



The influence of learning style in understanding analogies and 2D animations in embryology course

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Abstract: Undergraduate students struggle to comprehend embryology because of its dynamic nature. Studies have recommended using a combination of teaching methods to match the student's learning style. But there has been no study to describe the effect of such teaching strategy over the different types of learners. In the present study, an attempt has been made to teach embryology using the combination of analogies and simple 2D animations made with Microsoft powerpoint software. The objective of the study is to estimate the difference in academic improvement and perception scale between the different types of learners after introducing analogies and 2D animation in a lecture environment. Based on Visual, Aural, Read/Write, and Kinesthetic (VARK) scoring system the learners were grouped into unimodal and multimodal learners. There was significant improvement in post-test score among the unimodal ($P<0.001$) and multimodal learners ($P<0.001$). When the post-test score was compared between the two groups, the multimodal learners performed better the unimodal learners ($P=0.018$). But there was no difference in the perception of animations and analogies and long-term assessment between the groups. The multimodal learners performed better than unimodal learners in short term recollection, but in long term retention of knowledge the varied learning style didn't influence its outcome.

Key words: 2D animations, Analogy, Learning style, Student's perception

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Introduction

The knowledge of embryology is vital for undergraduate students to understand the mechanism behind both normal and abnormal development [1, 2]. Hence to understand embryology, students are required to visualize the dynamic changes in 3-dimensional view and familiarize new embryological terms [3, 4]. From a teacher's point of view, it's difficult

to clinch the attention of the students and indulge them in discussions during the lectures. Previous strategies used in embryology education include 3D constructing models, discussing clinical cases of malformations and web-based learning [5-7]. The commercially available embryology models are expensive, lack detailed information and not feasible in a large group teaching.

Learning style refers to the individual tendency to perceive and process information during the learning process [8]. The psychosocial model is based on personal preferences and the nature of interactions between the educator and learner. An example of a psychosocial model is the Visual, Aural, Read/Write, and Kinesthetic (VARK) model. Visual learners prefer graphical and symbolic representations of information. Aural learners prefer auditory information and concentrate on

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listening to a live lecturer. Read/write learners prefer lecture notes, handouts, and textbooks. Kinesthetic learners prefer hands-on experience, practical application, use of models and real-life experiences [8, 9].

Some learners might have a specific preference for a single modality (unimodal), while others prefer to learn a combination of modalities (multimodal). Previous studies have stated that the teacher should diversify their teaching style in order to fulfill each distinctive student's learning style [9-11]. But studies have found no significant difference in academic performance between diverse learning style [12, 13]. Few lacunae in the literature are, the baseline knowledge of the different type of learners was not taken into consideration and the effect of a teaching technique over the different types of learners was not analyzed.

According to the mapping theory, analogy is mapping of knowledge from one domain (the source) over another (the target). The source has specific attributes (characteristics) and is linked by a system of relations, which also holds in the target. In simple words, it's the process of understanding a novel situation from an already familiar concept [14, 15]. The use of analogies results in a deeper level of understanding for the learner and is effective in decreasing both learner and instructor's anxiety [16, 17]. In medicine, microscopic images, physiological phenomenon, and dermatological lesion are usually remembered by using memorable catch-phrases [16, 18, 19]. But they are not routinely used as a teaching strategy for medical students.

In recent years, studies have proven that static images worked on par with animations in a teaching environment. The static images allowed learners to review the information for as long as they need to achieve understanding [20, 21]. The animation may be an effective tool in depicting a task that the learner may subsequently emulate (e.g., knot tying) but less effective in illustrating a non-human motion (e.g., how a machine works) [22, 23]. A study found that availability of video resources did not enhance the performance of students in anatomy and radiology [24]. Another study has found, 3D technologies made the students to perform better in laboratory examinations but not in learning process [6]. To our knowledge, the role of learning style in understanding the animations have not been discussed.

Studies have recommended using a combination of teaching methods to match the student's learning style [10, 11]. But there has been no study to describe the effect of such teaching strategy over the different types of learners. In the present

study, an attempt has been made to teach embryology using the combination of analogies and simple 2D animations made with Microsoft powerpoint software. The aim of the study is to identify the influence of learning style in understanding analogies and 2D animations among first-year MBBS undergraduates in a learning environment. The objective of the study is to estimate: (1) the score improvement after analogy and 2D animation teaching among unimodal and multimodal learners and (2) the difference in pre-test, post-test, and follow up score between unimodal and multimodal learners.

Materials and Methods

This was a quasi-experimental study with pre-test, post-test design of a single group with a follow up after 7 months. The study was approved by the institutional research and ethical committee, Sri Manakula Vinayagar Medical College, Puducherry. The study group included first-year MBBS undergraduates, their participation was voluntary and was assured of their right to withdraw from the study at any time. Informed written consent was obtained from every participant before data collection and confidentiality of all responses was maintained throughout the study.

The copyright request for using the VARK questionnaire, version 7.8 (<http://www.vark-learn.com>) was obtained and the students were administered a 16-item VARK questionnaire. Each question had four options and the respondents were asked to choose one or more options which matched with their perception or leave it blank if it did not apply. The questionnaire was considered valid if 12 out of the 16 questions was answered. Based on the scoring chart the number of V, A, R, and K was tabulated. The standard algorithm provided by the VARK website was used to assess each student's preference. Based on the score, the students were grouped into unimodal and multimodal learners.

The students were asked to answer the pre-test questionnaire to assess their baseline knowledge on the subject. The embryology lectures were taken by the same lecturer and the topics included are gametogenesis, 1-3 week of development and neural folding. The lecture classes were taken for 50 minutes with apt analogies, animations made in Microsoft Powerpoint software. The analogies were presented in visual medium and its mechanism was explained. An analogy and its target have been explained in Table 1. Based on the analogy clinical cases were also discussed, a 32-year-old female with previous history of abortion was prescribed hormonal pills.

The topic of discussion was decidual reaction and its relevance to this clinical scenario. Similarly, lock and key model analogy for species-specific interaction during fertilization, old book model for non-disjunction of chromosomes was explained.

The animations were designed as per the multimedia principles to minimize the intrinsic cognitive load. An overview of important terms and its relationship was narrated before the animation (pretraining), using the function key “appear” in Microsoft powerpoint software the animation is broken down into segments (segmenting), and the learning concept is narrated to augment the visual content (modality) [25]. Colour coding was also given to different parts of the animations to delineate structures for proper understanding as represented in Fig. 1. At the end of the general embryology lecture session, a post-test questionnaire was given to answer. The questions were framed in multiple-choice format to analyze the factual knowledge and clinical case-based format for appropriate use of embryological terms, explaining the embryological basis of the anomaly and rationalizing a statement in reference to the scenario. And again after 7 months, the students were assessed for long-term retention of the acquired knowledge.

The student’s perception questionnaire was tested for validity in a group of 23 students (Cronbach’s alpha=0.713). The

session was managed by an external faculty, blinded to the objectives of the study. The perception of the students towards their interest in the lecture, understanding of the subject, deviation of the subject and motivation in discussion during the lecture, and recollection of the subject during examination was assessed using a 5-point Likert scale. The overall rating of the embryology lecture and feedback was also obtained.

Paired sample *t*-test was used to find out any significant improvement in the pre-test and post-test scores among unimodal and multimodal learners. Independent sample *t*-test used to determine the difference in pre-test, post-test scores and perception scale between unimodal and multimodal learners. The statistical analysis was done using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) and a *P*-value of <0.05 was considered statistically significant.

Results

A total of 148 students participated in the study, two students were absent throughout the study. The frequency of the different type of learners was unimodal 62 (41.3%) and multimodal 86 (57.3%). Among the unimodal learners there were visual 6 (4%), aural (nil), read/write 28 (18.6%), and kinesthetic learners 28 (18.6%). There was significant improvement in post-test score among the unimodal ($P<0.001$) and multimodal learners ($P<0.001$) as mentioned in Table 2. When the post-test score was compared between the two groups, the multimodal learners performed better than the unimodal learners ($P=0.018$) as mentioned in Table 3. There

Table 1. An analogy used in the lecture

Analogy	Target
Soil	Endometrium of uterus
Seed	Zygote
Burying the seed in soil	Implantation
Sunlight and water	Nutrients for the developing zygote (Progesterone, increased blood supply)
Flower	Baby

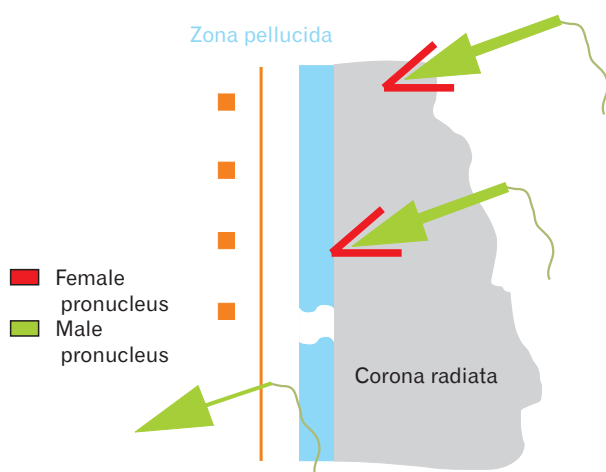


Fig. 1. 2D animation used in the lecture.

Table 2. Pre-test, post-test scores between unimodal and multimodal learners

Type of learners	Pre-test score	Post-test score	Paired sample t test P-value
Unimodal (n=62)	1.46±0.47	6.64±0.98	0.001*
Multimodal (n=86)	1.51±0.54	6.94±0.76	0.001*

Values are presented as mean±standard deviation. * $P<0.05$ indicates significant difference.

Table 3. Comparing the performance between unimodal and multimodal learners

Score	Unimodal learners	Multimodal learners	Independent sample t test P-value
Pre-test score	1.46±0.47	1.51±0.54	0.120
Post-test score	6.64±0.98	6.94±0.76	0.018*
Follow up score	4.58±2.07	4.23±1.94	0.563

Values are presented as mean±standard deviation. * $P<0.05$ indicates significant difference.

Table 4. Analogy perception scale between the learners

Statement	Unimodal learners (n=62)	Multimodal learners (n=85)	Independent sample t test P-value
1. The use of analogies was more interesting and enjoyable	1.39±0.61	1.40±0.58	0.884
2. The use of analogies enabled better understanding of embryology	1.68±0.67	1.67±0.76	0.214
3. The use of analogies deviated my focus from the subject	4.19±0.80	4.04±0.85	0.310
4. The use of analogies motivated my participation in discussion	2.02±0.96	2.04±0.87	0.363
5. The use of analogies helped in recollection of the subject during exam preparation	2.32±0.97	2.26±0.92	0.696

Values are presented as mean±standard deviation.

Table 5. 2D animation perception scale between the learners

Statement	Unimodal learners (n=62)	Multimodal learners (n=85)	Independent sample t test P-value
6. The use of 2D animations was more interesting and enjoyable	1.68±0.71	1.68±0.75	0.832
7. The use of 2D animations enabled better understanding of embryology	1.56±0.61	1.59±0.69	0.367
8. The use of 2D animations deviated my focus from the subject	4.31±0.87	4.21±1.01	0.823
9. The use of 2D animations motivated my participation in discussion	2.18±0.89	2.25±0.83	0.676
10. The use of 2D animations helped in recollection of the subject during exam preparation	2.05±0.83	2.09±1.0	0.030*

Values are presented as mean±standard deviation. * $P < 0.05$ indicates significant difference.

was no significant difference in the perception of animations and analogies between the groups and long-term retention of knowledge (Tables 4, 5). There was significant difference in the question 10, where the multimodal learners perceived that the animations helped them in recollection of the subject during assessment than the unimodal learners ($P=0.030$). The overall rating of the embryology lectures was excellent (38.7%), good (51.3%), regular (6.7%), and poor (1.3%) respectively, and 87.3% of students preferred to have similar kind of teaching methods in other disciplines.

The feedback from the students included the positive as well as negative comments, the positive comments were as follows: (1) complicated concepts were explained in a simple and understandable way; (2) less monotonous and felt less sleepy; and (3) analogies were interesting and helped in recollection of the subject during examination. The negative comments were as follows: (1) YouTube videos can be used to summarize the events at the end of the lecture; (2) more clinical cases with relevant information can be added; and (3) lectures would have been followed by peer interaction.

Discussion

The present study focuses on the influence of learning style in understanding analogies and 2D animations among first-year MBBS undergraduates in lecture setting. The frequency distribution of learning style among undergraduates obtained in the present study was unimodal 62 (41.3%) and multimodal 86 (57.3%). The frequency was similar to previous

studies where majority of them are multimodal learners with percentage ranging from (60%–80%). The wide range in frequency distribution indicates the varied learning style across the cultural background and population [10, 11]. The authors chose to compare the learning outcome between unimodal and multimodal learners rather than splitting the group into visual, aural, read or kinesthetic learners because the groups were not evenly distributed (visual learners 6 [4%], aural learners [nil]) and to observe whether multimodal learning has any advantage over a unimodal learning.

The pre-test score among the unimodal and multimodal learners indicates that their learning style didn't influence their baseline knowledge about familiar topics like gametogenesis, implantation and fertilization. The intervention was designed to provide an effective teaching environment for visual and aural learners because they formed the majority of the subset and they were present in both unimodal and multimodal group. Even though there was significant academic improvement among both the groups, the post-test score of multimodal learners was higher and reflects that, multimodal learners use their varied learning style to achieve academic improvement. However, the multimodal learners follow-up score was less than the unimodal learners but not statistically significant. This demonstrates that learning style might influence the academic performance in short-term recollection of knowledge but not in long-term. The possible explanation behind the parallel long-term performance of both groups could be loss of retained knowledge among the multimodal group of learners. Recently, a study has found that transition

of learning style occurs over the course of the teaching and transition of unimodal to multimodal learners improved their academic performance [26]. Previous studies have stated that identifying the learning style could enable the teachers in designing the curriculum to match the teaching modalities [10, 11]. But from the present study, the authors suggest that designing such course material may bring an immediate false perception of knowledge acquisition but not in long-term retention.

3D digital animations provide several advantages for the learners in enhancing spatial ability, forming a clear representation of the anatomical structures, a better understanding of spatial and topographical relationships between anatomical structures [27, 28]. But we can't generalize that all animations are better than static 2D images. Some animations can be very challenging for learners, because of higher cognitive load and the difference in the spatial ability of the learners [29]. Furthermore, an illusion of comprehension may occur when processing animation, especially when learners study them in a passive mode, without being totally engaged in the learning activity [30]. So, a motivated, low cognitive loaded, interactive platform will provide a better learning environment [31]. In the present study, the lecturer created opportunities for interaction with the learners (collaborative learning) using analogies, 2D animations and minimizing the cognitive load. This mode of teaching was focussed on visual and aural learners as they are the major proportion of learners in unimodal and multimodal group. Since there wasn't a control group to compare the data, we were unable to justify the role of the intervention in score improvement. However, both unimodal and multimodal learners showed score improvement implicating their understanding. This proves that understanding analogies and simple animations doesn't require a particular learning style.

The perception scale was designed to identify the role of learning style over the learner's influence on affect (interest in subject), attitude towards the subject (understanding) and on preparation. The present study revealed that both unimodal and multimodal learner's perception of analogies and 2D animations are the same. There was significant difference in the question 10, where the multimodal learners perceived that the animations helped them in recollection of the subject during assessment than the unimodal learners. Students from both the groups found that the analogies and 2D animations are interesting, helped them in understanding the subject, motivated them in participating discussions and helped in recol-

lection of the subject. Hence, the understanding and perception of analogies and simple 2D animations is independent of their learning style.

The overall rating of the class also didn't vary among the unimodal and multimodal learners. And they preferred to have similar type of teaching modalities in other disciplines of medicine. The limitations of the study were as follows: (1) limited sample size; (2) the study was not designed to identify the transition in learning style; and (3) the animations used in the study are simple 2D animations made using Microsoft powerpoint software and lacked depth perception. In future, students can be encouraged to create their own analogies as a part of active learning and the role of individual learning style in their respective teaching environment can be researched.

Our teaching curriculum mandates the teachers to provide a self-directed learning environment for the learners. But lectures are still part of the teaching system in a large group setting. The traditional didactic lecture primarily focuses on aural learners and the attention span diminish significantly after 20 minutes [32, 33]. The authors found that the nature of the analogy, timing of the analogy and the support resources used can have an impact on learners. The use of visually enriched analogy or an animation during the initial 15–20 minutes of lecture heightened the enthusiasm and engaged the students thereby minimizing the boredom. The study provides an insight on the use of analogies and simple animations in a teaching context and how it is perceived by learners of different style.

To conclude, the results from the present study can be applicable to a lecture environment as well. But the advantage in the study was, students were introduced to a new learning technique and the study provides an insight on how a learner reacts to an interactive learning environment. The understanding and perception of analogies and 2D animations is the same for both unimodal and multimodal learners. The learning style might influence the academic performance in short-term recollection of knowledge but not in long-term. So, course designing purely based on the learning style have to be reconsidered.

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