

## Learning style preferences of preclinical medical students in a Malaysian university

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### Abstract

**Background:** Academic demands of medical students are quite high. They require several skills involving sensory components such as visual, auditory, reading-writing and kinesthetic modes. The academic performance naturally differs in students and depends on their study habits including the learning style. It is believed that self-confidence is the first requisite to great achievements.

**Objective:** We undertook this study to establish our hypothesis based on the assumption that students' self-confidence and academic performance are directly related and the differences in learning style of each student could influence the academic performance.

**Method:** To explore the pattern of preferred learning styles of 82 students, we administered the VARK questionnaire to the participants. To assess self-esteem, Rosenberg self-esteem questionnaire was used and the academic performance was based on the overall results of the formative assessments.

**Results:** Among the respondents, 84% preferred multimodal style of learning. Out of that, dual, trimodal and quadrimodal styles were preferred by 8.5%, 2.4% and 73.2% respectively. The remaining 16% of the students preferred single mode. Female students had more diverse learning style preferences with several VARK combinations. A large proportion of our students were in the average group in terms of self-confidence and academic performance.

**Conclusion:** Most students in this study preferred multimodal inputs in their learning process. Our study did not reveal any major gender differences in preferred learning styles. The results of self-esteem, learning style preference and academic performance did not have any bearing on each other.

**Keywords:** learning style, academic performance, self-confidence, VARK questionnaire

### Introduction

A learning style or preference is the complex manner in which learners most efficiently and most effectively perceive, process, store, and recall what they learn (James & Gardner, 1995). VARK, a guide to learning styles classifies learning preferences based on sensory modalities into four modes such as Visual (V) – seeing graphs, charts, flow diagrams, drawings, diagrams, pictures, colored word accents, demonstrations etc.; Auditory (A) – listening, interacting, discussing,

speech; Reading-writing (R) – textual contents, reading books, word lists, writings, handouts; and Kinesthetic (K) – physical touch, manipulating objects or materials. Students will have their own individual learning style preferences ranging from single preference (unimodal) to multiple (multimodal) preferences (Lujan & DiCarlo, 2006). Although, learners can use all of the four (V, A, R, K) sensory modes of learning, one mode is often dominant and preferred. A large body of literature also supports a gender-based preference in learning style in which males and females are unique.

Academic demands of medical students are rigorous since medical education involves a large volume of content and different ways of delivery of information and knowledge. Today's medical students are quite heterogeneous in terms of age, experience, culture, ethnicity, educational backgrounds and level of preparedness as well as learning preferences. Health professionals usually

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require several simultaneous skills involving sensory components such as visual (deciphering graphic content in research articles), auditory (listening to patients or clients), reading-writing (reading journal articles and keeping records), and kinesthetic (learning or performing physical examination and procedures). In that sense, an instructor's most important responsibility and challenge is to present information through a variety of teaching methods since teaching and student learning styles may affect student academic success. Therefore, faculty members must have content knowledge, pedagogical knowledge, and knowledge of the learner and his/her characteristics to be effective teachers (Gudmundsdottir & Shulman, 1987).

Academic performance of a student depends on study habits including the learning style (Latha et al., 2009). It is believed that self-confidence is the first requisite to great undertakings. Therefore judging and believing in one's ability (self-esteem and self-confidence) and academic performance may also be inter-related. Based on this assumption, students' self-confidence and academic performance are expected to be directly related. It is also true that the academic performance is different in students with different learning styles.

Thus, we were interested to evaluate the relationship between (i) learning style preference and academic performance (ii) the self-esteem/self-confidence and academic performance and (iii) the gender differences in learning style preference. On the basis of the hypotheses students with high self-confidence should do well academically and students with orientation for one particular learning preference may achieve different level of academic grade as compared to another student with a different learning style.

### **Materials and methods**

We, in the Faculty of Medicine and Health Sciences of the University Sultan Zainal Abidin (uniSZA), Kuala Terengganu, Malaysia, were interested in evaluating the preferred learning style of preclinical (year 1 and 2) medical students. This is in keeping with the view that we could design appropriate teaching modes in the future in accordance with the students learning styles that may help their academic performance. The medical program of the faculty follows an integrated system of teaching and learning during this phase. The teaching methods involved didactic lectures, small group teaching, laboratory exercise,

problem based learning, computer learning activities and self-directed learning. To achieve our first goal, we designed a descriptive study to explore the pattern of preferred learning styles of the students and administered the VARK questionnaire to the participants. We selected the VARK test due to its ease of use, wide distribution in the field of education and recent usage in studies of health profession students. VARK questionnaire is a 16-item, self-reported, multiple-choice questionnaire that can be completed online in about 10–15 minutes. VARK questionnaire is a freeware that can be accessed at <http://www.varklearn.com/English/page.asp?p=questionnaire> (Fleming, 2008). Students were allowed to choose multiple answers per item to adequately describe their preferred response(s) to the situations presented. The total number of student responses was tallied for each of the four sensory modalities (V, A, R, and K) and for all possible combinations of the modalities (e.g., VA, VRK, etc.). The scoring algorithm on the VARK website was applied to identify each student's modality preferences. The second objective was to assess self-esteem by administering Rosenberg self-esteem questionnaire (Rosenberg, 1989) to relate with academic performance that was based on the overall results of the formative assessments. The gender differences in learning styles was also analyzed from the data obtained.

Faculty research committee granted permission to conduct the study. Eighty two (28 male (34%); 54 female (66%)) students consented to participate as volunteers after we explained the purpose of the study.

### **Data analysis**

We report the VARK data as students having one (unimodal) learning preference (i.e., either V, A, R, or K) or multimodal (i.e., 2–4) learning preferences. According to the VARK instrument inventor (Fleming, 2008), a total of 23 combinations of learning styles (12 unimodal and 11 multimodal) are possible. But we considered only 15 styles in our study ignoring the mild, strong and very strong categories in unimodal learning styles (Table 1). Data are reported as percentage of students in each category of learning style preference. The number of students who preferred each mode of learning was divided by the total number of respondents to determine the percentage. We present the data for the whole group of students (total) as well as for male and female students separately.

Self-esteem was reported as poor, average, good and excellent based on the score from 0 to 30 expressed in percentage values. The self-esteem was considered correspondingly high when the score was high. Academic grades were also considered as poor to excellent based on overall performance in

several formative examinations. Correlation between self-esteem and academic grades was tested on each student by comparing the results of the two variables. The percent value of self-esteem and academic grade was considered better related only when the difference between the two was less than 5%.

*Table 1: Possible combinations of VARK modes*

| Single mode     | Multimode |         |            |
|-----------------|-----------|---------|------------|
|                 | Dual mode | Trimode | Quadrimode |
| V (Visual)      | VA        | VAR     | VARK       |
| A (Aural)       | VR        | VAK     |            |
| R (Read/Write)  | VK        | ARK     |            |
| K (Kinesthetic) | AR        | VRK     |            |
|                 | AK        |         |            |
|                 | RK        |         |            |

*Table 2: Overall distribution of students with VARK learning style preferences*

| Preferred mode | n  | %    |
|----------------|----|------|
| Single mode    | 13 | 15.9 |
| Multimode      | 69 | 84.1 |
| - Quadrimode   | 60 | 73.2 |
| - Trimode      | 2  | 2.4  |
| - Dual mode    | 7  | 8.5  |

## Results

Among the 82 respondents, 84% preferred multimodal style of learning. Out of that, dual, trimodal and quadrimodal styles were preferred by 8.5%, 2.4% and 73.2% respectively (Table 2).

The remaining 16% of the students preferred single mode. Amongst those who preferred

unimodal styles, basically there were none for the visual mode (V). The preference was almost equal for the other 3 single modes (A: 4.9%; R: 6.1%; K: 4.9%). The preference was slightly over 1% for subgroups of dual and trimodal options but for AK mode (3.7%) (Table 3).

*Table 3: Students' distribution with subgroups of VARK learning style preferences*

| SM              | DM |     | TM |   | QM  |     |   |     |      |    |      |
|-----------------|----|-----|----|---|-----|-----|---|-----|------|----|------|
|                 | n  | %   | n  | % | n   | %   |   |     |      |    |      |
| Visual (V)      | 0  | 0   | VK | 1 | 1.2 | ARK | 1 | 1.2 | VARK | 60 | 73.2 |
| Aural (A)       | 4  | 4.9 | AR | 1 | 1.2 | VRK | 1 | 1.2 |      |    |      |
| Read/Write (R)  | 5  | 6.1 | VA | 1 | 1.2 | -   | - | -   |      |    |      |
| Kinesthetic (K) | 4  | 4.9 | AK | 3 | 3.7 | -   | - | -   |      |    |      |
|                 | -  | -   | RK | 1 | 1.2 | -   | - | -   |      |    |      |

SM= Single mode, DM= Dual mode, TM= Trimode, QM= Quadrimode

*Table 4: Gender based distribution of students with VARK learning style preferences*

| Gender | n/% | Single mode | Dual mode | Trimode | Quadrimode | Total |
|--------|-----|-------------|-----------|---------|------------|-------|
| Male   | n   | 4           | 1         | 0       | 23         | 28    |
|        | %   | 4.9         | 1.2       | 0       | 28         | 34.1  |
| Female | n   | 9           | 6         | 2       | 37         | 54    |
|        | %   | 11          | 7.3       | 2.4     | 45.1       | 65.9  |

In general, females registered higher for all modes of learning (single, dual, tri and quadrimodes) when the data was analyzed for the whole study population (Table 4). When the data was expressed for the male and female groups separately, though female students showed marginally higher preferences for different subgroups of learning styles, male subjects had higher preferences for quadrimode (82%) and kinesthetic mode (K) in unimode category (7.1%) (Table 5). However, we did not use any statistical tool to

measure the level of significance. Female students had more diverse learning style preferences with several VARK combinations (Table 5) as compared to male students. For example, males had only one dual mode (AK) learning style preference as compared to five different dual mode preferences of female students. Similarly, for trimodal preferences there were two combinations (ARK, VRK) among the female students and none in males.

**Table 5: VARK data separated for male and female students**

| Gender | n/% | SM |     |     |     | DM  |     |     |     | TM  |     | MM  |      | Total % |      |
|--------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|---------|------|
|        |     | V  | A   | R   | K   | VK  | AR  | VA  | AK  | RK  | ARK | VRK | VARK | SM      | MM   |
| Male   | n   | -  | 1   | 1   | 2   | -   | -   | -   | 1   | -   | -   | -   | 23   | -       | -    |
|        | %   | -  | 3.6 | 3.6 | 7.1 | -   | -   | -   | 3.6 | -   | -   | -   | 82   | 14.4    | 85.6 |
| Female | n   | -  | 3   | 4   | 2   | 1   | 1   | 1   | 2   | 1   | 1   | 1   | 37   | -       | -    |
|        | %   | -  | 5.6 | 7.4 | 3.7 | 1.9 | 1.9 | 1.9 | 3.7 | 1.9 | 1.9 | 1.9 | 68.5 | 16.4    | 83.6 |

*SM = Single mode, DM = Dual mode, TM = Trimode, MM = Multimode,  
V = Visual, A = Aural, R = Read/Write, K = Kinesthetic.*

**Table 6: Self esteem and academic grades of students**

| Self esteem grade |           |           | Academic grade |               |
|-------------------|-----------|-----------|----------------|---------------|
| % of students     | Score (%) | Rating    | Marks (%)      | % of students |
| 4.8               | >85       | Excellent | 85-100         | 0             |
| 21.7              | 65-84     | Good      | 65-84          | 8.4           |
| 57.8              | 50-64     | Average   | 50-64          | 66.3          |
| 15.7              | <50       | Poor      | 0-49           | 25.3          |

The distribution of students based on self-esteem and academic performance grades is given in Table 6. A large proportion of our students were in the average group. There was no good relationship between self-esteem and academic grades in 70% of the subjects (48% of the students who had better self-esteem ratings had lower academic achievements while 22% of the students had lower self-esteem and better academic achievements). Only 30% of the total subjects had shown a reasonably acceptable correlation between self-esteem and academic grades, and that was interestingly only among the students with lower self-esteem.

Overall, the individual analysis of each student with relevance to learning styles, academic performance and self-esteem did not show any good relationship between the tested variables.

## Discussion

Learning style as defined by Keefe is the 'composite of characteristic cognitive, affective and physiological characters that serve as relatively stable indicators of how a learner perceives, interacts with and responds to the learning environment' (Keefe, 1987). The field of learning styles is complex, with over 70 different models which are based on a number of assumptions (such as learning styles are fixed, flexibly stable, contextually determined, or even nonexistent) and focus on different aspects of the learner (cognitive personality style, information processing style, or instructional preferences) (Coffield et al., 2004). However, it is important to recognize two factors that influence learning; stimuli (environmental, emotional, sociological, physical and psychological) and preference for learning/processing new information (Dunn & Dunn, 1993). Disparity between learning and delivery of instruction may lead to frustration in students. This can be reduced by knowing the students learning style preferences which can be employed to teach them. When information is presented using students' preferred learning style, not only teachers are better able to connect with students but students also achieve higher scores (McManus, Livingston & Katona, 2006; Miller, 1998)

It is generally observed that multimodal style of learning is the most preferred one by the students. It has been suggested that multimodal preferring students may adjust to the different teaching styles and opt out for alternative strategies, such as being visual at

one time and reading/ writing at another time (Fleming, 1995). In contrast, the students who prefer a single mode as dominant mode of learning (either V, A, R, or K), can also use all of the sensory modes in learning. Some students may prefer one of the modalities over the others so strongly that they struggle to understand the subject matter unless special care is taken to present it in their preferred mode.

The majority of the respondents in our study (84%) had multimodal VARK learning preferences and the remaining 16% preferred single mode which confirms previous observations. A similar report has shown that 60% of their subjects had two to four (multimodal) learning preferences and the remaining 40% of the students had one strong learning preference (Breckler, Joun & Ngo, 2009). In other studies, assessment of learning styles preferences among first-year medical students showed that only 36.1% of the students preferred a single mode of information presentation in contrast to most students (63.8%) who had multimodal learning preferences (Lujan & DiCarlo, 2006, Baykan & Naçar, 2007) as compared with a slightly lower percentage (i.e., 56%) in dental students (Murphy et al., 2004).

Gender is among a number of factors that has been found to influence student learning style other than age, academic achievement, brain processing, culture, and creative thinking etc. (Honigsfeld, 2001). Recently published reports have suggested that a higher percentage (64%) of male medical students had multimodal learning preferences as compared to females (Lujan & DiCarlo, 2006; Wehrwein, Lujan & DiCarlo, 2007). It is important to note from these studies that up to 87.5% of males and only 45.8% of females preferred multiple mode of presentation for their learning demonstrating the impact of gender on learning style preferences. Whereas, in the same study while a majority of male students preferred multimodal instruction, specifically, four modes (VARK), and a majority of female students preferred single-mode instruction with a preference toward K (Wehrwein, Lujan & DiCarlo, 2007). Contradicting results have been reported in a study from California using the same learning style instrument showing that there was slightly more females with multimodal preferences compared with males (Breckler, Joun & Ngo, 2009). Interestingly, one another study has reported that both male (56.1%) and female (56.7%) students preferred multiple modes of information

presentation, and the numbers and types of modality combinations were not significantly different between genders (Jill, Heidi & Stephen, 2007).

In our study both male and female students showed similar levels (85.6% male vs. 83.6% female) of preferences for multimodal learning. Even when the subgroup distribution of learning style preferences was considered for single, dual, and multimodal categories, the pattern appeared to be the same for both genders, though female exhibited a slightly higher percentage. This may be without any statistical differences although we did not use any statistical tool for confirmation. Furthermore, our study found the majority of the students prefer multimodal input of information, the types and modality combinations were different from the other studies. For example, female students had more diverse learning style preferences with several VARK combinations as compared to male students. This observation supports the findings of Philibin and his coworkers (1995) who found that males identified with a small subset of learning styles, whereas females distributed more broadly across the learning style spectrum.

Regarding the single mode learning style preferences, one study (Breckler, Joun & Ngo, 2009) has reported that the percentages of students preferring a single mode in descending order were K (16%), R (15%), A (5%), and V (4%). Wehrwein et al., (2007) reported that 54% of the females and 12.5% of the males in their study preferred single mode of learning style with varying options for each of the VARK styles. In another study, females and males had significantly different learning style preferences where females mostly preferred visual learning (46%) followed by aural (27%), read/write (23%), and kinesthetic (4%) and males most preferred visual learning (49%) followed by read/write (29%), aural (17%), and kinesthetic (5%) modes (Dobson 2009). In our study, none of the students preferred visual mode (V), while other modes (A, R, K) was preferred almost equally (5-6%) but with a slight edge to R mode. When the gender criteria was considered, males did show slightly higher preference to K mode (7%) whereas females showed preference to R (7%) and A (6%).

We preferred the Rosenberg self-esteem scale (Rosenberg, 1989) as it is perhaps the most widely used self-esteem measure that provides a positive or negative orientation toward

oneself. It is freely available, easy to use and has been validated across a large and diverse number of sample groups. Self-esteem is one component of self-concept. Self-efficacy or mastery and self-identities are important components of self-concept. People motivated to have high self-esteem indicate positive self-regard. Self-esteem can be used as an independent or intervening variable and generally it is a stable characteristic of adults. Rosenberg self-esteem test is a 10 item Lickert scale and are answered on a four point scale ranging from strongly agree to strongly disagree. The scale ranges from 0-30 with 30 indicating the highest score possible. However, this scale can be changed according to convenience and requirement with suitable changes being incorporated. By using this scale, we found that approximately 60% of our students had an average level of self-confidence. Almost the same percentage of students had similar level of academic grades. However, when the academic performance was checked for each of the student against their self-esteem score, there was no correlation. So, there was no correlation between academic performance and learning styles. However, there may be other factors such as aptitude, hard work, regularity etc. that would influence academic performance.

### **Strengths and weaknesses of VARK**

This subject has been discussed by most researchers in the field who have used the VARK instrument and does not need further emphasis. One can refer to Wehrwein's paper (2007) that has quite elaborately touched on the issue. However, in brief, the VARK instrument has its own limitations in scope, validity, and reliability in studies on learning preferences as it does not take into consideration other learning criteria that are clearly important in a classroom setting, such as engagement, motivation, and enthusiasm. Despite the limitations of VARK it is one of the most popularly used instruments. However, very recently, Leiti (2010) has provided preliminary evidence of the validity of the VARK. Even According to Fleming (2008), VARK is not a complete learning style inventory but rather provides users with a simple profile of their basic sensory learning preferences. Yet, the VARK learning philosophy at least offers and encourages teachers to acknowledge that there are learning differences and to make efforts to address some of these differences in their classrooms by attempting a wide range of teaching approaches (Dunn & Griggs, 2003). It

offers a positive, inclusive affirmation of the learning potential of all students. Thus, the VARK philosophy encourages a belief that everyone can learn if their preferences are addressed.

### Future plans

The results of the present investigation has encouraged us to look into learning style preferences of university students in different disciplines such as nursing, medical laboratory technology, physiotherapy, nutrition and dietetics and also clinical students. This is in consideration of the growing body of evidence showing that learning style preferences may change over time and with different levels of education (Breckler, Joun & Ngoh, 2009).

### Conclusion

A majority of students in this study preferred multimodal inputs in their learning process. Our study did not reveal gender differences in preferred learning styles. The results of self-esteem, learning style preference and academic performance did not have any bearing on each other. It is believed that storing of knowledge up to 40% is achieved by visual sensory mode. However, our students in the present study lack that component of learning style.

When students exhibit significantly different learning styles, the instructor need to address this fact and develop appropriate learning approaches as it can enrich the learning experience (Tanner & Allen, 2004). But, it should be noted with caution that while sensory preferences are useful as a launching point for inquiry, they should not be used as the only source of information for creating learning improvement (Suskie, 2004). The main usefulness of learning style information is for the students and to provide vocabulary to help them define appropriate learning strategies (Coffield et al., 2004). However, recognizing that there are different styles of learning and evolving one's repertoire of learning strategies may be particularly relevant for medical students desiring careers as clinicians and health professionals to improve their academic performance and develop ways to master the lifelong professional skills (Murphy et al., 2004).

### References

- Baykan, Z. &Naçar, M. (2007) Learning styles of first-year medical students attending Erciyes University in Kayseri, Turkey, *Adv Physiol Educ*, 31, pp. 158-160.
- Breckler, J.,Joun, D. &Ngo, H. (2009) Learning styles of physiology students interested in the health professions, *Adv Physiol Educ*, 33, pp. 30-36.
- Coffield, F. et al., (2004)*Learning Styles and Pedagogy in Post-16 Learning: a Systematic and Critical Review*, London: Learning Skills and Research Centre.
- Dobson, J.L. (2009) Learning style preferences and course performance in an undergraduate physiology class. *Adv Physiol Educ*, 33, pp. 308-314.
- Dunn, R. & Griggs, S. (2003) The Dunn and Dunn learning style model and its theoretical cornerstone. In: *Synthesis of the Dunn and Dunn Learning Styles Model Research: Who, What, When, Where, and So What*. New York: St. John's Univ. Center for the Study of Learning and Teaching Styles.
- Dunn, R.S. & Dunn, K. (1993) *Teaching secondary students through their individual learning styles.Practical approaches for grades 7-12*.Allyn and Bacon, Boston. MA.
- Fleming, N.D. (1995) I'm different; not dumb. Modes of presentation (VARK) in the tertiary classroom. In: *Research and Development in Higher Education*, edited by Zelmer A. Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australasia, 18, pp. 308-313.
- Fleming, N.D. (2008) VARK: a Guide to Learning Styles [online], Available at: <http://www.vark-learn.com/english/page.asp?p=questionnaire>
- Gudmundsdottir, S. & Shulman, L. (1987) Pedagogical content knowledge in social studies, *Scand J Educ Res*,31, pp. 59-70.
- Honigsfeld, A.M. (2001) A comparative analysis of the learning styles of adolescents from diverse nations by age, gender, academic achievement level and nationality (Doctoral dissertation). *Dissert AbstrInt*, 62, p. 969.
- James, W. & Gardner, D. (1995) Learning styles: implications for distance learning, *New Dir Adult Contin Educ*,67, pp. 19-32.
- Jill, A.S., Heidi, L.L. & Stephen, E.D. (2007) Does gender influence learning style preferences of first-year medical students?, *Adv Physiol Educ*, 31, pp. 336-342.
- Keefe, J.W. (1987) Learning style: Theory and practice. Reston, Virginia: National Association of Secondary Schools Principals.



- Latha, R.K. et al., (2009) Predominant learning styles adopted by AIMST university students in Malaysia, *South-East Asian J Med Edu*, 3, pp. 37-46.
- Leiti, W.L., Svinicki, M. & Shi, Y. (2010) Attempted validation of the scores of the VARK: Learning style inventory with multitrait-multimethod confirmatory factor analysis models, *Educational and Psychological Measurement*, 70, pp. 323-339.
- Lujan, H.L. & DiCarlo, S.E. (2006) First-year medical students prefer multiple learning styles, *Adv Physiol Educ*, 30, pp. 13-16.
- McManus, I.C. Livingston, G. & Katona, C. (2006) The attractions of medicine: the generic motivations of medical school applicants in relation to demography, personality and achievement, *BMC Med Educ*, 6, pp. 11-30.
- Miller, J.A. (1998) Enhancement of achievement and attitudes through individualized learning-style presentations of two allied health courses, *J Allied Health*, 27, pp. 150-156.
- Murphy, R.J. et al., (2004) Student learning preferences and teaching implications, *J Dent Educ*, 68, pp. 859-866.
- Philbin, M. et al., (1995) A survey of gender and learning styles, *Sex Roles J Res*, 32, pp. 485-495.
- Rosenberg, M. (1989) *Society and the adolescent self-image*. Revised edition. Middletown, CT: Wesleyan University Press.
- Suskie, L. (2004) What are learning styles? Can we identify them? What is their place in an assessment program? In: RL Swing (Ed). *Proving and Improving. Vol II: Tools and techniques for assessing the first college year*. Columbia, SC: National Resource center for the First year experience and students in transition, University of South Carolina [Online], Available at: [www.brevard.edu/fyc/listserv/remarks/suskie2.htm](http://www.brevard.edu/fyc/listserv/remarks/suskie2.htm).
- Tanner, K. & Allen, D. (2004) Approaches to biology teaching and learning: Learning styles and the problem of instructional selection-engaging all students in science courses, *Cell Biol Educ*, 3, pp. 197-201.
- Wehrwein, E.A., Lujan, H.L. & DiCarlo, S.E. (2007) Gender differences in learning style preferences among undergraduate physiology students, *Adv Physiol Educ*, 31, pp. 153-157.