | 1 | 7 | 5.42 | 1.211 | 6.64 | 4.21 |
| 3-e | 106 | 1 | 7 | 4.91 | 1.619 | 6.52 | 3.29 |
| 3-f | 106 | 1 | 7 | 3.00 | 1.568 | 4.57 | 1.43 |

**Table 4:** Evaluation of questionnaire reliability.

|  | Factors | |
|---|---|---|
|  | **1** | **2** |
| 3-c AUT | 0.828 | -0.066 |
| 1-a AUT | 0.787 | -0.056 |
| 2-d AUT | 0.738 | -0.030 |
| 1-c AUT | 0.700 | 0.008 |
| 3-d AUT | 0.594 | 0.002 |
| 1-b CON | -0.017 | 0.704 |
| 1-d CON | 0.047 | 0.698 |
| 3-f CON | -0.043 | 0.460 |
| 2-c CON | -0.067 | 0.460 |
| 3-b CON | 0.230 | 0.455 |
| 2-a CON | -0.246 | 0.449 |
| 3-e CON | 0.281 | 0.412 |

**Table 5a:** Factor analysis total variance explained.
AUT = Autonomous Regulation
CON = Controlled Regulation

| Factors | 1 | 2 |
|---|---|---|
| 1 | 1.000 | 0.318 |
| 2 | 0.318 | 1.000 |

**Table 5b:** Interfactor correlation matrix.

|  |  | AUT | CON |
|---|---|---|---|
| AUT | Pearson's product-moment correlation coefficient | 1 | 0.250 |
|  | Significance probability (two-sided test) |  | 0.009 |
| CON | Pearson's product-moment correlation coefficient | 0.250 | 1 |
|  | Significance probability (two-sided test) | 0.009 |  |

**Table 5c:** Coefficient correlation.

consistency of our questionnaire (Table 4).

Factor analysis was performed via Principal Factor Method. Variation of characteristic values were as follows: 4.21, 2.19, 1.46, and 1.15.

From this result and findings of scree plot, a 2 factor structure emerged which was appropriate for the data. Therefore, we performed factor analysis through Promax rotation of Principal Factor Method, with a 2 factor structure as the hypothesis (Figure 5). From this, 2 questions with no adequate factor loadings were removed. Subsequently, we repeated the analysis without these questions. Table 5a, 5b and 5c shows the factor patterns and correlation between the factors after rotation. Prior to rotation, statistical explanations of all variances in the 12 remaining questions were 49.86%, with 2 factor structure as hypothesis.

The first factor comprised of 5 questions; these questions implied either an identified or integrated regulation, indicating a more autonomous regulation form. The second factor comprised of 7 questions; these questions implied an introjected or an external regulation, indicating a more controlled regulation form.

The mean value of the 2 subscales for the questionnaire was calculated. The subscale score of the autonomous regulation form was 5.45 ± 0.93. The subscale score of the controlled regulation form was 3.59 ± 1.00. The α coefficient of both the subscales was calculated to investigate internal consistency. The calculated Cronbach α was as

**Figure 5:** Factors analysis (Principal factor method * promax rotations).
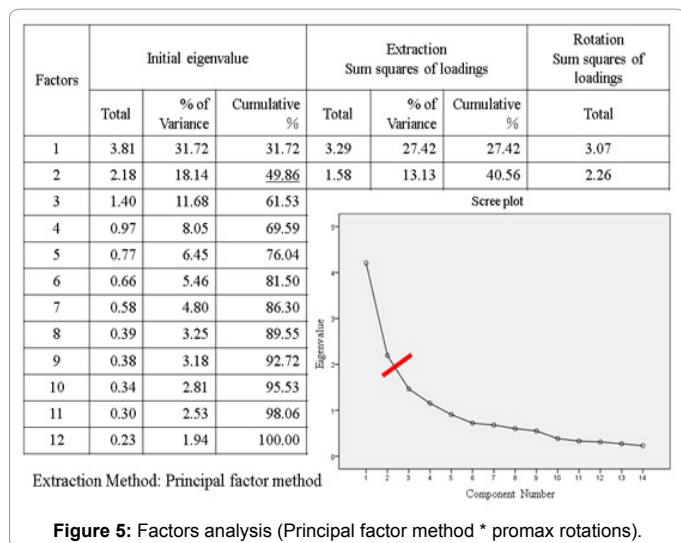
| | | Degree of knowledge/ interest | AUT | CON |
|---|---|---|---|---|
| Degree of knowledge/ interest | Pearson's product-moment correlation coefficient | 1 | 0.198 | 0.086 |
| | Significance probability (two-sided test) | | 0.042 | 0.382 |
| AUT | Pearson's product-moment correlation coefficient | 0.198 | 1 | 0.250 |
| | Significance probability (two-sided test) | 0.042 | | 0.010 |
| CON | Pearson's product-moment correlation coefficient | 0.086 | 0.250 | 1 |
| | Significance probability (two-sided test) | 0.382 | 0.010 | |

**Table 6:** Coefficient correlation.

follows; autonomous regulation form: α = 0.85, controlled regulation form: α = 0.73. There was a positive correlation between the 2 factors. The 2 factors coexisted in the same individual.

**Correlation between the answers of knowledge questionnaire and motivation forms:** The degree of knowledge/interest for semi-adjustable articulators was elevated in students who scored high in the autonomous regulation form (p = 0.04). This is consistent with previous research [19] (Table 6).

## Discussion

In class we showed recorded FGPs, explaining that dentulous adults have various condylar paths and that setting the appropriate angle for each patient is important. After observing these FGP findings, student awareness on semi-adjustable articulator improved. However, in the ensuing questionnaire, half of students indicated they did not fully understand the insights that a semi-adjustable articulator provided. Furthermore, exam scores demonstrated student knowledge/interest on semi-adjustable articulators was not high, in spite of having used it in class.

One of the reasons may be that our subject was a bridge at molar region, and our model had an average condylar path angle and cuspid protected occlusion. Therefore students might not recognize the utility of semi-adjustable articulators. Furthermore, it is possible that classroom practices did not promote student interest [9] and may have led to lower interest and poorer conceptual learning.

By adopting behaviors associated with autonomy support [14] into our classroom practice, we were better able to facilitate student knowledge/interest on semi-adjustable articulators via FGPs. Moreover, the theory highlighted our education program's shortcomings. Our experience thus far emphasizes certain aspects of classroom practice that we had neglected. Via SDT, we were better able to understand and positively impact student motivation. Through additional insights provided by SDT, we hope to further improve classroom practice so students might be more prepared for their clinic in the future.

## Conclusion

From these results, it was suggested that observing the FGPs was useful in recognizing the utility of semi-adjustable articulators when a bridge at the molar region is made. Moreover, it was suggested that student motivation helped promote their understanding. This highlights the need to support student motivation in our classroom.

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