DESIGN LEARNING MIND-SETS

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Abstract

It is postulated that students have prevailing mind-sets which influence the performance of their design learning during their university education. These mind-sets - when identified - can be influenced appropriately to augment students' design learning capabilities. In light of this assumption, this paper intends to present insights towards characterizing design learning mind-sets. This will be based on a theoretical framework that involves two main constructs: pedagogy and student's learning approaches. These two constructs are explored through the Approaches and Study Skills Inventory for Students (ASSIST survey) and semi-structured interviews administered to industrial design students. This paper presents the results obtained from one university. Based on examining the ASSIST survey and transcripts of the semi-structured interviews conducted, insights were obtained regarding: 1) the learning approaches that industrial design students deployed; and 2) how learning approaches that industrial design students deployed and pedagogy administered by teachers informs the state of students' design learning mind-sets.

Keywords: Design education, Design learning, Mind-set

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1 INTRODUCTION

Studies have shown that the state of mind-sets of students affects the success of their learning. The concept of mind-set is closely connected to individual beliefs about own abilities and capabilities. According to research findings two different assumptions are mirroring the view on mind-sets, the *entity* and the *incremental* presumption. The supporters of the entity theory advocate that basic qualities like intellectual abilities are innate and an unchangeable state of a "fixed or being mind-set". In contrast, following the incremental theory advocates that basic abilities can be developed through hard work and dedication as a "growth or becoming mind-set" (Yeager & Dweck 2012; Johnson & Stapel 2010). It has been indicated that these mind-sets are susceptible to cultivation by prominent counterparts such as parents, teachers, coaches and superiors (Dweck 2006).

In the context of design learning, students face several challenges. They are expected to develop design abilities that comprise solving ill-defined problems, adopting meta-cognitive strategies and employing abductive and appositional thinking (Cross 1990; Kolko 2009; Roozenburg 1993). These abilities can't be elucidated as a variant of routine procedures (Gero 2000). Their design learning can also be further limited by prior knowledge that may be "incorrect, inconsistent or incompatible" (Newstetter & Michael McCracken 2001).

Several studies have advocated the enhancement of students' learning capabilities through cultivation of mind-sets. These include recommendations to develop "entrepreneurial mind-sets" in engineering education (Ali et al. 2012; Huang-Saad 2009; Kriewall & Mekemson 2010), 'proper method mind-set towards systematic methods'(Person, Daalhuizen, and Gattol 2012) and 'strategic mind-set awareness' for situations of complexity and high uncertainty (Yorks and Nicolaides 2012).

However, how does this concept of mind-sets apply to design learning? When faced with complex and open-ended design tasks, how do design students cope with these uncertainties, what approaches do they deploy in their learning?

2 INVESTIGATING MIND-SETS IN DESIGN

2.1 Exploring the design learning mind-set (DLM)

The exploration of the design learning mind-set (DLM) construct commences with a working definition derived from an amalgamation of definitions based on Figure 1:

A design learning mind-set can be defined as a characteristic mental state that influences how the person interprets and responds to situations in design education. It can be discerned through the learning approaches the person applies.

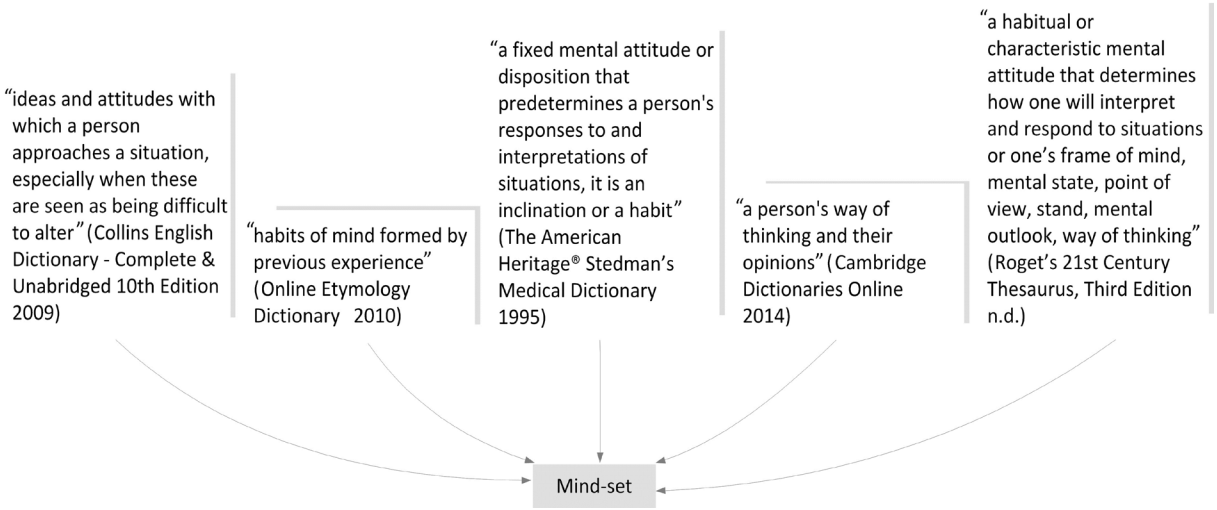

Figure 1. Definitions of mind-set

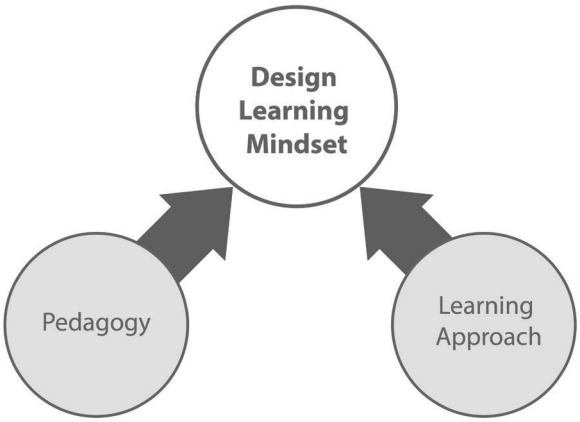

Figure 2. Theoretical research model of the design learning mind-set

This study thus proceeds with the development of a theoretical framework that presumes that a student's mind-set in design learning can be characterized through 2 constructs which are; the *student's learning approach* and the *pedagogical* experiences faced in their design education. These factors ascertain the direction of enrichment with regards to the student's design learning. The constructs involved are illustrated in the theoretical framework as in Figure 2.

2.2 Learning approach

Students entering design schools in higher education systems have been exposed to experiences from previous education systems that demand to follow certain requirements. An education system can described as an accumulation of methods of assessment (Bain & Thomas 1984; Scouller 1998; Segers et al. 2006), teaching methods and approaches (Gow & Kember, 1993; Trigwell, Prosser, & Waterhouse, 1999) and classroom activities (Brown et al. 1989; Hamer 2000; Svinicki & Dixon 1987); thus different educational systems influence the ways of how students choose to formulate and deploy their learning **approaches**. The following have been described as three key learning approaches:

1. Surface approaches with intention of memorising - often without understanding by rote learning; (Marton & Säaljö, 1976; Kember, 2000)
2. Deep approaches to seek comprehension (Noël Entwistle & Marton, 1989; Marton & Säaljö, 1976; Jackson, 2012).
3. Strategic-in- between-=approaches that combine understanding and memorising to 'seek comprehension then committing to memory' or 'memorising to achieve understanding' (Kember 2000, p.104).

These approaches have been reported to influence student's learning outcomes in different ways. The deployment of surface approaches with the emphasis to reproduce information is expected to limit the progress of higher levels of understanding (Marton & Säaljö 1976). These approaches could well have been embedded in students due to the structure of schools that rely on passive rote learning with a tendency to favour reproduction of information, rather than encouraging the active meaningful learning (Ausubel & Fitzgerald 1961).This indicates the prevalence of dissimilar approaches in design learning that students deploy. Some approaches contradict the requirements for design learning in higher education.

3 EMPIRICAL APPROACH

This study explores the *pedagogy* and *learning approach* using two research methods, a questionnaire, the Approaches and Study Skills Inventory for Students (ASSIST survey) (Entwistle 1997) and semi-structured interviews.
The combination of quantitative and qualitative data provides a foundation to explore the characterization of the *DLM* construct. The quantitative analysis of the survey is compared to the thematic analysis (Charmaz, 2006) of the semi-structured interviews to tackle the established research questions. In the qualitative analysis, the constructs of the ASSIST survey are utilized to provide a lens for interpretation of the data.

3.1 Research questions

As there is still no common understanding about the definition and the way a mind-set is built, we started with the following two basic questions:
What is mind-set towards design learning?
And more specifically:
How can a mind-set be defined, characterized and categorized?
Based on the theoretical framework, these guiding questions were then further broken down into two concrete research questions which will be considered each separately:

1. What are the learning approaches that industrial design students deploy?
2. How do learning approaches of industrial design students and pedagogy administered by teachers influence the students' design learning mind-set?

The current concepts of mind-sets are limited in its way to support the understanding of characteristics with regard to design learning. Consequently, the characterization of design learning mind-sets from the findings was developed primarily through exploring the existing learning approaches scales. The learning approaches as interpreted by the ASSIST survey comprise three main categories with 52 items and are measured through related sub-scales on a five-point Likert scale. The approaches and its sub-scales are categorised into:

1. **Deep learning approach including the sub-scales:** Seeking meaning, relating ideas, use of evidence and interest in ideas.
2. **Strategic learning approach including the sub-scales:** Organised studying, time management, alertness to assessment demands, achieving and monitoring effectiveness.
3. **Surface learning approach including the sub-scales:** Lack of purpose, unrelated memorising, syllabus-boundedness and fear of failure.

The ASSIST survey also comprises two other categories relating to student's preferences with regards to types of instruction. These two categories include "supporting understanding" that is related to the deep learning approach and "transmitting information" that relates to a surface learning approach. The three learning approaches and students' preferences of types of instruction form the basis of interpretation of the semi structured interviews conducted.

3.2 What are the learning approaches that industrial design students deploy?

The ASSIST survey and semi –structured interviews were distributed to industrial design students in a public university in Malaysia. Data for the purpose of this analysis were derived from 20 first year students and 25 final year students that responded to the survey; and semi-structured interviews from 3 first year and 3 final year students. A total of 411 minutes of interview recording was collected for the 6 interviews. All 6 interviews were fully transcribed on a verbatim basis and coded in two phases: initial coding and focussed coding (Saldana 2009).
In the initial coding phase, the transcriptions were coded to preserve actions and stuck as closely to the data as possible by an incident-to-incident basis. In the following focused coding phase, the initial codes were iteratively re-categorized and merged with the existing ASSIST survey categories which provided the lenses for the coding process.

In the following we will describe the results of the questionnaire (3.2.1) and of the interviews (3.2.2) will be described.

3.2.1 ASSIST survey

The ASSIST survey data was computed in SPSS and its mean scores were analysed using the independent samples T-test. Figure 3 shows a comparison of mean scores for the 3 learning approaches deployed by the first year and final year students. The graph generally shows an increase in all 3 types of learning approaches. However, only the mean scores for the deep learning approach significantly increased with $p<0.01$. There were no significant changes for the mean scores of the strategic learning approach with $p=0.70$ and surface learning approach with $p=0.60$

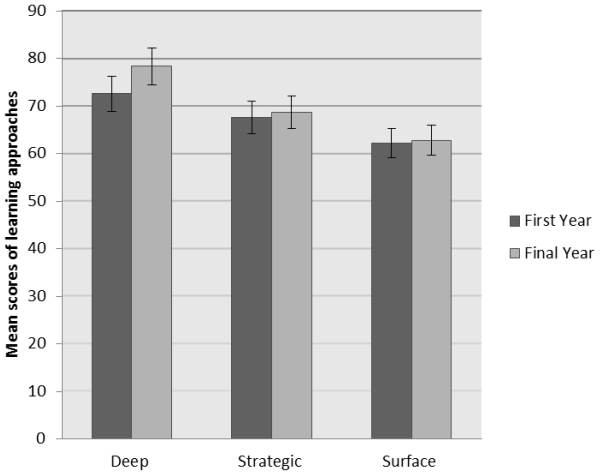

Figure 3. Mean scores of learning approaches in University X

In the progression of comprehending the statistical data at hand, it was imperative that a closer look at the existing data needs to be conducted. Subsequently, the individual scores of each student was scrutinised. Among the 45 respondents, there were cases where the mean scores for the other two learning approaches were approximate to the mean score of their highest learning approach. This indicated that the pure categorisations of the three types of learning approaches as instigated by the ASSIST survey was inadequate to explain the learning approaches that the students were deploying.
Consequently, the mean scores of each learning approach for each student was then compared. The scores that differed from each other at less than 5 points were distinguished. Table 1 shows the learning approaches that the students deployed.

Table 1. Learning approaches deployed by students in University X

	1 Learning approach			2 Learning approaches			3 Learning approaches				Total
	Deep	Strategic	Surface	Deep-Strategic	Deep-Surface	Strategic-Deep	Deep-Strategic-Surface	Deep-Surface-Strategic	Strategic-Deep-Surface	Surface-Strategic-Deep	
First Year	6	2	2	0	5	3	0	0	1	1	20
Final Year	16	0	0	3	1	2	1	2	0	0	25

The combinations of learning approaches that students deployed could be categorised into three groups that consisted of one, two and three learning approaches. Each combinatory category consists of sub-categories that are arranged based on the sequence of higher mean scores followed by lower mean scores.
From the table above, 57% of the students deployed exclusively one learning approach. The remaining 31% and 11% of the students could be discerned to deploy two and three learning approaches. 13% of

the students deployed a combination of deep and surface learning approaches and 18% of them deployed a combination of deep and strategic learning approaches.
Out of the 20 first year students, 50% of them deployed a combination of two or three learning approaches. There appeared to be decrease in the percentage of combinatory learning approaches as out of the 25 final year students, 36% of them deployed a combination of two or three learning approaches.

3.2.2 Semi-structured interviews

Concurrent to the analysis of the ASSIST survey data, the analysis of the semi-structured interviews supported a deeper exploration of the learning approaches that the industrial design students were deploying. The ASSIST survey constructs had provided a critical lens to the categories and sub-categories that emerged from the transcribed interviews. Several sub-categories were added, removed and renamed compared to the original sub-categories presented in the ASSIST survey. This can be discerned from Table 2.

Table 2. Co-occurrences and frequency of quotes

Co-occurences of quotes between interviewees			Frequency of quotes							
			Year 01				Final Year			
Codes	Year 01	Final Year	Student 1	Student 2	Student 3	Total count	Student 1	Student 2	Student 3	Total count
deep learning: facing ambiguity	3	3	4	1	4	9	1	7	0	8
deep learning: interest in ideas	3	3	5	1	4	10	3	8	0	11
deep learning: relating ideas	3	3	2	4	5	11	1	19	7	27
deep learning: seeking meaning	3	3	4	3	2	9	5	16	2	23
deep learning: using evidence	3	3	2	1	3	6	3	8	3	14
			17	10	18	45	13	58	12	83
strategic learning: alertness to assessment demands	2	3	6	5	0	11	1	2	5	8
strategic learning: monitoring effectiveness	3	2	3	2	7	12	0	2	0	2
strategic learning: organised studying	3	3	2	7	6	15	2	2	1	5
strategic learning: time management	2	2	3	1	0	4	1	1	0	2
			14	15	13	42	4	7	6	17
surface learning: administering routine actions	3	3	13	14	7	34	6	11	4	21
surface learning: anticipates dictation	2	1	3	5	0	8	0	0	3	3
surface learning: limited use of evidence	3	3	1	2	1	4	1	2	2	5
surface learning: shallow conception of knowledge	3	3	1	7	4	12	6	4	6	16
			18	28	12	58	13	17	15	45
Learning approaches deployed			Surface-Deep-Strategic	Surface	Deep-Strategic-Surface		Deep-Surface	Deep-Surface	Surface-Deep	

A new sub-category of "facing ambiguity" was introduced in the deep learning approach. This sub-category refers to incidences where the students indicated reactions that precipitated positive actions when faced with ambiguous situations. With regards to the strategic learning approach, the sub-categories remained similar to those advocated by the ASSIST survey. The sub-categories in the surface learning approach category was revised with four different sub-categories:

1. *Administering routine actions* was based on "Unrelated memorising" from the ASSIST survey. It currently includes additional activities that is expected from design learning such as sketching, prototyping, etc.
2. *Anticipates dictation* emerged from incidences where students relied on their teachers to decide their next course of actions.
3. *Limited use of evidence* is related to incidences where students indicated superficial attempts to using evidence in their design learning.
4. *Shallow conception of knowledge* is related to incidences where students indicate unawareness towards the possible depth of knowledge that needs to be conceived.

The last two sub-categories emerged from quotations that indicated that students were deploying activities that were categorised in the deep learning approach such as *seeking meaning, relating ideas and using evidence* on a superficial level.
The utilization of frequencies was used to distinguish patterns that might emerge by the importance that students place on their accounts of their design learning experiences. The types of learning approaches that students deployed were then enumerated by the total frequencies of the sub-categories in each learning approach. The frequencies suggest that two of the first year students deployed all three learning approaches while one of them deployed a surface learning approach. The frequencies also indicated that the final year students consistently deployed deep and surface learning approaches in their design learning.
Comparing the frequencies of the deep learning approach deployed by the first and final year students, the frequency has more than doubled indicating more deep learning approaches being deployed in the final year. The frequencies also suggest that the strategic learning approach decreased in more than half. The frequencies for the surface learning approach is approximately similar.

3.3 Design learning mind-sets informed by industrial design students' learning approaches and teachers' pedagogy

The theoretical research framework that this study is based upon suggests that pedagogy administered by teachers influences the student's learning approach and design learning mind-set. Thus, a comparison of the learning approaches that the students deployed compared to the type of instruction that the students prefer is further probed into. This is illustrated in Figure 4.

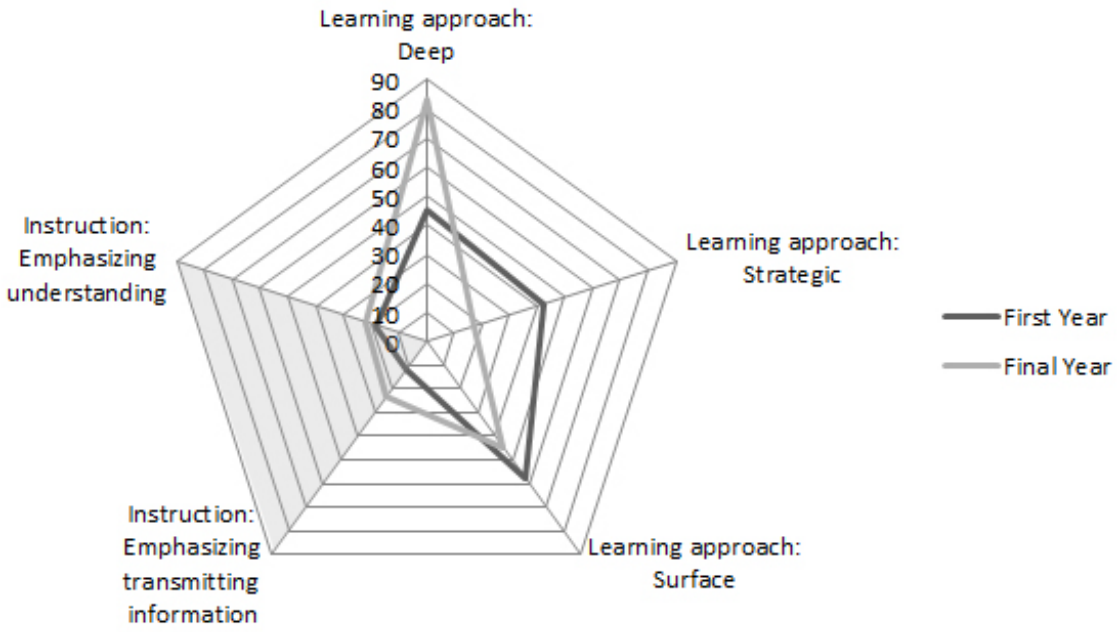

Figure 4. Comparison of first year and final year: learning approaches and instruction preference

The differences in the three learning approaches do not seem to influence the preference for teachers whose instructions emphasize understanding. However, the final year students that are in favour of deep learning approaches and less value strategic learning approaches preferred teachers whose instructions emphasize transmitting information.
The connections of the learning approaches that students deploy with the preferred instruction informs of the possible types of mind-sets that design students possesses in design learning. This inter-connection is illustrated as in Figure 5.

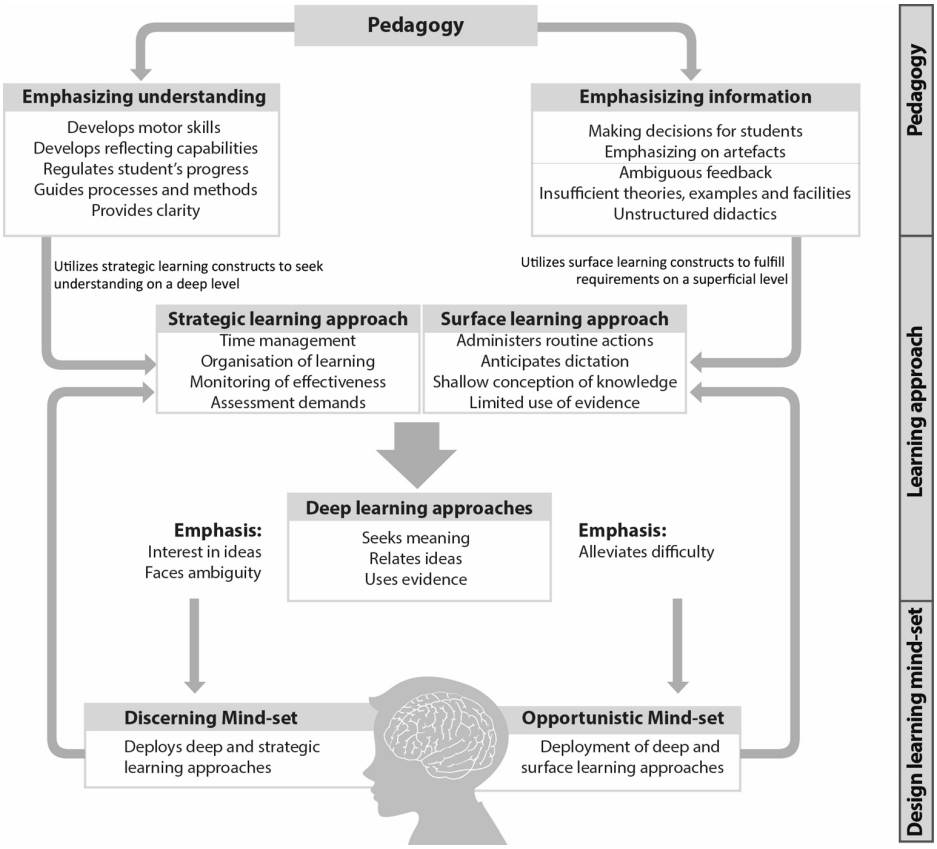

Figure 5. Comparison of first year and final year: learning approaches of the students and instructions by the teachers.

The types of instruction that makes up the pedagogy is categorised into two opposite approaches:
1) Instructions that emphasize understanding and
2) Instructions that emphasize information. Instructions that emphasize understanding tend to stimulate students' reflecting capabilities, regulate students' progress, guide students' processes and methods and provide clarity for the students. Instructions that emphasize information seem to be caused by ambiguous feedback, insufficient theories, examples and facilities, and unstructured didactics that might lead to teachers making decisions for students and instructions that emphasize on artefacts. These methods of instruction influences the learning approaches that the students deploy.
Activities required in design learning are strongly associated to deep learning approaches such as to seek meaning, relate ideas and to use evidence. Based on the analysis of the interviews, students deployed two different learning approaches that informs of the type of design learning mind-set that they possess.
The first learning approach deploys the activities required by the deep learning approach on a superficial level of understanding in order to get by. This learning approach informs to an ***opportunistic mind-set***. It is characterised with an emphasis to alleviate difficulties. The second learning approach deploys strategic learning approaches seeking deeper levels of understanding in the conquest for knowledge. This learning approach informs of a ***discerning mind-set*** in terms of design learning. It is characterised by an interest in ideas and the endeavour to face ambiguity.

4 SUMMARY AND FUTURE WORK

Evidence of different types and characterizations of mind-sets that students build during their design learning have been identified and shown. The combination of different instruments utilized for the analysis has provided a consolidated theoretical framework for further exploration. In particular, the findings regarding the distinctions between the learning approaches that are deployed by the two different types of design learning mind-sets.

This framework will allow a systematic elaboration of the distinctive design learning mind-set types. The results provide opportunities for further classification of specific learning activities related to the different design learning mind-set types. The final aim would be to test methods of intervention that would enable the improvement of these design learning mind-sets.
Next steps in this research will include observing and analysing students in controlled situations where critical situations can be introduced to observe the dynamic of students' learning approaches when faced with ambiguity. Additional survey and interview data will also be required for the establishment of accurate measurements of the constructs. It is hoped that through a rigorous design of proper experimental procedures, the characteristics of the design learning mind-sets may be accurately discerned.

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