

4.1 Introduction

The reason for evaluating instruction programmes is to determine their effectiveness. To evaluate such effectiveness implies that the instructor/educator should have clear objectives for the different aspects of the programme within a pre-determined subject content or domain (Kirkpatrick, 1994). The four levels in Kirkpatrick's model (figure 2.1) represent a sequence of methods for evaluating instructional programmes. Each level builds on the previous one, implying a hierarchical order in which to execute the evaluation, with the process becoming more difficult and time consuming to perform at each higher level, but also providing more valuable information (Kirkpatrick, 1994). In this study information was sought regarding the learning of constructs specific to the domain of aesthetics, namely design principles, elements and techniques (Tversky, 1999).

In this study I examined the effectiveness of an electronic tutorial within a design and technology programme of which the objectives were twofold:

1. to gain knowledge and skills:
    - differentiate between the constructs of design principles, elements and techniques;
    - identify the above concepts in a given design through visual analysis; and
    - visualise the above concepts through free hand drawings.
2. to change behaviour through sustained performance:
    - demonstrate the conceptual understanding of the constructs of design principles, elements and techniques by applying it in new designs of their own.

The main research question to be answered is:

What was the role of the tutorial, *Design in Action* (a computer-aided tool), in Kirkpatrick's three levels of learning in a first year design and technology education programme?

Three research questions were derived from this question (see chapter 3). The first question will now be addressed**.**

4.2 Research question 1: What are the implications of the participants' reaction to the tutorial with regard to the possible improvement thereof?

Sub-question 1: Were the participants satisfied/dissatisfied with the tutorial?

Sub-question 2: What was the perceived usefulness of the tutorial?

Sub-question 3: What in the tutorial were the participants dissatisfied with?

In the following sections the levels will be discussed at which learning took place as a result of integrating the tutorial as a building block in the understanding and using of the design knowledge of three participants.

4.2.1 Data collection for research question 1

The different activities in the module under discussion were focused on the understanding of formal aesthetic design constructs that are appropriate to the domain in a design and technology education context by applying formal design theory and visualisation skills during a project. It will be shown how intervention in the module with *Design in Action*, an electronic tutorial in Microsoft PowerPoint™, contributed to participants' different levels of learning. The first level, i.e. reaction, at which learning took place as a result of integrating the tutorial, will be discussed.

4.2.2 Level 1: Reaction

According to Kirkpatrick, the word *reaction* implies that evaluation on this level measures how those who participate in the training react to it. He says:

> *Evaluating reaction is the same thing as measuring customer satisfaction. If training is going to be effective it is important that trainees react favourably to it. Otherwise, they will not be motivated to learn* (Kirkpatrick, 1994 p.27).

Kirkpatrick (1994) is further of the opinion that learners' reaction is an indication of their motivation and that, although a positive reaction does not guarantee learning, a negative reaction almost certainly reduces its possibility. He maintains that the future of a programme depends on positive reaction. It is important not only to get a reaction, but also to get a positive reaction.

At the first level, i.e. reaction, I assessed participants' initial reactions to the tutorial. It offered insight into participants' satisfaction or dissatisfaction with certain aspects of the tutorial and the perceived usefulness of the tutorial. Although measuring reaction is not an indication of the learning that takes place (Kirkpatrick, 1994), a positive reaction to the tutorial would indicate that the participants were motivated to interact with the tutorial. Table 4.2 indicates the questions eliciting the three categories of responses:

- general satisfaction;
- dissatisfaction; and
- perceived usefulness.

4.2.3 Discussion

In the discussion that follows, I will analyse and discuss three praticipants' responses to the questionnaire. I will analyse and discuss what the general satisfaction, dissatisfaction and perceived usefulness of the tutorial were. From the data presented, research question 1, "What are the implications of the participants' reaction to the tutorial with regard to the possible improvement thereof?" will now be answered. (See table 3.13 in chapter 3 for the coding system used to analyse reaction).

4.2.3.1 Sub-question 1: Were the participants satisfied/dissatisfied with the tutorial?

In this section, the affective reactions of the three participants will be presented. Evidence from the questionnaire and semi-structured interviews are drawn upon to support the discussion (addendum 2). It will be argued that their general satisfaction contributed to their motivation to use the tutorial and have a positive influence on their future application and transfer of the content of the tutorial.

The questions in the questionnaire used to gather information about the general satisfaction with the tutorial through affective responses, were the following:

- Question 1: "What did you like most about the tutorial?"
- Question 4: "Could you understand the language and the terminology used in the tutorial?"

From their responses it was apparent that participants found the tutorial easy to work with, that they were comfortable working with it, found the examples pleasing and experienced the tutorial as accessible:

- *It is easy to work with and you can work at your own pace*[7] (participant 9).
- *It was very user-friendly, there was nothing strange to the program… everyone who had CIL in the first year, ought to know how to work the program* [8] (participant 14).
- *It was easily accessible and easy to work with* (participant 21).

There was some satisfaction with the comprehensiveness and organisation of the tutorial:

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[7] *"Dit was maklik om daarmee te werk en ek kon dit op my eie tyd doen"* (participant 9).

[8] *"Dit was baie 'user-friendly', daar is niks rêrig snaaks aan die program nie … almal wat CIL gehad het in die 1ste jaar hoort te weet hoe om die program te werk"* (participant 14).

> *I won't change anything. It is very comprehensive and well organised*[9] (participant 14).

The participants also liked the choice of examples as well as the layout in the tutorial:

- *I liked the colour examples very much. It was comfortable to use and everything was well organised*[10] (participant 9).
- *For me the layout of the program was the best, anybody could understand it. It was also interesting to see what people use to design*[11] (participant 14).
- *I liked the graphics. The colour and quality is really good* (participant 21).

It became clear that participants did not only like the examples used for the sake of its appearance, but also realised the educational value thereof:

> *I understand now that there are many different ways of achieving the same principle. Maybe if you could add more examples to show the different ways of reaching the same principle. The graphics make it much easier to remember and apply* (participant 21).

Participants found the language and terminology used in the tutorial clear, unambiguous and accessible. There was also a suggestion that even more illustrating examples be added to the tutorial:

> *Yes, very straightforward and easily understood. Maybe a little more pictures to show…* (participant 21).

The questionnaire and semi-structured interviews indicated that the participants were generally satisfied with the tutorial's organisation and visual appeal. The aspects participants liked and enjoyed most were:

- easy to use;
- easy to access;
- easy to understand the text; and
- visual appeal.

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[9] *"Ek sal niks verander nie. Dit is baie volledig en goed georganiseer"* (participant 14).
[10] *"Ek het baie van die kleur voorbeelde gehou. Dit was baie gerieflik om te gebruik en alles was mooi uiteengesit"* (participant 9).
[11] *"Vir my was die uitleg van die program die beste, enige iemand sal dit kan verstaan. Dit was ook vir my interessant om te sien wat mense gebruik om te design"* (participant 14).

The conclusion of sub-question 1 is, therefore, that the simplicity of the tutorial contributed to its ease of use and participants' general satisfaction with the intervention. Literature indicates that compliance to the above aspects would eliminate confusion and cognitive overload with the participants. Various references can be detected relating to learners' access to content and the fact that a user interface of the computer-aided material should facilitate access to the content (Atkinson, 1998; Recker, 1995).

The findings further indicated that the linearity of the tutorial contributed to its ease of use and, therefore, participants' general satisfaction. Research has shown that some learners find non-linear organisation confusing and opaque, contributing to cognitive overload for the user (Atkinson, 1998), and that hierarchical and linear organisation ensures transparency and easy access.

In addition, it was concluded that the visual appeal of the tutorial contributed to participants' enjoyment levels and motivational levels, which is confirmed by researchers in the field (Hannafin & Peck, 1988; Kirkpatrick, 1994). Considering all the findings of sub-question 1, there was sufficient evidence to conclude that participants were in general satisfied with the tutorial.

4.2.3.2 Sub-question 2: What was the perceived usefulness of the tutorial?

The term "perceived usefulness" is described as trainees' belief about the value and usefulness of the training; the extent to which they believe they will use the training on the job (Alliger *et al.*, 1997). In this study, it refers to the extent to which participants believed that they could apply the knowledge and believed that they would use the knowledge in other design related modules. (See table 3.13 in chapter 3 for the coding system used to analyse reaction.)

Establishing participants' perceived usefulness of the tutorial was mainly elicited from their utility judgements made in response to the following questions:

- Question 5: Would you prefer to have had exposure to this tutorial at the beginning of your module on graphic design?
- Question 9: Which aspect of the design theory in the tutorial did you understand the least?
- Question 11: Did you manage to complete the exercise in time?
- Question 12: Which aspect of design theory did you learn most about through the use of the tutorial?

Not all participants had a clear idea of which aspect of the tutorial content was least useful, i.e. which they had learned least about: *Nothing*[12] (participant 9). There was also some indication that all aspects were equally well explained. *Everything*[13] (participant 14). However, it became clear that the constructs “design principles" and "design elements" were better understood than isolated principles and elements*: The design elements and principles. Useful* (participant 21). Some participants thought that the principles "balance" and "illusion of motion" were understood better after exposure to the tutorial than any others. *Balance and illusion of motion*[14] (participant 9).

However, certain principles and elements were less well understood than others, e.g. the element "rhythm" and the principle "unity":

- *Everything was understandable. I understood everything equally well. Maybe just rhythm not*[15] (participant 9).
- *Unity and how to achieve it in a design* (participant 21).

A better understanding of the particular design elements developed gradually:

> *At the beginning I did not understand the elements. It was only later on in the tutorial that I started realising what was going on in the slides on unity. Now I understand it better* (participant 21).

During the semi-structured interviews, it became evident that by working through the tutorial, participants realised that the visual examples could also help them in one of the other modules in the design and technology programme earlier in the year:

- *Yes – because it’s easier to understand visual information*[16] (participant 9).
- *… it would have made things much clearer*[17] (participant 9).
- *Yes, I think it would have helped me with my designs. I believe everybody would have performed better*[18] (participant 14).

Useful suggestions for improving the module by introducing the tutorial earlier in the design and technology programme were evident from the semi-structured interviews:

> *Yes, maybe a lesson concentrating on this. Maybe also not on own time but during class time* (participant 21).

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[12] *“Niks”* (participant 9).
[13] *“Alles”* (participant 14).
[14] *“Balans en 'illusion of motion' ”* (participant 9).
[15] *“Dit was alles verstaanbaar, ek het alles ewe goed verstaan. Miskien net ritme nie”* (participant 9).
[16] *“Ja – want dit is makliker om visuele inligting te verstaan”* (participant 9).
[17] *“Ja, dit sou dinge baie duideliker gemaak het”* (participant 9).
[18] “Ja, ek dink dit sou my baie gehelp het met my ontwerpe. Ek glo almal sou beter gedoen het” (participant 14).

Those aspects participants indicated as the ones they had learned most about indicated that they considered the tutorial useful in supporting them to learn about certain design aspects. I learned from the responses to the questionnaire and semi-structured interviews that participants perceived the tutorial as useful, and, therefore, considered their time well spent because of the tutorials:

- relevance to the module;
- usefulness to other modules; and
- practical applicability.

4.2.3.3 Sub-question 3: About what in the tutorial were the participants dissatisfied?

There were two questions in the questionnaire that elicited information from affective comments by the participants (addendum 2):

- Question 2: "What would you have liked different in the tutorial?"
- Question 3: "What did you like least about the tutorial?"

It was evident from the responses to the questionnaire that some participants thought that the illustrative examples in the tutorial were too small and in response to question 2, participant 9 suggested that the pictures in the tutorial be larger: *… the pictures to be enlarged*[19].

Another suggestion for improvement of the tutorial was expressed in the dissatisfaction emerging from responses to question 2. Some participants were dissatisfied with the tutorial's lack of help. The responses suggested the inclusion of more navigational buttons, improving participants' sense of where they were in the tutorial:

> *I didn't like it at all to jump from one slide to another. It would really help if there were a way to know where to look for the answers in the exercise*[20].

Participants were irritated by the fact that the tutorial took very long to open from the Internet, as well as the time it took for some of the links from the tutorial to the Internet. In response to question 3, they wrote:

- *It is too slow to open from the site*[21] (participant 14).
- *The Internet links take a while to open. I don't know if you could do*

[19] *"Vir die prente om groter te wees"* (participant 9).
[20] "*Ek het niks daarvan gehou om heen en weer rond te spring van een 'slide' na die ander nie. Dit sal rêrig help as daar 'n manier is om te weet waar om na die antwoorde te soek in die oefening"* (participant 9).
[21] *"Dit is te stadig om van die 'site' oop te maak"* (participant 14).

something about that?[22] (participant 9).

- *The Internet links take a while to open*[23] (participant 14).

Some participants indicated that the language and terminology used in the tutorial was not always clear. *Not clearly* [24] (participant 9). However, it later emerged from the semi-structured interviews that the constructs were not clearly understood (contrary to what participant 21 said earlier), rather than specific terms, due to unclear titling of the design principles and design elements on each slide in the tutorial:

> *Some of the terminology was not clear. I think I was not always certain whether I was busy with principles and when with elements. Maybe it should be made clearer. Maybe clearer sections or something*[25] (participant 9).

During the interviews it became evident that participants took up to four hours and more to complete the tutorial and all the exercises. It became clear that they worked through the whole tutorial in one session, despite the fact that it was time consuming. They responded to question 11 in the following way:

- *Yes, it took approximately 4 hours' hard work*[26] (participant 14).
- *I completed all of them in my own time, but was time consuming, maybe should have been fewer designs to explain* (participant 21).

During the interviews, it was evident, however, that participants confused "own time" with "own pace":

> *I did work in the time you reserved the laboratory for us. I actually mean I worked at my own pace. There was nobody telling us how far we should be. I just carried on until I was finished with everything*[27] *(*participant 14).

Despite the fact that the laboratory was reserved for four hours, some participants did not manage to complete all the exercises:

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[22] *"Die Internet 'links' vat 'n rukkie om oop te maak. Ek weet nie of mevrou iets daaraan kan doen nie?"* (participant 9).
[23] *"Die internet 'links' vat 'n rukkie om oop te maak"* (participant 14).
[24] *"Nie duidelik nie"* (participant 9).
[25] *"Van die terminologie was nie duidelik nie. Ek dink ek was nie altyd seker of ek besig was met 'principles' en wanneer met 'elements' nie. Miskien moet dit duideliker gemaak word. Miskien duidelike afbakening of iets"* (participant 9).
[26] *"Ja, dit het sowat 4 ure se harde werk gekos"* (participant 14).
[27] *"Ek het gewerk in die tyd wat Mevrou vir ons die lab bespreek het. Ek het eintlik bedoel ek het teen my eie tempo gewerk. Ek het maar net aangehou totdat ek klaar was. Daar was niemand wat vir ons gesê het waar moet ons trek nie"* (participant 14).

> *I rushed through the last three answers. I didn't have more time. And I couldn't go back to some of which I was uncertain. It took me about four hours to go through everything*[28] (participant 9).

Although participant 9 did not regard this as dissatisfaction, it was considered too long for one session and, therefore, I interpreted it as inferred dissatisfaction. There was also some indication that the exercise at the end should be interactive, multiple-choice, instead of paper and pencil.

> *I would have liked it if there were multiple-choice questions in the exercise. Questions with more clues. Spelling should not have to be perfect*[29] (participant 9).

The responses to the questionnaire and the semi-structured interviews indicated to me that participants were dissatisfied with the following aspects of the tutorial (Addendum 2 and Addendum 4):

- its length;
- the time it takes to open from the Internet;
- limited navigational options; and
- lack of interactivity.

4.2.4 Conclusion

The conclusion derived at through analysing the data in support of answering research question 1 is summarised here:

- Despite participants' negative reactions about the time it took to open the tutorial from the Internet, they were highly motivated to work through the tutorial, implying their overall positive feelings about the tutorial. This was a clear indication of the participants' motivation and positive attitude towards the design tasks in the module. They thought that the tutorial was easy to use, which indicated their satisfaction with the programming of the tutorial.
- The semi-structured interviews confirmed what was found in the literature, i.e. despite negative responses to other aspects of the tutorial, participants considered the relevance of the tutorial as so important that they would revisit and reuse it for the rest of the module as well as for other modules in the programme (Clark, n.d.).
- From the participants' dissatisfaction with the above aspects of the tutorial I learned that,

[28] *"Ek het die laaste drie vrae afgerammel. Ek het nie meer tyd gehad nie. En ek kon nie teruggaan na party waarvan ek onseker was nie. Dit het my omtrent vier ure gevat om deur alles te kom."* (participant 9).
[29] *"Ek sou daarvan gehou het as daar meervoudige keuse vrae in die oefening was. Vrae met meer leidrade. Dit moet so wees dat spelling nie perfek hoef te wees nie"* (participant 9).

in order to maximise their satisfaction, and, therefore, their motivation to use the tutorial, some changes needed to be made. The tutorial should be shortened and presented in a different access format, and additional navigational options should be added. This would ensure that participants do not become discouraged because of their negative experiences and that they would not want to engage in the tutorial again. Kirkpatrick confirms the importance of eliminating negative reactions as far as possible, in order to prevent participants from not learning anything because of a negative reaction to the training (Kirkpatrick, 1994).

The second question, derived from the main research problem, will subsequently be discussed.

4.3 Research question 2: What are the implications of the participants' retention of knowledge towards possible improvement of the tutorial?

Sub-question 1: What knowledge was retained immediately after exposure to the tutorial?

Sub-question 2: What knowledge was retained after some time?

4.3.1 Data collection for research question 2

The data gathered for answering research question 2 are of a qualitative nature. Data informing me about the participants' immediate retention (sub-question 1) were derived from an exercise relating to visual analysis, consisting of fifteen questions answered on paper copy (Addendum 5). The written responses of the participants will be presented. Data are presented in the form of qualitative descriptions, explanations and interpretations, reflected against the recognised domain specific constructs and criteria (Addendum 6). For the purpose of this discussion, responses to three questions randomly chosen were analysed and interpreted (see figure 3.7 in chapter 3 for the analysing process regarding the immediate retention).

Data were gathered from a sequential test that required participants to visualise their understanding of some of the design principles and design elements. The responses, in the form of schematised drawings reflected participants' conceptual understanding of design principles, elements and techniques. These competencies were to be demonstrated after the completion of the tutorial. Participants' drawings and qualitative interpretations will be presented as part of this discussion.

4.3.2 Level 2: Learning

Kirkpatrick maintains that three learning objectives of training programmes should be strived for at the second level of evaluation:

> *Measuring learning therefore means determining one or more of the following: What knowledge was learned? What skills were developed or improved? What attitudes were changed?* (Kirkpatrick, 1994 p.42).

According to Kirkpatrick it is important to measure learning because no change in behaviour can be expected unless one or more of the above learning objectives have been accomplished by the participants: "Moreover, if we were to measure behaviour change (level 3) and not learning and if we found no change in behaviour, the likely conclusion is that no learning took place" (Kirkpatrick, 1994 p.42). From table 3.4 it can be seen that the three questions of the exercise discussed further on, established participant's immediate retention. It can also be seen that these three questions in the test measured participants' retention of specific design principles and elements after a period of time.

4.3.3 Discussion

The data presented now will support the argument that participants demonstrated immediate retention of the design principles; that they retained knowledge of design elements to a lesser degree; and showed very little evidence of understanding the use of techniques to realise design principles. I will draw on evidence from the exercise completed immediately after the intervention with the tutorial to support the discussion of research question 2.

4.3.3.1 Sub-question 1: What knowledge was retained immediately after exposure to the tutorial?

In this section, the three participants' responses to three questions in the visual analysis exercises completed directly after their first exposure to the tutorial will be presented. Evidence from the exercise supports the discussion. It will be argued that participants' retained knowledge about some design principles and design elements was average to fairly good, but that the retention of design techniques and the way in which techniques act as the manipulation of principles and elements to realise a particular visual effect, was poor (table 4.1).

In the responses to question 2, there was evidence of confusion between the two types of asymmetrical balance, indicating poor retention of the design principle balance explained in the tutorial:

*Symmetrical balance – shapes are repeated in the same positions on either side of a central vertical axis (*participant 9).

Participant 9's response indicated to me that this participant did not understand the design principle depicted in question 2, because the participant incorrectly identified/named it "symmetrical balance" instead of "asymmetrical balance". This demonstrates that the participant relied on her memory (incorrectly so) instead of on her conceptual understanding of how techniques are applied to create the principle "asymmetric balance" by referring to the specific elements used in this design.

There was also evidence that participants, although their retention of design principles was adequate, lacked understanding of how it was achieved and what underlying elements contribute to its structure:

- *Asymmetrical balance is achieved with dissimilar objects that have equal visual weight or eye attraction* (participant 14).
- *This design has asymmetrical balance, having dissimilar objects that have equal visual weight or equal eye attraction* (participant 21).

There was no indication that the above participants understood that techniques are applied to organise design elements on the format to realise a design principle, because the participants did not refer to any element specifically used in the illustration to substantiate their responses. In addition, these participants also used inappropriate terms for the design elements "shape" and "size", namely "objects".

The analysis of responses to question 9 of the exercise indicated that the participants demonstrated retention of some techniques applied, but did not retain knowledge and understanding of the design elements involved in a design, e.g.

- *The objects in the slide looks like they are moving and are repeated* (participant 9).
- *Figure repeated. Fuzzy outlines. Multiple images* (participant 14).
- *The figure has been repeated with a fuzzy outline of multiple images* (participant 21).

The participants were not required to identify the design principle realised in question 9. Their retention of the correct terminology pertaining to design elements was poor. They used terms like "objects" and "figures" instead of "shapes". Although they remembered some of the terms for the techniques used in the design, e.g. "repetition", they had not retained knowledge of terms such as "optical movement" in the tutorial, which they replaced by "look like they are moving". This indicated to me that participants retained understanding

of the concept as well as the effect of the appropriate technique used, although they did not necessarily remember the exact term used in the tutorial. There was also an indication that participants could identify some techniques by using the same terminology as in the tutorial, e.g. “repeated” “fuzzy” and “multiple”.

The third example, question 12, and the sample of responses to it is discussed below. The image in question 12 appeared elsewhere in the tutorial, in slide 22, as illustration of scale and proportion and was, therefore, a familiar image to the participants.

Good retention of design principles, but not of the design elements, was evident from the responses below:

- *Small human figure against the huge sunflower shows how relative the concept of size is. The light areas represent smoothness and dark represents roughness* (participant 9).
- *Unrealistic proportions of the small human figure against the huge flower size. It creates surface quality* (participant 14).

The responses of participants 9 and 14 indicated to me that there was little understanding of the visual effect that technique has on the design elements. Neither of the participants quoted above recognised the type of texture applied here, i.e. tactile texture, and failed to recognise the interrelationship between proportion, technique and texture.

However, signs of good retention of design elements could be seen in the response of participant 9:

> *Texture: it looks as if you can actually touch it. The little man that is small emphasises the sizes and proportions of objects compared to each other* (participant 9).

Partial retention of design elements was evident in the response above. Participant 21 described tactile texture without using the correct terminology. This meant that the participant understood the concept. It was also a demonstration of her understanding of the function of scale in the design.

An analysis of all the responses of participants 9, 14 and 21, and how it related to their conceptual understanding of all the constructs involved in the exercise, are summarised and rated in table 4.7. The rating used was:

- 0 - 2 = poor (no understanding of any of the concepts required);

- 3 = fair (could identify some of the concepts (principles and elements) correctly, but without reference to detail of technique used;
- 4 – 5 = good (clear understanding of most concepts and reference to detail specifics of the designs).

Table 4.1 indicates that participants 9 and 14 had poor to average retention of design principles and design elements, and poor understanding of the interrelationship between principle, elements and techniques to create a particular visual effect, whereas participant 21 demonstrated good retention of design principles, fair to good retention of design elements and good understanding of how techniques are used to create visual effect.

Table 4.1 Summary of participants' conceptual understanding of all the constructs in the exercise

Design principles	**Participant 9**	**Participant 14**	**Participant 21**
Unity	Poor	Fair	Good
Balance	None	Poor	Good
Illusion of motion	Poor	Fair	Good
Proportion	Good	None	Poor
Design elements			
Shape	Good	None	Good
Line	Fair	Good	Fair
Texture	Fair	None	None
Colour/tonal value	Not clear	None	Good
Rhythm	None	Fair	Fair
Techniques			
Contrast	None	None	Good
Repetition	Good	None	Good

Participants' responses to the exercise indicated to me that their immediate retention of the three main constructs, design principles, elements and techniques varied:

- principles – fairly good on average;
- elements – fairly poor on average; and
- techniques – very poor on average.

I learned from this that they could identify most design principles fairly well; they could not distinguish between design principles and design elements well and in most cases design elements were known fairly poorly. Their knowledge and understanding of the concept "design techniques" (explaining "how") was very poor at this stage of the module. I learned from this that they did not yet understand that the techniques were used to manipulate spatial arrangements (Tversky, 1999):

- repetition;
- addition;

- omission;
- distortion;
- enlargement; and
- diminution.

Subsequently sub-question 2 will be addressed.

4.3.3.2 Sub-question 2: What knowledge was retained after a period of time?

On the second level of learning, according to the augmented framework of Kirkpatrick's (1994) evaluation model, participants' demonstrated capability in the context of the module under discussion. For this purpose I examined the responses to a sequential test two weeks after the first exposure to the tutorial, testing two design skills:

- visual analysis identifying, explaining and describing constructs; and
- free-hand drawings schematising constructs.

The test consisted of a criterion-based section consisting of two sections pertaining to this study. The first was a section of three questions testing participants' development in visual analysis. The second section consisted of four questions requiring participants to draw their understanding of design constructs. The discussion that follows will take place in this order.

Visual analysis

The questions in the test under discussion were completely open-ended and non-directed. Students were given three images of designs that they had to analyse and discuss without directing them in any way towards specific constructs in operation. This presented difficulty in the research as there were numerous possible combinations and relationships (Tversky, 1999) that could not be foreseen. The coding system in table 3.15 in chapter 3 was, therefore, closely followed to validate the interpretation of responses. The trends emerging from analysing the responses to the visual analysis questions in the test will now be discussed.

At the time of the test, varying degrees of ability to distinguish between the constructs, design principles and elements were evident. Confusion between design principles and elements were apparent in students identifying symmetric balance as a design element instead of a design principle in question 5.2:

> *The design element used for this is symmetric balance because the shape of the wine glass on both sides of the vertical line is the same…*[30] (participant 9).

When asked to identify the design principles and explain which design elements were used to realise the principles, the majority were able to identify the design elements, e.g.

> *The design principles are balance and unity. The design elements used to achieve this are repetition, a focal point, continuation, transparency and colour…*[31] (participant 9).

However, while they were mostly able to identify many of the design elements in question 5.3, some could identify only the design principle rhythm in this question correctly, not being able to identify unity and balance:

> *The elements used to achieve this design was colour, the colour had to blend in with the design. There is shape because the designer made use of a lot of line. Its appearance looks as if it has a rather rough texture. It definitely has rhythm because your eye moves across it in a rhythmic way*[32] (participant 14).

Understanding the design principle of balance remained a problem to some participants. Some still did not know the difference between symmetrical and asymmetrical balance. The response below indicates that participant 21 only considered one object in the design, and did not consider the variety of elements making up the whole design and contributing to the creation of balance (participant 21 only considered the wine glass and not the rest of the objects/elements in its vicinity):

> *Symmetrical balance has been achieved by the wine glass placed in the centre of the design (*participant 21).

If the participant had considered all the elements at play in the design, the participant might have identified the type of balance correctly as asymmetrical. However, the response quoted above indicates that understanding of how the balance was created in the design was still poor and evident in the incorrect explanations. These were due to failure in considering that

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[30] *Die ontwerpelemente gebruik hiervoor is simetriese balans omdat die vorm van die wynglas aan albei kante van die vertikale lyn dieselfde is ..."* (participant 9).

[31] *Die ontwerpbeginsels is balans en eenheid. Die ontwerpelemente wat gebruik is om dit te verkry is repetisie, 'n fokuspunt, kontinuasie, transpiransie en ook kleur* (participant 9).

[32] *Die elemente wat gebruik is om die ontwerp te bereik was kleur, die kleur moes inskakel by the ontwerp. Daar is vorm in die ontwerp omdat die ontwerper van baie lyn gebruik gemaak het. Sy voorkoms lyk asof dit nogal 'n growwe tekstuur het. Hy het definitief ritme omdat jou oog oor hom beweeg op 'n ritmiese manier* (participant 14).

there were many dissimilar objects created by a variety of elements and techniques in the two sides of the axis of the design in question 5.2, and not only one:

> *Visual balance is achieved by the dark coloured strip in comparison with the busy focal point in the top half of the picture; therefore, colour is an important role…*[33] (participant 9).

Although participants' responses to the three questions under discussion still contained elements of vagueness and uncertainty, it seemed as though increased awareness of detail was evident in the specificity of the descriptions and explanations of the designs. Prevailing uncertainty could be seen in the following responses:

- *The transparency causes the focal point and thus gives visual balance, the repetition of the photographs in the blocks creates unity, the colour of the blocks where some are light and others dark, creates unity and the repetition of the photographs give unity*[34] (participant 9's response to question 5.1).
- *They made use of size and shape that are balanced against one another, which forms a unity. The design has volume and there is also an element of colour as well as rhythm. The element of motion also comes in here because the grapes form a repetitive pattern*[35] (participant 14's response to question 5.2).
- *The tee pot has rhythm as a result of the play with colours and the pattern that guides your eyes. The design has volume because it is 3-dimensional*[36] (participant 14).

Participant 9's statement that "transparency causes the focal point and thus gives visual balance" indicates that the participant does not understand

- that "focal point" and "balance" are both design principles; and
- that one principle can not "cause" another, but are being created in the way elements are used.

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[33] *Visuele balans word verkry deur die donkerkleurige strook in vergelyking met die besige fokuspunt in die boonste helfte van die prent, dus is die kleur 'n belangrike rol* (participant 9).

[34] *Die transpirasie veroorsaak die fokuspunt en gee dus visuele balans, die repetisie van die fotos in die blokkies skep eenheid, die kleur van die blokkies waar party lig en ander donker is skep eenheid en die fotos wat herhaal word gee eenheid* (participant 9)

[35] *Hulle het gebruik gemaak van grootte en vorm wat teenoor mekaar gebalanseer word wat 'n eenheid vorm. Die ontwerp het volume en daar is ook 'n element van kleur asook ritme. Die element van beweging kom ook hier voor omdat die druiwe 'n repiterende patroon vorm* (participant 14).

[36] *Die tee pot het ritme a.g.v. die speling met kleure en patroon wat jou oë lei. Die ontwerp het volume omdat hy 3 dimensioneel is.* (participant 14).

The vagueness in participant 9's referencing and lack of specifics can also be seen in the above response to question 5.1. There is no indication of what it is in the design that the participant considered as the "focal point" or in which elements (e.g. shapes, sizes, tonal value) the "balance" was seen.

Participant 14's response to question 5.2 was equally vague. The statement "They made use of size and shape that are balanced against one another, which forms a unity" was non-specific. There was no explanation of how size and shape were used or how balance was created. The participant also made the conceptual mistake to ascribe the creation of one design principle, "unity", by another principle, "balance".

A lack of reference to detail was evident in participant 21's response. There was neither an explanation of how there was "played with colours and pattern" nor any explanation of what was meant by "volume" and how it relates to 3-D. This was also evident in participant 14's response to question 5.3.

From the above responses it was evident that some participants did not grasp the intricate interplay between design principles, design elements and techniques on a format. However, some participants' responses indicated an emerging increase in sensitivity for detail. This could be seen in their use of appropriate terminology; detailed references to specific elements and techniques in the design and insightful explanations of how techniques were used in establishing design principles. An example of such increase in sensitivity for detail is evident in participant 21's response to question 5.1:

> *Unity has been achieved in their design - this has been achieved by the repetition of the square shape in which the images are set. It has also been created by the continuation of the line behind the images. An illusion of space has been created by the transparentness of the images. Balance has been achieved through the equal scale of each square and the fact that the squares are proportionate to one another. Rhythm has been created through the regular repetition of the squares* (participant 21).

In addition, clear reference in explanations to specifics seen in the designs supported the emerging indication of clarity of understanding. Explicit explanation in responses to question 5.2 and 5.3 verbalised that the design principle "unity" is caused by the similarity of the shapes in proximity to each other:

- *In this design the wine glass shape reflects the shape of the woman's neck and this creates unity, because the two are a similar shape and are placed close to one another* (participant 21, question 5.2).
- *…and then unity is achieved through the shapes because all the shapes are then put together in one focal point* (participant 21, question 5.2).
- *The shape of the handle is also similar to the shape of the spout and this creates unity* (participant 21, question 5.3).

Participants 9 also demonstrated increasing sensitivity for detail in the description of the design in question 5.2 relating to texture namely how texture can be created:

> *… there is also texture in the round grapes and transparency of the woman's face that is abstract*[37] (participant 9).

One response to question 5.3, however, indicated emerging understanding of the techniques used to realise balance by referring to elements moving in different directions in space:

> *Balance in this design has been achieved by the spout going out in one direction and a part of the handle going out in another* (participant 21).

Similarly some sensitivity to the visual effect of technique and design elements on the viewer was increasing:

> *An illusion of space has been created by the transparency of the bowl. These shapes guide the viewer's eye from the heading to the bowl of the wine glass (woman's head) (*participant 21, question 5.2).

Participants' responses to the visual analysis questions in the test indicated the following pertaining their retention of knowledge after a period of time:

- they could not differentiate well between design principles and elements;
- they could identify most design elements;
- the design principle "balance" was not understood yet;
- there was an emerging increase in sensitivity to detail;
- some understanding of the purposeful use of techniques to create specific principles was emerging; and
- they could transfer some knowledge from 2-D designs to 3-D objects.

[37] *… daar is ook tekstuur in die ronde druiwe en transpiransie van die vrou se gesig wat abstrak is* (participant 9).

Drawings

Drawings use a small number of segments or elements in varying combinations to produce a potentially infinite set of different drawings. Studying the segments of sketches give insight into what conceptual modules are operative and how they are schematised (Tversky, 1999, p.6). In this study, I analysed the following constructs as segments of participants' drawings:

- design elements;
- design principles;
- techniques; and
- ways of arrangement on the format;

in order to establish

- how much knowledge they retained;
- what their conceptual understanding of the constructs were; and
- the skills and intent evident towards realising a particular design principle.

In this section it will be argued that:

- Participants, who reproduced the examples in the tutorial accurately, did not necessarily have better conceptual understanding of the constructs tested.
- Schemas not resembling the examples in the tutorial closely, but realised the design principle in question by using other design elements, techniques and arrangements on the format, demonstrated intent as well as conceptual understanding.

Schemas of participants' understanding of how to visualise the design principles "unity, asymmetrical balance" and "visual texture" will be presented and analysed.

Discussion

In the same test as discussed in the previous section (4.3.4.2, Visual analysis) a second section consisting of three questions, required participants to demonstrate knowledge, understanding and visualising skills of specific design principles, elements and techniques through visualisation or drawing schemas. I designed directed drawing tasks towards specific design principles and design elements and techniques in order to gather information about the segments (Tversky, 1999) of the constructs in their schemas (drawings). I wanted to know:

- What participants learned about the design principle "unity"?
- What participants learned about the design elements "shape, size, pattern, tonal value, line" and "texture"?
- What techniques could they implement to manipulate the elements and arrange them in such a way that the design principle required is realised?

Information about the above questions would help me to establish (1) what the participants knew and understood about the underlying conceptual structure of the domain of aesthetics in product design (Tversky, 1999), and (2) how the tutorial contributed to their knowledge and understanding.

The drawing tasks in the test were:

- Question 1: Illustrate the design principle "unity" achieved through "shape" and "pattern".
- Question 2: Illustrate the design principle "asymmetrical balance" achieved through "size" and "tonal value".
- Question 3: Illustrate the design principle "visual texture" achieved through "line, tonal value" and "shape".

In order to ensure validity and reliability, I created a coding system that I used for evaluating the drawings in the test (table 3.14 in chapter 3).

Participants' responses to question 1 indicated that they were able to create the principle of "unity" fairly well. Analysing their schemas and comparing them to slides in the tutorial (Addendum 14) indicated that they had good retention of the constructs used in the tutorial illustrating the design principle "unity".

Participant 9 was successful in purposeful application of the technique "repetition", by repeating the design elements "shape, line" and "tonal value" (figure 4.1). The participant arranged it in such a way on the format that the pattern of open and filled rectangular shapes that were created closely resembled the design of the woven wire construction in slide 9 in the tutorial illustrating the principle "unity without variety" (figure 4.2).

On the other hand, it seemed as if participant 14 recalled the design on slide 14 of the tutorial (figure 4.4) and schematised her recall as illustrated in figure 4.3. It is evident that the participant imitated the general shape of the basket in figure 4.4 and used the same spherical shape, on which she arranged rectangular shapes in patterns forming rows, very similar to the design in figure 4.4. It is apparent that participant 14 understood the design principle of unity by adding her own elements, namely the circular shapes as a handle for the lid of the basket, which is similar in size and shape to the circular shapes on the horizontal lines running in between rectangular shapes on the basket itself.

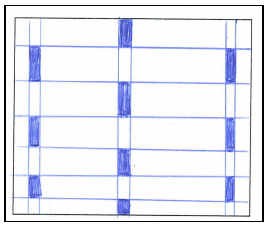

Figure 4.1 Participant 9's schema the design principle "unity"

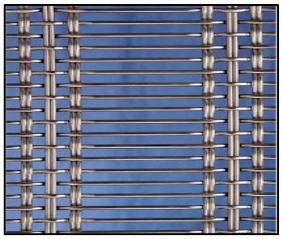

Figure 4.2 Image in tutorial illustrating the design principle "unity without variation" (slide 9)

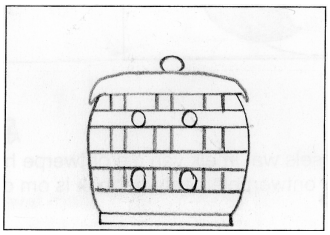

Figure 4.3 Participant 14's schema of the design principle "unity"

Figure 4.4 Image in the tutorial depicting the design principle "unity" (with emphasis on unity) (slide 14)

In contrast to the examples of unity without variation in the tutorial recalled by participants 9 and 14, participant 21 seemed to have recalled an example illustrating the principle "unity with variety" (figure 4.6).

From this response it was evident that the participant not only recalled the image in the tutorial well, but that the participant also understood how purposeful arrangement of the design elements could contribute to realising the principle "unity with variety", preventing the viewer from getting visually uninterested (Addendum 14, slide 13). Participant 21 used the technique of repetition to create patters of line and shape, and added variation to the unity by placing a dark rectangular shape as a "surprise" element (variety) on the format.

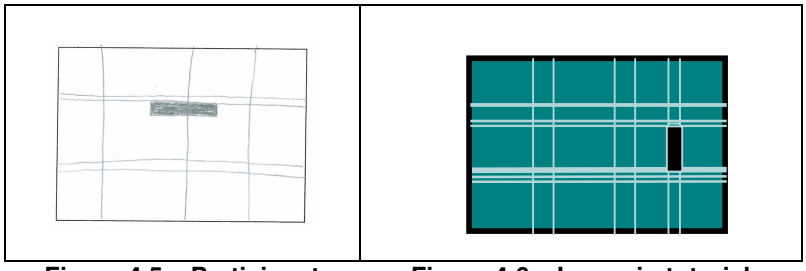

Figure 4.5 Participant 21's schema of the design principle "unity with variation"

Figure 4.6 Image in tutorial illustrating the design principle "unity without variation" (slide 13)

The second question in the test on drawing directed participants to visualise the design principle of "asymmetrical balance" through the use of the elements "size" and "tonal value". Although there was four designs in the tutorial illustrating the principle "asymmetrical balance", it seemed that there was one image recalled by more participants than any other design, namely the one in figure 4.8.

Participants 9 (figure 4.7) and 14 (figure 4.9) seemed to have had good recall of the techniques implemented as well as the way in which elements were arranged around the horizontal axis to achieve asymmetrical balance. However, both participants used fewer elements than used in slide 21 (addendum 14). The techniques recalled were that of repetition and of reversal. The design elements used were shape, line and tonal value. Both participants managed to arrange the elements in such a way on the format that asymmetrical balance was successfully realised.

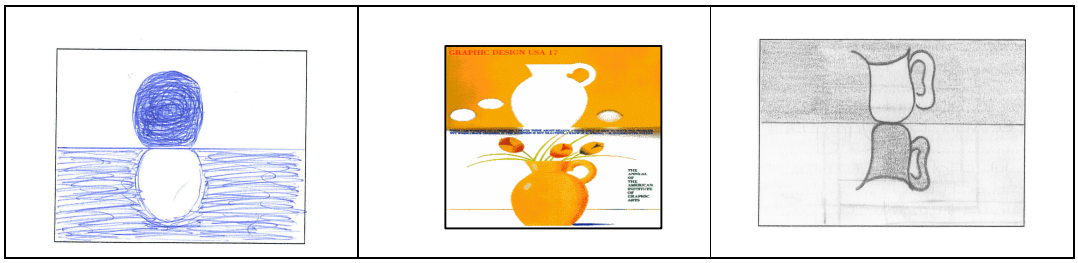

Figure 4.7 Participant 9's schema of the design principle "asymmetrical balance"

Figure 4.8 Image on the tutorial of the tutorial illustrating asymmetrical balance (slide 21)

Figure 4.9 Participant 14's schema of the design principle "asymmetrical balance"

The schema in figure 4.9 indicated participant 14's good recall of the example in the tutorial (figure 4.8) and how asymmetrical balance was achieved by using the elements "tonal value" and "shape". The resemblances can be seen in the way these elements were arranged around the horizontal axis of the format. In both images a medium tonal value in the

background of the top half of the format is balanced with a white background with medium-dark shape at the bottom. Neither of the participants' schema attempted to add new or different elements or arrangements than those in figure 4.8.

Contrary to this, participant 21 demonstrated her understanding of asymmetrical balance by implementing other techniques and arrangements of the same elements as the schemas in the tutorial. Figure 4.10 illustrates how participant 21 visualised the principle.

In the schema in figure 4.10, the shapes are placed at a diagonal angle from one another around the invisible horizontal axis, and not in a straight angle as in slide 21 (figure 4.8). Participant 21 also manipulated the sizes of the shapes to be completely different from one another, unlike the exact same sizes used for the dominating shapes in figure 4.8. This participant used tonal value to contribute to the visual balance by placing the small dark shape in the top right half of the format, balancing it with the larger white shape in the left bottom corner of the format.

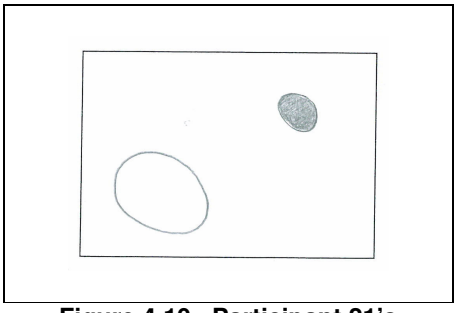

Figure 4.10 Participant 21's schema of the design principle "asymmetrical balance"

In question 3 of the test students were required to illustrate the design principle of visual texture achieved through line, tonal value and shape. The many different ways in which it is possible to combine and arrange the small number of design elements on the format in order to realise the same design principle, was evident in the different responses examined.

I found it more difficult to establish which of the designs in the tutorial illustrating visual texture, seemed to have been recalled. However, from close analysis of each schema in the responses, some resemblances emerged. It seemed as though participant 9's schema (figure 4.11) resembled some aspects of the image in figure 4.12 (Addendum 14, slide 33), illustrating the principle "visual texture" closest.

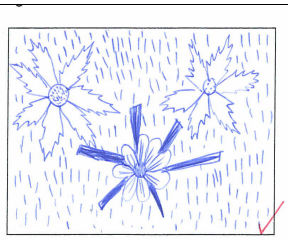

Figure 4.11 Participant 9's schema of the design element "visual texture"

Figure 4.12 Image on the tutorial depicting the design element "visual texture" (slide 33)

Recall of slide 33 (figure 4.12) was evident in the similarities between the schema of the student and that in the tutorial. Similarities are, e.g. the use of the elements "line" and "tonal value". Small, short dark lines in the background with lighter tones in between, creating visual texture, i.e. texture that can be seen, but not felt (Addendum 14, slide 32). In addition, both schemas used a shape resembling a flower on top of the texturised background; in the case of the image in the tutorial, the shape of a disa flower emerges from the white square shape, while participant 9 arranged three different flower-shapes randomly on top of the textured background, indicating a good understanding of how to visualise the design principle "visual texture" by using the elements "line, tonal value" and "shape". This participant successfully realised the principle "visual texture".

Some participants managed to visualise their understanding of the element of visual texture in a complete abstract way, not resembling any particular image in the tutorial, and yet creating a schema appropriately by using the required elements in completely new and abstract arrangements. Figure 4.13 illustrates the successful abstraction of the concept "visual texture" by participant 21.

The participant manages to draw three different schemas on the same format, using the element "line" to create shape and tonal value through density of her marks. Each schema differs in shape and organisation as well as the way lines run in different directions and spaced in a variety of ways, thus contributing to the illusion of visual texture. The participant uses shape in an abstract way, not resembling an object as seen in participant 9's schema (figure 4.13).

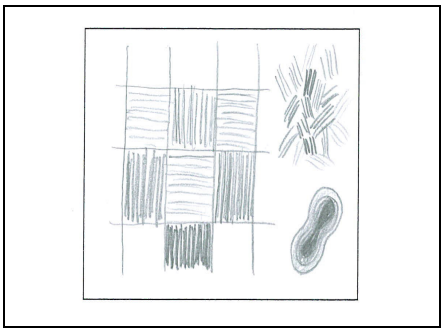

Figure 4.13 Participant 21's schema of the design element "visual texture"

In contrast to this, some participants did not seem to know the difference between the principle "visual texture" and "tactile texture". This is evident in the schema of participant 14, illustrated in figure 4.14. Close analysis of the schema indicated greater similarities to the image in figure 4.15, which illustrates the element of tactile texture.

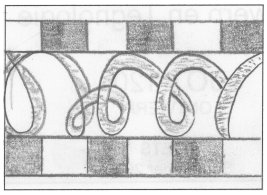

Figure 4.14 Participant 14's schema of the design element "visual texture"

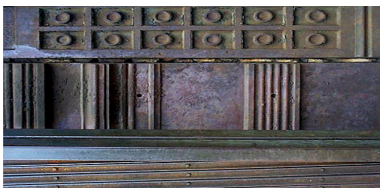

Figure 4.15 Image on the tutorial illustrating the design element "tactile texture" (slide 34)

The similarities between the two schemas were imbedded in the way in which participant 14 used the elements "line, shape" and "tonal value" to resemble her understanding of raised areas and sunken areas on a tactile surface. The participant seemed to have enlarged certain elements, namely the white and medium-dark toned rectangular shapes in border-like patterns on both sides of curling medium-light toned lines creating a distinct feeling of a surface texture that can be felt when touched. It was the illusion of large flat raised areas on the format resembling the large flat raised areas in the image in the tutorial that indicated her recall of figure 4.12, illustrating tactile texture instead of visual texture (figure 4.15).

In summary it could be said that the drawings indicated that all the participants knew the design principles. However, not everyone recalled the design element "visual texture". It

was further evident that participants in most cases recalled a specific design in the tutorial illustrating the particular design principle/element in question.

4.3.4 Conclusion

The conclusion derived at answering research question 2 was supported by analysing the data on immediate retention and learning after a period of time, is presented here. The findings indicate significant correlations between learning on the immediate retention level and that of learning after a period of time pertaining to their understanding of the constructs of the domain under discussion:

- participants knew the design principles fairly well, except for the concept "balance", which seemed to be problematic for some in both stages;
- participants knew most of the design elements fairly well, except for "texture" which seemed to be problematic for some on the level of learning after a period of time;
- knowledge of how design techniques are implemented to manipulate elements and arrangements on the format started to emerge in the visual analysis as well as in the drawings at the level of learning after a period of time, which demonstrated an improvement from the level of immediate retention when knowledge seemed to be very poor; and
- there seemed visible evidence of the contribution that the tutorial made on the immediate retention of knowledge as well as in learning after a period of time.

4.4 Research Question 3: What are the implications of participants' behaviour/transfer for possible improvement of the tutorial?

Sub-question 1: How was knowledge transferred to participants' designs for their projects?

Sub-question 2: What was the sustained change in behaviour in the end-of-year examination?

4.4.1 Data collection for research question 3

The different activities in the module under discussion, which were focused on demonstrating the transfer of knowledge and sustained change in behaviour, will now be discussed. Data for establishing the transfer that had taken place were drawn from representational drawings[38] of designs for a project. Data for establishing whether the participants' ability to transfer knowledge demonstrated in the project could be sustained in a new situation were

[38] Representational drawings "show your intentions..." (Caborn *et al.*, 1989 p.32).

drawn from preliminary drawings[39] in the end-of-year examination. For analysing and interpreting the data for research question 3, I used the same procedure and system as were used to analyse the drawings discussed in section 4.3.2. (See table 3.14 in chapter 3 for the coding system used.)

4.4.2 Level 3: Behaviour/transfer

Participants' capabilities to apply the design principles and design elements in their own designs in their projects and in a sequential examination were designed in order to establish the extent to which participants' design skills had improved during the course of the module, as a result of the intervention with the tutorial.

Kirkpatrick names the third level in learning "behaviour". He describes behaviour evaluation as the extent to which trainees applied the learning and changed their behaviour immediately after and several months after the training, depending on the situation (Kirkpatrick, 1994).

4.4.3 Discussion

In the discussion that follows, I will analyse and discuss the representational drawings of the three participants under discussion. I will analyse and discuss what transfer of knowledge had taken place in their 3-D designs of different lamps. From the data presented, research question 3: "What are the implications of participants' behaviour/transfer for possible improvement of the tutorial?", will be answered.

4.4.3.1 Sub-question 1: How was knowledge transferred to participants' projects?

In the discussion that follows, it will be argued that participants retained their knowledge and were able to differentiate between the various design elements and could draw from their previous experience in order to develop better conceptual understanding of the constructs specific to the domain of aesthetics in design environments.

The representational drawings in the project indicated that although participants retained knowledge of the design principles and design elements fairly well, they failed to add much visual interest to their designs because of a lack of contrast and anomaly that usually prevent visual boredom on the side of the viewer (Wong, 1993).

Participant 9's portrayal of her lamp design reveals the design principles and design elements clearly. This participant's representational drawing (figure 4.16) depicts a

[39] Preliminary drawings "includes a simple investigation of the problem ..." and "are used to convey information related to shape, form and overall appearance" (Caborn *et al*., 1989 p.32).

magenta-coloured square box-shaped lamp. The participant manages to create unity by using the same transparent tissue paper on all sides, contrasting its thin visual weight and colour with the heavy visual weight of the brown bamboo frame. The lines of the bamboo frame form a decorative border. The repetitive use of the black coloured rope and the way in which it is tied around the connecting bamboo sticks, creates a pattern and adds visual interest to the design. Symmetrical balance is achieved by the equally visual weight around the vertical and horizontal axis.

The participant represented the idea clearly and with sufficiently clarity. It is evident that participant 9's intention was to design a transparent magenta box-like lamp with a bamboo frame tied with string and standing directly on the surface. However, in spite of her clarity and successful realisation of some design principles, this design lacks visual interest due to its emphasis on unity without variety through contrast or anomaly (Wong, 1993).

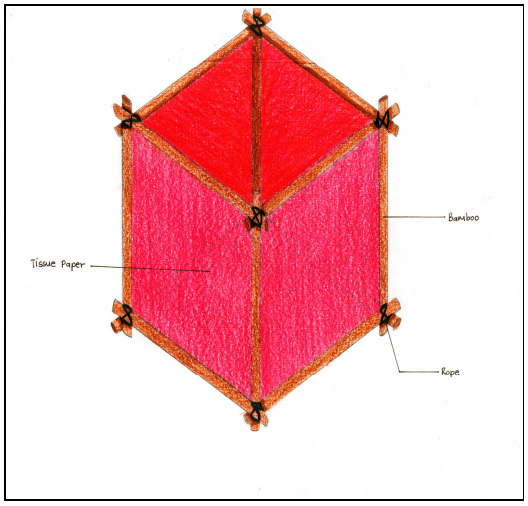

Figure 4.16 Participant 9's representational drawing in the design phase of the project

An analysis of participant 14's design in figure 4.17 demonstrates that the participant successfully revealed the design elements and its appropriate arrangement in order to realise particular design principles. This participant achieved unity by using the curved line at the bottom, repeated in the curvature of the sides of the lamp, as well as in the decoration at the top. Participant 14 created unity with variety by including straight lines in the "windows" or holes where the light would shine through. Symmetrical balance was created by the way in which participant 14 arranged the negative spaces around the vertical axis of each segment of the lamp. Horizontal asymmetry was achieved by her use of tonal value, placing the darker (and heavier) black at the bottom and gradually introducing lighter red and

yellow. This participant's use of shape and size also contributes to asymmetrical balance. In addition, the way in which the participant places the wider half-circular shaped negative spaces at the bottom of the lamp also supports the concept of visual balance asking for heavier shapes to be at the bottom of a format rather than at the top. This creation of scale through the negative and positive spaces in relation to each other indicates participant 14's sense of proportion. There was an equal distribution of visual weight around the vertical axis at any of the six sides of the lamp. Horizontally the yellow light shining through the "windows" asymmetrically balanced the black at the bottom.

Participant 14 represented the idea clearly and with sufficient clarity. It is evident that this participant intended to design a lamp that resembled a building/tower standing directly on the surface. However, the design also lacks visual interest due to limited variation of technique and lack of contrasting elements (Wong, 1993).

In contrast to the two previously discussed designs, the drawing by participant 21 represented more visual interest, while at the same time revealing the design elements and principles clearly (Tversky, 1999). This participant also successfully revealed the idea with clarity.

Participant 21 created various design principles, namely unity, balance, illusion of movement, rhythm, scale and proportion. The participant arranged numerous design elements by applying techniques creatively; namely repetition, change of direction, contrasting scale by repeating the design elements of colour and shape in order to create unifying patterns. The participant repeated the decorative wavy pattern resembling waves, suggesting movement (in correspondence with her marine theme) at the top and the bottom of the shade.

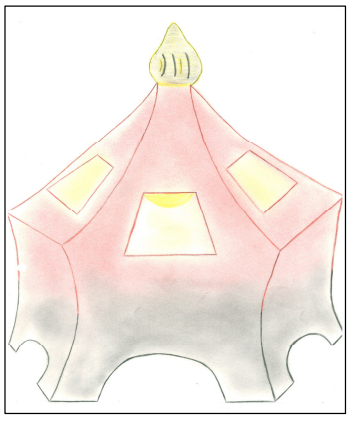

Figure 4.17 Participant 14's representational drawing in the design phase of the project

Participant 21 also repeated the cut-out shapes of the stylised fish. All the shapes used in this design were geometrical and stylised, contributing to the unity in the design. The background colour of the shade was ultramarine, supporting the marine theme. The round shape of the lampshade also suggested movement. This participant achieved asymmetrical balance around the horizontal axis by using different shapes and sizes of the cut-outs bearing equal visual weight, on the unifying background colour and patterned border. This subtle asymmetry contributed to the visual interest of the design. Visual interest was further created by the contrast in scale. The big, solid shapes of the top and bottom of the shade, contrasted with the small scale of the cut-outs. There was no single focal point in the design. The design rather kept the viewer's eye moving around the whole format, interest being maintained by the subtle variation in direction of the wavy pattern bordering the top and bottom of the lamp as well as of the negative space of the fish.

The representational drawings of the project indicated to me that transfer of knowledge had taken place. Participants were able to transfer their knowledge of design principles, design elements and design techniques they have learned through 2-D designs in the tutorial to 3-D designs as visualised in real 3-D space. They managed to demonstrate this transfer of knowledge because their drawings:

- revealed the design elements and techniques clearly;
- represented the ideas well; and
- were sufficiently clear.

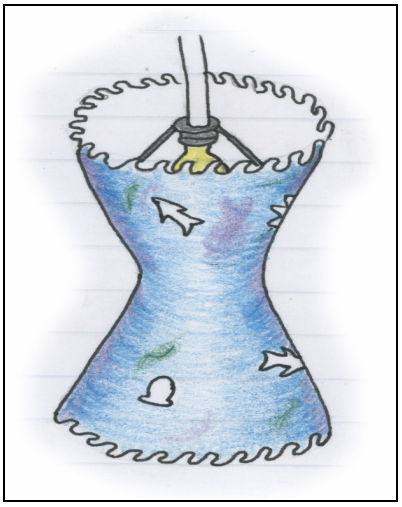

Figure 4.18 Participant 21's representational drawing in the design phase of the project

However, except in the case of one participant, there was a general lack of visual interest in participants' designs. They were uninteresting and visually boring due to a lack of variety of techniques and contrasting elements.

4.4.3.2 Sub-question 2: Was the changed behaviour sustained?

In the discussion that follows, I will analyse and discuss preliminary free-hand pencil drawings of a lamp designed for a different purpose than those designed in the participants' projects. From the data presented, research question 3 will now be answered.

It will be argued that participants sustained transfer of knowledge by revealing design principles, design elements and techniques with clarity. It will also be argued that:

- creating balance in 3-D objects is problematic;
- some improvement in the visual interest in their designs was evident;
- although not everybody could represent their ideas clearly enough, there was enough evidence of other improvement in order to infer that there was a change in participants' behaviour.

The exploratory drawing by participant 14 (figure 4.19) is an example of poor behavioural change. Although the participant managed to reveal the minimum design principles, elements and techniques required by the problem statement, this participant could represent the idea with limited success. In addition the participant lacked the technical skill to convey 3-D shapes convincingly. Visual interest was also evident in a limited way.

Participant 14 managed to reveal the design elements and techniques used to realise some design principles. The participant realised the principle "unity" by repeating the idea of nature through the organic shape of the connecting piece running from the electric fitting to the lampshade and the texturised geometric leaves on the edge of the shade. Emphasising the leaves created a focal point. This was achieved by guiding the viewer's eye (through the illusion of movement in the organic shape of the connecting piece) to the front of the design and the edge of the shade. There is no symmetry in the design indicating that the participant knew the difference between symmetry and asymmetry. Her design, although demonstrating an attempt at realising asymmetrical balance, is not well balanced due to the fact that too much visual weight is put on the front edge of the lampshade. The wide side of the triangular shape at the front, together with the heavy shapes of the leaves, is not sufficiently balanced by the shapes and their sizes to the back of the shade and connecting piece. The shape of the shade together with the placement of the connecting piece defies her attempt at realising asymmetrical balance.

Participant 9's design was not represented with sufficient clarity. It was not clear where the light would be shining through. The participant also failed to convince the viewer of the 3-D shape of the shade due to her inability to apply the elements "line" and "tonal value" to support the round shape of the triangular shade. In spite of this lack of technical drawing skills, the participant represents the idea clearly enough to let the viewer understand how the connecting piece should fit into the shade and into the electrical fitting. Participant 9 brought limited visual interest into the design through the geometric shape of the shade contrasted by the organic shape of the connecting piece. There was limited use of texture, line and movement, categorising this as a weak design with very little visual interest and little improvement from the design in the project discussed previously. The participant also failed to indicate how the electrical parts inside the lamp were envisaged. It was not clear where and how the electrical fitting in the shade would function.

In contrast to the weak design by participant 14, significant improvement was evident in the exploratory drawing by participant 9 (figure 4.20). Although the participant's one-point perspective drawing seemed to distort the design somewhat, there was sufficient evidence of skill and knowledge to convince the viewer of the intent. Participant 9 revealed the design elements and techniques used to realise particular design principles with conviction. Unity was achieved through the repetition of the rectangular shapes in the stand; line was created by the clear edges of the shapes, rhythm through the pattern of solids and open textured areas in the shade and the stand and through contrasting tonal values in both the stand and the shade.

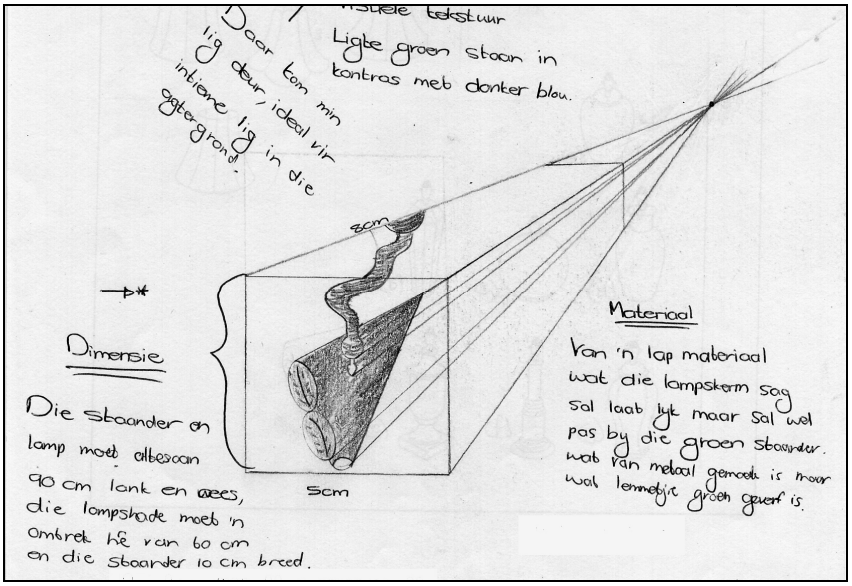

Figure 4.19 **Participant 14's exploratory drawing in the end-of-year examination**

Asymmetric balance was achieved successfully through the equal spread of visual weight around the horizontal axis of the design. The long, narrow shape of the stand balances the large, wide oval shape of the shade. Emphasis on the shade was created by the sudden contrast between rectangular shapes in the stand and the oval shape of the shade. Attention was further drawn to the shade by direction of the textured pattern running horizontally around the shade.

The participant represented the idea well. The 3-D shape was convincingly conveyed through her skilled use of line and tonal value. The shade's oval shape was created convincingly by modelling the shape with line. Visual depth was created by darker areas where light failed to reach and light areas where light is reflected most, supporting the definition of shape and size. Visual interest was created by the big variety of contrasting elements and techniques in the design. The participant contrasted solid areas with open, textured areas; direction of pattern is changed in the stand and the shade; eye movement ensured by the textured pattern in the shade running around the shade and guiding the viewer's eye around the whole design. In addition to this, it is clear to the viewer how the participant envisaged the electrical fitting in the shade. Participant 9 demonstrated significant improvement in realising visual interest by combining design elements and techniques in a creative and novel way.

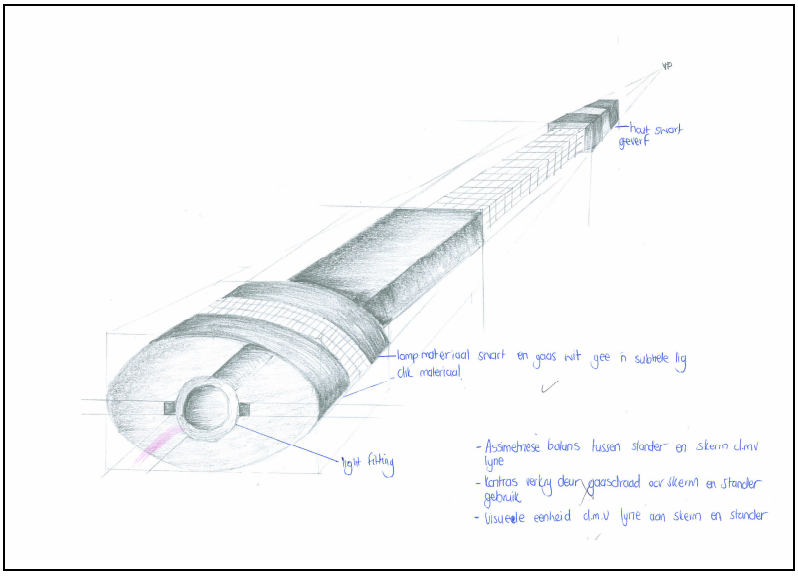

Figure 4.20 **Participant 9's exploratory drawing in the end-of-year examination**

On the other hand, participant 21's exploratory drawing in the end-of-year-exam (figure 4.21) exemplifies sustained transfer of knowledge, without significant improvement since the evaluation in the project, discussed previously, although it was already fairly good, as indicated in the earlier discussion.

This participant created unity by repetitively use of the same organic quality in the design evident in the shape, pattern and texture of the shade and the stand. Emphasis was put on the shade by the wavy pattern guiding the viewer's eye around the whole shade. By balancing the short, wide shape of the shade with the longer and thinner stand, the participant created asymmetrical balance around the horizontal axis. However, the long flat part of the shade resting on the surface was disturbing and its excessive length somewhat defied the balance created. Rhythm was successfully created by the repetitive curve in the shape of the linear pattern on the shade as well as by the round shape in the organic pattern in the stand.

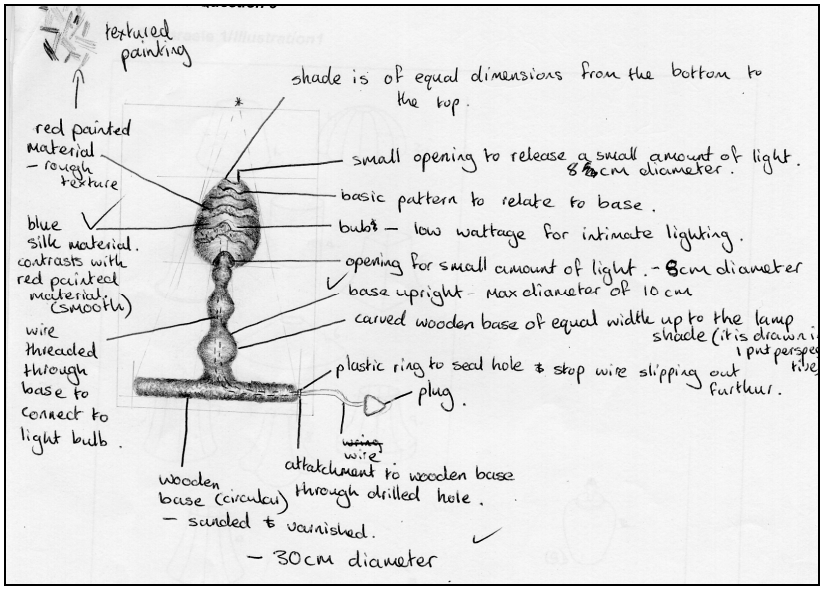

Figure 4.21 **Participant 21's exploratory drawing in the end-of-year examination**

Participant 21's idea was presented clearly in her drawing. She created shape successfully through line and tonal value. With a variety of marks she managed to define the 3-D shape as well as the texture of the shade and the stand. Using darker tones for areas where light is not reflected and lighter tones where light is reflected created depth.

The participant used the technique of contrast and variety in texture to create visual interest in her design. However, it seemed that contrast is not big enough to make it as visually exciting as in the design by participant 9 discussed previously. This is due to the fact that

there is an over-emphasis on repeating similarities and unity without any elements of surprise.

4.4.4 Conclusion

The conclusion derived at answering research question 3 was supported by analysing the data of representational drawings in projects and exploratory drawings of lamp designs in the end-of-year examination. The findings indicated that transfer of knowledge had taken place in the projects. Participants were able to transfer their knowledge by revealing the design principles, design elements and some of the techniques clearly. They represented their ideas fairly well with sufficient clarity. However, except in the case of one participant, there was a general lack of visual interest in participants' designs. It was visually uninteresting due to a lack of variety of techniques and contrasting elements. On the other hand, participant 9 demonstrated significant improvement in realising visual interest by combining design elements and techniques in a creative and novel way. Participant 21's exploratory drawing in the end-of-year-exam (figure 4.21) exemplified sustained transfer of knowledge without significant improvement since the evaluation in the project, discussed previously, although it was already fairly good, as indicated in the earlier discussion.

4.5 Conclusions and recommendations

The findings of this research will now be concluded. The findings for each research question will be summarised separately with recommendations for the improvement of the tutorial.

4.5.1 Research question 1: What are the implications of the participants' reaction to the tutorial for the possible improvement thereof?

Sub-question 1 Were the participants satisfied/dissatisfied with the tutorial?

Sub-question 2: What was the perceived usefulness of the tutorial?

Sub-question 3: What about the tutorial were the participants dissatisfied with?

The conclusion derived at through analysing the data in support of answering research question 1 is summarised below:

- Did the participants like and enjoy the training?
- Was it easy?
- Were the participants comfortable using the tutorial?
- Did participants understand how to work with the tutorial?
- Did the participants consider the training relevant?

- What was the perceived practicality and potential for applying the knowledge and learning?
- Was it good use of participants' time?
- Which aspects of the tutorial did participants not like?

In order to maximise users' satisfaction, and therefore their motivation to use the tutorial participants' dissatisfaction with the some aspects of the tutorial should be taken into consideration. The tutorial should:

- be shortened, by breaking it up in separate sections that could be worked through independent of each other;
- be accessed in alternative ways; and
- include navigational options.

Despite participants' negative reactions about the time it took to complete the tutorial, their motivation to work through the tutorial implied their overall positive feelings about the tutorial. This indicated that the participants were motivated and felt positive about the design tasks in the module. They thought that the tutorial was easy and enjoyable to use. Except for some negative responses towards navigational aspects, their responses indicated their general satisfaction with the programming aspects of the tutorial. The findings in research question 1 indicated the following:

- possible limitations of the tutorial;
- possible limitations in the delivery of the tutorial; and
- participants' motivational levels in using the tutorial.

4.5.2 Research question 2: What are the implications of participants' retention of knowledge for possible improvement of the tutorial?

Sub-question 1: What knowledge was retained immediately after exposure to the tutorial?

Sub-question 2: What knowledge was retained after some time?

In their schemas of design principles and design elements, I investigated the data informing me of:

- how well the drawings revealed the design elements and techniques used to realise design principles in the schemas as well as in the designs;
- sufficient clarity in the schemas; and
- sufficient visual interest in the designs.

The conclusion derived at answering research question 2, which was supported by analysing the data of immediate retention and learning after some time, is presented here. The findings indicate significant correlations between learning on the immediate retention level and that of learning after some time pertaining to the participants' understanding of the constructs of the domain under discussion:

- participants knew the design principles fairly well, except for the concept "balance", which seemed to be problematic for some in both stages;
- participants knew most of the design elements fairly well, except for "texture" which seemed to be problematic for some on the level of learning after a period of time;
- knowledge of how design techniques are implemented to manipulate elements and arrangements on the format started to emerge in the visual analysis as well as in the drawings at the level of learning after some time, which demonstrated an improvement from the level of immediate retention when knowledge seemed to be very poor; and
- there seemed visible evidence of the tutorial's contribution in immediate retention of knowledge as well as in learning after some time.

The implications of the above findings for improving the tutorial can be summarised as follows:

- the principle balance needs clarification with more explicit explanations and examples
- the element texture needs clarification, more explicit examples;
- explicit explanations and examples about technique should be included;
- explicit explanations and examples about visual interest should be included; and
- interactive exercises/experiments with techniques revealing explicit visual effects in order to make students aware of the concept “visual interest” should be included.

4.5.3 Research question 3: What are the implications of participants’ behaviour/transfer for possible improvement of the tutorial?

Sub-question 1: What knowledge was transferred to participants’ designs for their projects?

Sub-question 2: What was the sustained change in behaviour in the end-of-year examination?

The conclusion to research question 3 was:

- All participants managed to reveal the design principles and elements with sufficient clearly, indicating that transfer of knowledge regarding principles and elements have taken place sufficiently in order to change participant's behaviour. This change in

behaviour was sustained after a period of time during the examinations.

- Some participants improved significantly in transferring their knowledge of design techniques from the first assessment on level 3 to the second assessment, while some participants who already performed well in the first assessment, did not improve much.
- Some participants' could represent their ideas well while some still had not achieved the necessary drawing skills.
- Most participants did not achieve creating visual interest well in the first assessment on level 3. However, in the second assessment significant improvement in the transfer of this skill was evident in the drawings of some participants.

The implications for improving the effectiveness of the tutorial are the following:

- students should be encouraged to revisit the tutorial more often once interaction is built in;
- an interactive visual analysis exercises should be included to give students greater exposure to this type of thinking; and
- the lecturer should ensure that the learning curve continue also for students who already perform well in level 2 by individualised enrichment and challenges – develop an advanced tutorial.

From the conclusion of this research I could group the tendencies occurring into segments of patterns, families of concepts and categories of learning, as illustrated in figure 4.22.

Figure 4.22 Segments of patterns, families and categories (see next page)

Figure 4.22 Segments of patterns, families and categories