Evaluating Image Training Systems for Medical Students

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Abstract. Skin cancer is one of the common and most fatal cancers. In most cases, the similarity between benign (healthy) and malignant (harmful) makes it so difficult to diagnose the lesion correctly. Moreover, there are two levels of categorization for skin lesions. In addition to benign vs malignant (basic level), each skin lesion can also be categorized as one of the sub-types of benign or malignant (subordinate level). In most medical schools the distinction between skin lesions is taught to students in just four sessions and at the basic level - i.e. benign vs malignant.
In this research, we designed a learning system which can assist students in learning skin lesions effectively in only a few sessions through an application using skin lesion images. We also compared these two levels, basic level and subordinate level, and found that indeed learning skin lesions at the basic level is more effective at distinguishing harmful cases than at the subordinate level as it could be hypothesized.

1 Introduction

When one finds a lesion on their skin, they visit a doctor who might refer them to a dermatologist if the lesion seems harmful. In Canada it can take up to six months to see a dermatologist. This fact creates a good deal of anxiety for the patient and this shows how important it is for the patient to have their lesions diagnosed correctly in the first step, but this is not an easy task for family doctors. The problem is that they have not seen many harmful skin lesions in their office, even though they see many skin lesions. Most of the cases they see are harmless. Seeing more harmful skin lesions can help them categorize new skin lesions more accurately.

1.1 Skin Lesion Categories

Skin lesions are separated into two groups of benign (harmless) and malignant (harmful), but not all malignant lesions are similar. The same is also true for benign lesions. That is why specialists created four subgroups for each of these groups so that lesions from the same subgroup are somehow similar. The subgroups of benign are Lentigo, Blue Nevi, Seb Ker and Acquired Melanocytic Nevi and the subgroups of malignant are Lentigo Maligna Melanoma, Acral Lentiginous, Nodular Melanoma and Superficial Spreading Melanoma. These are the most common types of skin lesions. Each lesion belongs to one of the

two groups (malignant or benign) and only one of the eight subgroups. The first categorization is called *Basic Level* and the second categorization is called *Subordinate Level*. In other terms, classifying lesions as 'benign' versus 'malignant' is a "basic-level" categorization; determining which of the four sub-types they are is a "subordinate-level" categorization.

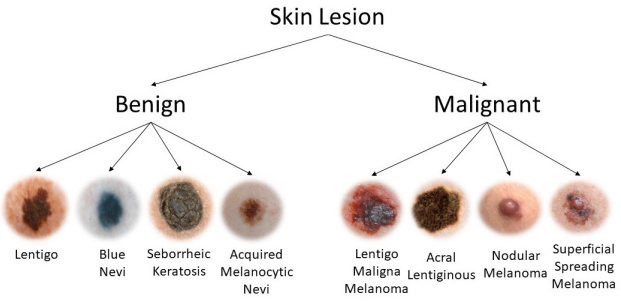

Fig. 1. Categorization of Skin lesions.

2 Related Work

We know for a fact that visual category learning connects specific perceptual experience with abstract conceptual knowledge [5]. It is also argued that providing better labels alongside images in a visual category learning task can lead to a better performance [3]. In this section we review two studies related to different learning levels in visual learning subjects.

In 2006, a team of researchers compared basic level learning and subordinate level learning in distinguishing between birds [6]. In their research, two different types of birds were chosen, and the experiment focused on only these two types: Owls and wading birds. Each of these types can be further divided into sub-types just like skin lesions. In their experiment, they separated participants into two groups. One studied owls in basic level and wading birds in the subordinate level and the second group studied wading birds in basic level and owls in subordinate level. For each level, the use was provided with a sequence of bird photos with a label in the corresponding level. Before starting the experiment a pretest is performed in order to make sure that none of the participants had prior knowledge about bird types. This pretest also helped measuring the participants' performance after the experiment. The post-test included birds from three different groups of trained species/trained exemplars, trained species/untrained exemplars and untrained species which reveals the generalization ability of users.

The results show that each group has a better generalization in the type of bird that they studied at the subordinate level. This suggests that learning birds at the subordinate level is more effective than learning birds at the basic level.

In 2017, a team of researchers designed an experiment to compare basic level and subordinate level learning in recognizing rocks [4]. They introduced

the "family-resemblance principle" first which states: "members of the same category share bundles of characteristic features that are not shared by members of contrasting categories". Then they defined two types of structure: compact structure which reflects the classic assumption of family-resemblance principle and dispersed structure which is exactly the opposite. The authors chose 30 rocks from three different types of rocks and asked the participants to rate the similarity between each pair. Using these pairwise similarities, they put the rocks in an M-Dimensional space which proved that rocks have a dispersed structure, because the members of a certain type of rocks were not really close. The classic research shows that when learning a new categorization in subordinate level the users end up having a better classification accuracy [2, 6]. However, it was not necessarily clear for subjects with a dispersed structure. To investigate, they chose two groups of rocks (nine sub-types - three from each type) in a way that one had a compact and the other had a dispersed structured. For each structure, they had two groups of participants learning these rocks in basic/subordinate level. The results show that subordinate level learning is more effective in the compact structure while in the dispersed structure the basic level learning leads to a better performance. More importantly, learning rocks in subordinate level in conjunction with basic level is more effective than each of them alone.

3 Proposed Method

Going through hundreds of skin lesion images in a class makes students tired and they might not be able to concentrate on the images after a while [7]. Moreover, research shows that making mistakes while learning actually helps the learning better [1] and when passively showing images, as it is currently done, students would not have the opportunity to categorize lesions and make mistakes.

We designed a system for improving the speed of learning process of skin lesions; an on-line tutoring system with a large enough skin lesion database. We built an application for the iOS and Android that lets dermatologists take pictures of the patient's lesion and send the photograph and a dermoscopy picture along with the description of the lesion and the consent of the patient to use the data for research and teaching purposes, to our database server remotely. We also developed an Android application for pre-test and post-test which is a basic level test on 24 images selected from all 8 subgroups.

For the main learning process, we developed an Android app which lets a medical student learn skin lesions through different sessions, in basic/subordinate level using images of both harmless and harmful lesions. Each session lasts 15 to 20 minutes. In each session the user is presented with 1) skin lesion images and labels in the relative level and 2) some tests along the process asking for the correct label of a skin lesion. We used only 3 subtypes of each skin lesion type and kept the 4^{th} subtype for measuring generalization in the post-test. In the benign sub session, we are trying to teach the difference between one benign sub-type versus other benign sub-types. In the malignant sub session, the students learn the difference between one malignant sub-type and other malignant sub-types.

The Target audience of our app are medical students and we want them to be the best they can in basic level so they can refer all and only harmful lesions to dermatologists. That is why our pretest and post-tests are in basic level.

We performed an experience for comparing basic level learning and subordinate level learning with 5 participants. One of the participants scored 83% in the pretest and was removed due to previous knowledge. The other 4 participants were divided into two groups; one learning in basic level and the other in subordinate level. Table 1 shows the results of their pretest and post-test.

Table 1. Improvement after training

Participants	Pre-test	Post-test
Basic Level Participant #1	58%	92%
Basic Level Participant #2	62%	96%
Subordinate Level Participant #1	58%	71%
Subordinate Level Participant #2	58%	75%

There were some skin lesion images in the pretest which are obviously malignant and it makes sense when the pretest results are slightly higher than chance. The results show that the participants of the basic level were more successful in generalizing their knowledge and had an average of 34% improvement in the process, while the participants of the subordinate level had and average of only 15% improvement. This suggests that learning skin lesions in basic level is more effective than learning skin lesions in subordinate level.

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