UNIVERSITY OF SOUTHAMPTON

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING

ELECTRONICS AND COMPUTER SCIENCE

TOWARDS A TRUST MODEL IN E-LEARNING

BY

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Thesis for the degree of Doctor of Philosophy

June 2016

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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When a student is faced with uncertainty in the trustworthiness of a learning activity to meet their intended learning goals, it may cause anxiety and a lack of confidence in the learning. A student's trust in the learning activity is needed to reduce this uncertainty. This work develops a conceptual trust model for e-learning activities.

The proposed student's trust model is the Learning Outcome-based Trust (LOT) model. The antecedents of trust are represented based on the intended learning outcome (ILO) structures and are used to estimate the trustworthiness values of the learning activity. Once values based on the antecedents of trust are known, these values are used to assess how much the student can trust the learning activity.

The LOT model was evaluate in two real learning situation: (1) where information about the trustworthiness of the learning activity was ambiguous, and (2) where information about the trustworthiness of the learning activity was clear. Students' trust mainly related to their propensity to trust and their prior knowledge when the trustworthiness of the learning activity was ambiguous. In contrast, students' trust mainly related to their perceived trustworthiness of the learning activity when the trustworthiness of the learning activity was clear. The LOT model showed significant prediction of student's trust. In addition, when the student learning path was used, trust was predicted significantly better than when the learning path was not given.

The LOT model may have useful application in recommendation systems or intelligent tutoring systems.

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Academic Thesis: Declaration Of Authorship

I, Woraluck Wongse-ek [please print name]

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

[title of thesis] Towards a trust model in e-learning

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
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6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Either none of this work has been published before submission, or parts of this work have been published as: [please list references below]:

Signed: ……………………………………………………………………

Date: 18/06/2016

Acknowledgement

First and foremost I want to thank my main supervisor Lester Gilbert, who taught me the right principles of life that pulled me out of my life crisis. He supported me to learn that I am toughest when I spot what is weak and how I might best develop those parts of my character. I want to thank my second supervisor Gary Wills, who is such an amazing inspiration and so caring towards me.

I would especially like to thank my family for all of your love, constant support and encouragement. In particular, I would like to thank my parents, my brother, my uncle Chavalit, and my aunt Achara. I literally could not have done this without you. Thank you for all the opportunities you have given me in order to reach the success.

This thesis could not be completed without your specific expertise and generous support, Kanyarat Puapan and Mayuree Boontad. I am grateful to the participants who so generously gave their willingness to participate in my study.

I am sincerely honored to have been selected as the recipient of the Scholarship of Faculty of Information and Communication Technology, Mahidol University. Thanks to your generous support for my studies at Southampton University.

To Gale's family, Maneenil's family, and Rojanaratanangkule's family, thank you for always being on my side, being my great supporters and guide. Lastly, I would like to thank my friends for being a significant part of my life and always supporting me, even if you are not always by my side.

List of Abbreviations

The following table describes the acronyms and abbreviations used throughout the thesis. The page on which each one is defined or first used is also given. Nonstandard acronyms that are used in some places to abbreviate the names of certain white matter structures are not in this list.

Abbreviation	Meaning
ILO	Intended learning outcome
dILO	The student's desired learning outcome
pILO	The student's prior knowledge/competence
LP	Learning path
LOT	Learning Outcome-based Trust
LOTA	LOT model applying the expert whole learning path or the given learning path
LOTB	LOT model applying the student's learning path
Method A	The method for calculating a degree of trustworthiness of learning activity applying the expert whole learning path or the given learning path
Method B	The method for calculating a degree of trustworthiness of learning activity applying the student's learning path
STQ	The questionnaire based on students' trust theories
Trust Dilemma I	Trust dilemma where the information about trustworthiness was ambiguous
Trust Dilemma II	Trust dilemma where the information about trustworthiness was clear
STU	Student
PT_{STU}	Student's propensity to trust
KW_{STU}	Student's prior knowledge
PI_{STU}	Student's perceived integrity of learning activity or the student's perception of integrity of learning activity
PB_{STU}	Student's perceived benevolence of learning activity or the student's perception of benevolence of learning activity
PC_{STU}	Student's perceived competence of learning activity or the student's perception of competence of learning activity

Abbreviation	Meaning
LOT	Learning Outcome-based Trust
LOTA	LOT model applying Method A
LOTB	LOT model applying Method B
I_{LOTA}	Integrity of learning activity based on LOT model applying Method A
B_{LOTA}	Benevolence of learning activity based on LOT model applying Method A
C_{LOTA}	Competence of learning activity based on LOT model applying Method A
I_{LOTB}	Integrity of learning activity based on LOT model applying Method B
B_{LOTB}	Benevolence of learning activity based on LOT model applying Method B
C_{LOTB}	Competence of learning activity based on LOT model applying Method B
pLO	A type of ILO in a learning path that implicates student's prior knowledge or student's prior competences. It is stated by relating with student's past experiences.
cLO	A type of ILO in a learning path that connects the dLO and the pLO.
dLO	A type of ILO in learning path that implicates learning purpose. It is stated by the student under the specific pedagogical context.
fLO	A type of ILO in learning path that implicates the ILO in a learning activity.

Chapter 1 Introduction

Although there is a wide variety of E-learning courses and learning activities available on the Internet, it is not easy for early-stage students to select appropriate learning activities for their intended learning outcomes. This research investigates the factors related to students' trust in learning activities and proposes a new trust model based on an analysis of these factors.

1.1 Motivation and Overview of Research

E-learning is concerned with delivering all activities relevant to teaching and learning through electronic media. E-learning supports self-education and knowledge sharing through collaboration. By this definition we refer to circumstances when students want to acquire knowledge and arrange their own learning without being constrained by time and place. E-learning helps to meet students' demands for improved flexibility and enhanced learning experience.

In self-directed learning or self-education, students take responsibility for their own learning process. E-learning allows them to tackle their course at their own pace and to pursue their own learning path strategy. For example, when students learn what they need to learn, they can skip an element of a course if they don't need to learn it.

Self-education is about students deciding not only where to take a course but also what they will be able to do at the end of the course, and how they will learn. The term for what students will be able to do is called an intended learning outcome. In self-education, students learn to achieve the intended learning outcome by undertaking the learning activity. From the students' perspective, the decision to determine which learning activities are suitable for their current level of attainment is not easy. The literature has shown that students will encounter feelings of anxiety and uncertainty about the learning outcome of their early-stage studies, at the time when everything is novel for them (Nevalainen et al., 2012; Barnett, 2007). For example, the students may feel uncertain when dealing with the unclear learning outcomes, encountering a new course, or having variety choices of learning activities.

Previous studies reported that students were satisfied with the self-directed learning approach used in e-learning (Ellis, 2004; McLoughlin & Lee, 2010; Zhang et al; 2004). Even though students directly benefit from enhancement of self-directed learning resources with e-learning, there are still problems that the students will encounter with feelings of uncertainty during their learning process (Dondi and Delrio, 2006). In self-directed learning, the students decide their own intended learning outcome and learning path (Garrison, 1997). The intended learning outcome (ILO) is the student's learning objective (Biggs, 2011). The learning path is the sequence of learning activities that students use to reach their learning objective (Williams & Rosenbaum 2004). In e-learning (Song & Hill, 2007), a feeling of uncertainty can occur at any point in the learning path, from setting up the desired learning outcome, from deciding the learning path, and from identifying appropriate learning activities. This research regards trust as a way of dealing with the feelings of uncertainty. Previous studies found higher degrees of individuals' trust decrease their feeling of uncertainty (Luo, 2002; Olekalns & Smith, 2009), where the identification of learning activities was regarded as an important stage in the self-directed learning path and a step towards achieving the desired learning outcome. Therefore, high degree of trust of the student for each learning activity can reduce the feeling of uncertainty during a self-directed learning process. The understanding of how the student trusts and what antecedents lead to higher degrees of student's trust is the essential focus of this research. This research aims to propose a new trust model based on intended learning outcome for understanding student's trust and its antecedents.

Trust is a mental state comprising the intention to accept vulnerability based on positive expectations of the property or behaviour of another (Rousseau et al., 1998). Having limited cognitive skill in the new course, students seek to reduce the feeling of uncertainty by applying a mental approach to select the appropriate learning activity. One helpful mental approach is trust, which in sufficient degree can serve as a mechanism to reduce the feeling of uncertainty (Kramer, 1999; Luhmann, 2000). Deciding to trust someone or something is performed by the mental calculations of the trustor. The developing degree of trust via predictability is influenced by three variables: the trustor's propensity to trust, the trustor's prior trust competences, and the trustor's perceived trustworthiness in the specific context.

In a learning situation, a student is a trustor who performs the mental calculations before deciding to trust a learning activity: a trustworthy learning activity is a learning activity in which the student can place his/her trust. The mental calculations before deciding to trust can be split into two parts: (1) the student's assumption to trust; and (2) the student's perceived trustworthiness in the learning activity.

An assumption of trust arises from the students' trust propensity, and their prior competences. Students use their assumption of trust to estimate the trustworthiness of the learning activity that was perceived. The perceptions about a learning activity's trustworthiness affect the degree to which a learning activity will be trusted. The students' perceived trustworthiness of a learning activity can be divided into three factors: competence, benevolence, and integrity. For example, if the learning activity's competence to support the student is imprecise, it will not be trusted. If the learning activity is perceived as benevolent, it will have a strong influence on serving a specific student's intentions. If the learning activity's integrity is questionable, e.g. its subject matter content being inconsistent with a student's intended learning outcome, trust will be missing. As the perception of each of these factors increases, we would expect an increase in willingness to take a risk in the learning process. We defined each of these trustworthiness factors so that it can be applied to calculate a degree of trustworthiness in the learning activity.

The learning path is a contextual aligning of intended learning outcomes, depending on the student's prior competences. Our analysis suggests a learning path serving as a source for measuring the degree of students' trust in a learning activity. The learning path is also deployed as an element to calculate the degree of trustworthiness in a learning activity. A learning path, which a student uses to achieve the desired learning outcome, could be created based on an ILO diagram (Tangworakitthaworn et al., 2013). The ILO diagram is used to represent a sequence of learning outcomes for each learning path. The ILO diagram consists of ILO nodes and the relationships between nodes with each node being able to be presented as an ILO statement.

The methodology for proposing the new trust model is threefold: The students' trust theories and the new trust model, which is called the Learning Outcome-based Trust (LOT) model, were proposed in Phase 1, the LOT model was evaluated in Phase 2, and the relationship between the antecedents to trust and perceived trustworthiness were studied in Phase 3. The LOT model can statistically significantly predict students' trust. Moreover, we can understand how the students place trust via the antecedents that are proposed in the LOT model.

1.2 Aim and Objectives

The ultimate aim of this research is to contribute a new trust model for students' trust based on learning outcome, called the Learning Outcome-based Trust (LOT) model. The model calculates the students' degree of trust in a learning activity during self-directed e-learning. The following three objectives support this aim:

- Firstly, to explore the antecedents of students' trust and propose a students' trust model (the LOT model) for understanding students' trust in self-directed e-learning.
- Secondly, to apply the proposed LOT model for calculating degree of students' trust in a learning activity.
- Thirdly, to validate the proposed LOT model and discuss whether the learning path influenced the students' perceived trustworthiness and whether a learning path can be used to calculate the degree of trustworthiness in a learning activity.

In this research, the LOT model was applied only to self-directed e-learning. The application of the LOT model in learning generally (e.g. with a human teacher) is a subject for future research.

1.3 Methodology

In Phase 1, a literature review of theory and research on trust and e-learning was undertaken to develop a new trust model in e-learning. Based on the literature review, a model of student's trust in learning activity was proposed. There were five steps in the development of the student's trust model: (1) determining the antecedents of student's trust, (2) defining the processes to calculate the students' trust using those antecedents, (3) designing a conceptual model of student's trust, (4) constructing a computerized model of student's trust, and (5) verifying the student's trust model. This phase address the first objective, to explore the antecedents of students' trust and propose a students' trust model (the LOT model) for understanding students' trust in self-directed e-learning.

In Phase 2, the performance of the proposed student's trust model was evaluated in terms of the correspondence between the degree of trust calculated by the LOT model and the degree of trust given by a group of actual students. There are five steps in Phase 2: (1) designing the experiment, (2) setting up the scenarios, (3) running the pilot studies, (4) running the experiments, (5) analysis the experiment results using regression analysis. This phase address the second objective, to apply the proposed LOT model for calculating degree of students' trust in a learning activity.

In Phase 3, the experimental results were discussed under four main headings: (1) how the LOT model predicted the degree of student's trust, (2) how the students' perceived trustworthiness of learning activity affected students' trust during self-directed e-learning, (3) whether the learning path influenced the students' perceived trustworthiness, and (4) whether the learning path was a suitable source of information for calculating the degree of trustworthiness in a learning activity. This phase address the third objective, to validate the proposed LOT model and discuss whether the learning path influenced the students' perceived trustworthiness and whether a learning path can be used to calculate the degree of trustworthiness in a learning activity.

1.4 Structure of the Report

The rest of the report is structured as follows: Chapter 2 presents the background of trust and a summary of existing research into trust. Chapter 3 presents an overview of teaching and learning activities relating to an uncertainty situation in higher education. First, the E-learning transaction is described to show the relationship between a teaching activity, a learning activity and an ILO. Second, the ILO and its importance are presented. Third, the uncertainty that is imposed by the idea of higher education is described. Chapter 4 presents students' uncertainty and students' trust theory is defined. In Chapter 5 the new conceptual students' trust model is proposed. Chapter 6 presents a construction of application for testing the students' trust model. In Chapter 7 the calculation of a degree of students' trust model is presented. In Chapter 8 the methodology for creating and testing the trust model is presented. The proposed model was tested using two Trust Dilemmas: first, testing the trust model in a trust dilemma where information about trustworthiness was ambiguous (Trust Dilemma I), and second, testing the trust model in a trust dilemma where information about trustworthiness was clear (Trust Dilemma II).

The proposed trust model performs well if it can predict the students' trust in each Trust Dilemma. The analysis of the experimental data with respect to student's trust is presented in Chapters 9 and 11, and discussed in Chapters 10 and 12. Chapter 13 presents the analysis of students' perception of trustworthiness, and is discussed in Chapter 14. Finally, conclusions with a summary of achievements thus far, along with future work, are drawn in Chapter 15.

1.5 Research Contributions

The main objective of this thesis is to propose a new trust model, the LOT model, for predicting students' trust in a learning activity. The LOT model deployed the learning path as the source data for calculating a degree of trustworthiness of a learning activity, which is the foundation of the trust model. Once we can examine a degree of trust in a learning activity, we will be able to develop computer agents to recognize a trustworthy learning activity for a specific context. The results shown in this thesis illustrate that the benefit is true. The main contributions of this thesis are listed as follows:

1) The definition of students' trust in a learning activity, the students' trust theories, and the antecedents to trust are studied and used to construct the Learning Outcome-based Trust (LOT) model. By using the LOT model, the students' trust in a learning activity is formalized as a computational concept based on the three antecedents to trust: students' assumption to trust, trustworthiness properties of a learning activity and pedagogical context.
2) The LOT model can calculate the degree of trust in a learning activity, in agreement with the student's actual trust. Further, the LOT model can predict the student's trust based on the proposed antecedents of trust.
3) The LOT model supports a better understanding of the factors that influence a student's trust in a learning activity, specifically identifying the properties of a learning activity which encourage such trust. These properties are the trustworthiness properties of a learning activity, consisting of:
    - Integrity, measured by the strongest relationship between the learning path ILOs and the learning activity.
    - Benevolence, measured by the relationship between students' prior knowledge and the learning activity.

- Competence, measured by the relationship between students' desired ILO and the activity.

4) The LOT model supports a conceptualization of students' trust in terms of students' choice behavior in two trust dilemma situations.
   - Where information about trustworthiness was clear, the student's perception of integrity was the most significant influence on students' trust. This suggests that if we want to encourage or build students' trust in e-learning, a clear learning path is the first priority to be considered.
   - Where information about trustworthiness was ambiguous, the student's propensity to trust and their prior knowledge were the most significant influences on students' trust. This suggests that the development of prior knowledge is a priority to be considered to help the student in disambiguating the situation.

1.6 Peer Reviewed Contributions

The following peer reviewed conference poster and paper based on the work of this thesis have been accepted.

Wongse-ek, W., Gilbert, L., Wills, B., "Calculating Learner's Trust in Teaching Activity". Poster session presented at: Reasoning Web 2012 Summer School; 3–8 Sep 2012; Vienna, Austria.

Wongse-ek, W., Gilbert, L., Wills, B., "Towards a Trust Model in E-learning: Antecedents of a Student's Trust" Proceedings of the IADIS International Conference E-learning 2013; 23–26 July 2013; Prague, Czech Republic.

Wongse-ek, W., Wills, B. & Gilbert, L., "Calculating Trustworthiness Based on Learning Outcome". In Proceedings of World Conference on E-learning in Corporate, Government, Healthcare, and Higher Education, 2014 (pp. 2085-2090). Chesapeake, VA

Chapter 2 Trust

2.1 Introduction

Chapter 1 showed examples of when the student is faced with uncertainty during their self-directed learning. This uncertainty may cause a student to face anxiety and suffer a lack of confidence in the learning activity. Developing student trust in learning activities is therefore recommended to reduce uncertainty in E-learning. For example, students' trust could decrease their feeling of uncertainty when choosing appropriate learning resources, or finding suitable colleagues in collaborative learning. This chapter is aimed at introducing the concept of trust, and gives the general antecedents and human reasoning in the making decision to trust.

2.2 Trust

Trust has been researched in several fields, each one from a different perspective, such as psychology (Karlins & Abelson, 1970; Bromley, 1993), sociology (Buskens, 1998), philosophy (Plato, 1955; Hume, 1975), economics (Celentani et al., 1966; Marimon et al., 2000) and computer science (Artz and Gil, 2007; Golbeck, 2008). Numerous studies have explored the various definitions of trust that are relevant to each research context. However, there is still no definitive interpretation or standardised model of trust (Beldad et al., 2010). There have been many attempts to define the concept of trust by researchers from several disciplines and backgrounds, resulting in overlapping definitions (Rousseau et al., 1998; Burke et al., 2007) of the concept of trust (Luhmann, 1979; Kumar et al., 1995; Mayer et al., 1995; Fung & Lee, 1999; Menon et al., 1999; Stewart, 1999; Gefen, 2002; Koufaris and Hampton-Sosa, 2003a). This section presents the overlapping definitions and concept of trust in general, together with an overview of the assessment of trust.

2.3 Definition of trust

A wide range of definitions of trust that have arisen, but certain concepts remain common among them (Rousseau et al., 1998; Burke et al., 2007). For example, Mayer et al.'s (1995) model, which is one of the most broadly cited, describes trust as "the willingness of the party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party". Another widely accepted definition of trust is "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behaviour of another" (Rousseau et al., 1998). A review of the literature on trust shows an assembly of core ideas around which a definition of trust is raised. Dealing with uncertainty is one such idea, in which the trustor experiences uncertainty about the potential interaction with the trustee acting in a specific situation. The interaction can be in the form of an individual or group. This uncertainty causes the trustor to decide which trustee can be trusted (Doney & Canon, 1997; Kee & Knox, 1970; Mayer et al., 1995).

Elements of trust	**Elements meaning**
Trustor	The trustor is the trusting agent or the person who performs the trust and transfers their property or effort to the trustee in a trust situation.
Trustee	The trustee is the trusted agent or someone who is responsible for looking after property that belongs to the trustor in a trust situation.
Behaviour of Actors (Action, Interaction)	The movement of an actor as it works or makes progress, including the trustor's action and the trustee's action.
Context	The situation that forms the setting for a trust statement in terms of which it can be fully understood.
Expected Outcome (Purpose, Goal)	The expected outcome that both the trustor and trustee hope to achieve.

Table 2-1: Elements of Trust in General

In sum, trust has several intensions. The definitions of trust typically refer to a situation characterised by the following five elements: trustor, trustee, behaviour of actors, context, and expected outcome. The trustor is considered as a cognitive agent. The trustee is an agent that is capable of producing some effect as an outcome of its behaviour. The underlying behaviour or properties of the trustee and its outcome is described as behaviour of trustee in context, possibly producing the expected outcome. Therefore our definition of trust is the following: trustor trusts trustee for performing behaviour, and is measurable in trustor's belief in trustee's trustworthy behaviour depending upon the specific context, corresponding to trustor's expected outcome and the propensity to trust of trustor. Table 2-1 shows a summary of elements of trust in general.

2.4 Concepts of general trust

From a comprehensive look at the literature, a number of common core concepts of trust are extracted. First, trust is an individual expectation of an outcome, relying on the belief that the behaviour will produce an outcome based on the expected behaviour of the trustee. At the same time, certainty in the trustee's behaviour is based on the expected outcome for the trustor, and this certainty is needed for the trustor to gauge the actual outcome as a consequence of their trust (Butler and Cantrell, 1984; McKnight et al., 1998). Second, trust must be evidence-based. Trust should be proportional to the degree of quality and relevance of evidence of trustworthiness, or propensity to trust; that is, the degree of trust should be moderated by the quality and trustworthiness of the evidence. (Colquitt et al., 2014; Larzelere & Huston, 1980; Wheeless, 1978) Third, trust can be partitioned by function and context (Butler and Cantrell, 1984; McKnight et al., 1998; Rotter, 1967; Webb and Worchel, 1986); for example, a patient doesn't have to trust in the doctor's surgical skill in order to have her as a tennis partner. Lastly, trust is never present as an absolute because it is a dynamic phenomenon (Hirshleifer and Riley, 1979; Mayer et al., 1995; Worchel, 1979). Trust can be recognised based on the phenomenon as shown in Table 2-2. For this reason trust is based on an individual's attitude, and the degree of willingness of people to trust is altered by a change of person or circumstance; for example, a trustor's trust of a trustee can be altered by a change in the situation. Therefore, one individual's trust of another is an open question, and could be represented by degrees of trust.

Trust is a complex phenomenon because the trustor could decide to trust in different ways based on the context (Kramer and Tyler 1996, Misztal 1996, Lane 1998). Trust was analysed into six types, derived from previous studies, as shown in Table 2-2.

In this research, self-directed learning is undertaken by a student, a trustor, who performs some mental analysis in deciding to trust a particular learning activity. The student's trust in this research was considered to involve only two types of trust: cognitive trust and generalised trust. This research was not concerned with communication between people or social aspects leading to trust. The information which influences the student's trust was considered to only be gained from the properties of the particular learning activity. Cognitive trust occurs when the student is willing to rely on the learning activity. Generalised trust occurs based on the student's psychological predispositions or propensity to trust. Propensity to trust is a stable individual difference that influences the chance that a person will trust (Rotter, 1967; Stack, 1978).

Type of Trust	**Description**	**Reference**
Cognitive trust	Grounded in rational, instrumental judgement, alignment of incentives	Johnson & Grayson (2005); Erdem & Ozen (2003)
Affective trust	Relational, ethics, empathy, or the morals created through interaction	Johnson & Grayson (2005); Ha Park et al, (2011)
Personal trust	Interpersonal trust, face work commitments	Zaltman & Moorman (1988); Cheng-shu (1996)
Impersonal trust	Trust in this system of expertise	Shapiro (1987); Culnan & Armstrong (1999)
Generalised trust	The belief that individuals will, in general, behave reasonably	Freitag & Traunmüller (2009); Leigh (2006); Rosenberg (1956)
Category based trust	When you decide to trust an entity from a similar category, such as a social category	Kramer (1999); Robert at el. (2009)

Table 2-2: Type of trust based on the context

2.5 Antecedents of trust

The decision to trust usually relies on the trustor's beliefs regarding three antecedents: the trustor's assumption of trust, the characteristic of the trustee, and the context. A review of the overlap of antecedents to trust found in recent models in E-learning is shown in Table 2-4, and a review of antecedents to trust from other previous studies is shown in Table 2-3. Characteristics of the trustee's trustworthiness include ability, integrity and benevolence (Butler, 1991; Lewis & Weigert, 1985; Mayer et al., 1995). Ability involves the skills and competences of the trustee in a specific context, related to the expectations of the trustor; integrity implies that the trustee follows moral and ethical principles that are acceptable to the trustor; benevolence involves a belief that the trustee has goodwill to the trustor. Depending on how the trustor sees these three characteristics of the trustee, the trustor asserts a certain willingness to depend on the trustee's characteristics for their expectation of a certain beneficial outcome, along with the belief that the trustee is not an opportunistic actor (Jarvenpaa et al., 2000). The willingness of the trustor could also rely on a third party, helping the trustor believe that the third party is a central qualifier for trust (Jarvenpaa et al., 2000; Gefen, 2002; Gefen et al., 2003; Koufaris & Hampton-Sosa, 2003a).

For making decision to trust in learning activities, the student as a trustor needs a good assumption of trust to estimate the trustworthiness of the learning activities. A good assumption of trust arises from a good propensity to trust, and their prior competences. Propensity to trust, or the disposition to trust, expresses an individual's tendency to believe or not to believe in others. In other words, the propensity to trust is seen as a personality trait that influences an individual's behaviour to a generalised expectation about the trustworthiness of others, especially when the trustor is still unfamiliar with the trustee (Gefen et al., 2003). Therefore, the trustor's propensity to trust is needed, especially when the trust prediction is based on little or no information about a learning activity.

Table 2-3 cross-references the relatively few studies on trust antecedents against the six antecedents identified in the LOT model. The studies were drawn from the domains of individual psychology, social psychology, marketing, medicine, e-commerce, and e-learning. The table shows that only one study considered all six antecedents, while the other 28 studies only considered various sub-sets of antecedents. In this sense, the LOT model represents an integration of the various concepts surrounding trust antecedents.

		Competence	Benevolence	Integrity	Context	Trustor's experiences	Propensity to trust
Psychology	Rotter, 1967						X
	Rosenberg, 1956						X
	Cook and Wall, 1980	X					
	Costa & McCrae, 1992						X
	Mayer et al., 1995	X	X	X	X		X
	Mayer & Davis, 1999	X	X	X	X		X
	Gefen, 2000	X	X	X	X		X
	Teo & Liu, 2007	X	X	X	X		X
Social	Strickland, 1958		X				
	Deutsch, 1960	X					
	Larzelere & Huston, 1980		X				
	Lieberman, 1981	X		X			
Marketing	Speckman & O'Neal, 1988			X			
	Ring and Van de Ven, 1992		X	X			
	Swan et al., 1999	X	X				
	Doney and Cannon, 1997		X		X		
	Gray., 1998			X			
Medical	Thom &Campbell, 1997	X		X			
	Anderson & Dedrick, 1990	X	X			X	
	Leisen & Hyman, 2004	X	X				
E-commerce	Salam et al., 2005	X	X	X	X	X	
	Metzger, 2006	X				X	
	Corbitt et al., 2003	X				X	
	Ba & Pavlou, 2002	X	X	X		X	
	McKnight et al., 2002	X	X	X	X	X	X
E-learning	Anwar, M., & Greer, J., 2012	X	X	X	X		
	Carchiolo, V et al., 2010	X			X	X	
	Yang, S.J.H et al., 2007	X			X	X	
	LOT model	X	X	X	X	X	X

Table 2-3: Review of antecedents to trust from other previous studies

Table 2-4 examines trust antecedents considered in e-learning references. These references consider various sub-sets of trust antecedents and of trust propensity. In particular, they each offer an individual view of the student's expected outcome of their e-learning experience. The LOT model provides an integration of the trust antecedents and trust propensity, and proposes the ILO as the information source for estimating students' trust in their e-learning experience.

<table>
<tr><th rowspan="3">Reference Model</th><th colspan="7">Antecedents to determine Trust</th><th rowspan="3">Sources of Antecedents</th></tr>
<tr><th colspan="3">Trustworthiness</th><th rowspan="2">Context</th><th rowspan="2">The Student's Expected Outcome</th><th colspan="2">Trust Propensity</th></tr>
<tr><th>Competence</th><th>Benevolence</th><th>Integrity</th><th>Propensity to trust</th><th>Prior Competence</th></tr>
<tr><td>Anwar, M., & Greer, J., 2012</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Expectation</td><td>No</td><td>No</td><td>Reputation</td></tr>
<tr><td>Carchiolo, V et al., 2010</td><td>Yes</td><td>No</td><td>No</td><td>Yes</td><td>Objectives</td><td>No</td><td>Prior-Experience, Requisites</td><td>Reputation, Peer-to-Peer, Recommendation</td></tr>
<tr><td>Yang, S.J.H et al., 2007</td><td>Yes</td><td>No</td><td>No</td><td>Yes</td><td>Requesting specific knowledge</td><td>No</td><td>Past Experience</td><td>Reputation, Social Network, Peer-to-Peer</td></tr>
<tr><td>LOT model</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td><td>Desired Intend Learning Outcome (dLO)</td><td>Yes</td><td>Prior Knowledge/ Prior Competence</td><td>Intended Learning Outcomes Diagram (ILOs Diagram)</td></tr>
</table>

Table 2-4: Review of the overlap of antecedents to trust of recent models in E-learning

A 'competent' trustor means a trusting actor who is able to do something in an expected context. A trustor's prior competences are identified as an existing behaviour that the trustor already has towards some expectation. The basis of behaviour in a trustor's competences requires knowledge available in the trustor's memory and the capabilities of the trustor's thought processes. Therefore, decision-making competences also require some knowledge and understanding of the relevance of what the trustor desires for making a good choice (Levin & Cross, 2004; Giffin, 1967; Szulanski et al., 2004). For example, if the trustor wants to choose appropriate online material to solve problems in calculus, they may already need to know something about algebraic fractions or the manipulation of equations.

“Competence” refers to the property of the trustee to support the trustor. In order to employ this idea in the LOT model, “competence” is defined as the property of a learning activity which supports the student’s learning objective. This use of the concept of competence constitutes a technical definition which is not that commonly seen in the literature on learning, although it is congruent with the idea that someone is competent if they can successfully undertake some activity. Competence is explained further in 6.3.2.

“Benevolence” refers to the trustee’s kindness, care, or concern for the trustor. In order to employ this idea in the LOT model, “benevolence” is defined as the degree to which the learning activity relates to the student’s prior knowledge. This use of the concept of benevolence constitutes a technical definition which is not that commonly seen in the literature on learning, although it is congruent with the idea that someone is benevolent if they are kindly and well-meaning. Benevolence is explained further in 6.3.2.

“Trust” refers to the feeling that a trustor places in a trustee, such that the trustee is considered trustworthy. The properties of trustworthiness are properties that the trustor relies on. The LOT model focused on the student’s trust in a learning activity, where the student is the trustor and the learning activity is the trustee. This use of the concept of trust is consistent with its use in the literature, and is further developed in Section 4.3.

2.6 Human reasoning in making decision to trust

A decision to trust may be split in two ways based on the trustor’s mental processes, as illustrated in Figure 2-1: deciding trust based on (1) dispositional trust, and (2) rational trust.

First, deciding trust based on dispositional trust or the propensity to trust is unaffected by the situation. Similarly, Mayer et al. (1995) and Bigley & Pearce (1998) have described this trust, based on personality traits, as a propensity to trust that influences the willingness to trust others. Mayer et. al. (1995) and Brown et al. (2004) argue that one’s propensity affects the individual’s disposition to trust and varies according to their life experiences, personality types, cultural background, education and several other socio-economic factors. Mooradian et. al. (2006) presents the individuals with a low propensity to trust as perceiving others as self-centred, conniving and potentially dangerous. On the other hand, people who have a high propensity to trust believe that most people are sincere, fair and have good intentions. The propensity to trust is an important factor influencing a trust antecedent in new, unusual, uncertain or unstructured situations and it is a measure of how willingly an individual will trust someone before he/she has any information about that person (Bigley and Pearce, 1998; Dirks & Ferrin, 2001; Gill et al., 2005; Goldberg, 1990; Rotter, 1980; Mayer et. al., 1995).

Second, deciding trust based on trustworthiness means relying on information about a trustee's trustworthiness. A trustor states their expectation and their plan to achieve it. The trustor's expectations can be used to predict the trustee's behaviour or trustworthiness, if the trustee will accept and follow a trustor's generally accepted set of values, norms, and principles (Chiu et. al., 2006; Levin et al., 2006; Möllering, 2002). This information about trustworthiness is affected by the situation. A decision to trust is the result of the prediction state, and can only come after the decision-making process; in other words, the trustor perceives this information of trustworthiness and accepts it into their domain of knowledge.

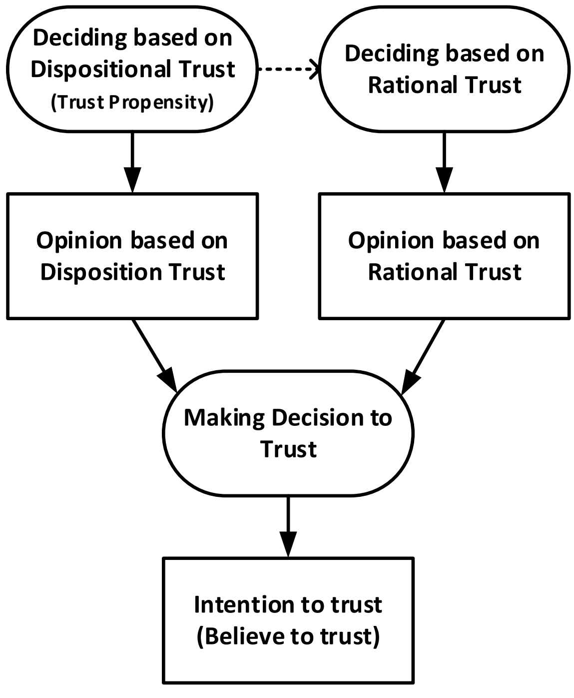


Figure 2-1: The trustor's mental process for making decision to trust

2.7 Summary

This chapter reviews a considerable amount of research on trust, defined as an essential element in facilitating the interactions between two parties under a situation of uncertainty by giving the conditions to obtain certain outcomes, e.g., the individual's effectiveness with such interactions (Camerer, 2003; Fukuyama, 1995; Kramer and Tyler, 1996; Marková, 2006). Works reviewed here encompass the academic fields of psychology, sociology, medical science, and economics in order to underline the expansive nature of the research on trust.

Chapter 3 Learning Activity in E-Learning

3.1 Introduction

This chapter situates three elements: the learning theories, a learning transaction and an intended learning outcome. These elements are the background knowledge to better understand the meaning of a learning activity. Therefore, a learning theory defines how people learn and helps us understand the inherently complex process of learning. In E-learning, students' learning occurs as a part of a set of E-learning transactions. Each E-learning transaction aims to deal with achieving an intended learning outcome.

Self-education is a particular type of learning where students do not rely on teachers, and where learning occurs anytime and anywhere. E-learning is a form of self-education, designed to be learning that does not require a teacher (Bouhnik & Marcus, 2006) and can be accessed at any time and any place (Capper, 2001). It is ideally suited to self-directed learning

3.2 Learning Theories

The conceptual model that describes how information is comprehended, processed and engaged during learning is called learning theory. There are three very influential learning theories: behaviourism, cognitivism, and constructivism. In behaviourism, learning is defined by the outward expression of new behaviours and changes in behaviour (Pavlov, 1927; Skinner, 1948; Watson, 1924). In cognitivism, learning is the process of connecting symbols in a meaningful and memorable way (Ausubel, 1980; Bruner, 1977; Gagné, 1985; Piaget, 1985). In constructivism, learning is the construction of meaning from experience (Piaget, 1950; Kolb, 1976; Vygotsky 1978; Lebow, 1993; Glasersfeld, 1989). In this research, the focus is on what the student is actually expecting with the learning outcome, and how to evaluate whether the teaching activities will be chosen to support a student's learning activity in order to achieve the ILO, based on the concept of all learning theories.

According to Laurillard's conversational model (1993), academic learning is defined as a discursive process between two actors' roles: "teacher" and "student". This model is constructed for describing the teaching-and-learning process based on both learning theory and a practical framework. There are four components of the teaching-and-learning process in Laurillard's conversational model: the teacher's concepts, the teacher's constructed learning environment, the student's concepts and the student's specific actions. Laurillard's conversational model can be used for designing pedagogical environments, and such pedagogical media can be considered to rely on the above four components.

Taking a general view of the learning transaction, this research uses the ELSYE model (Gilbert & Gale, 2008), which is inspired by Laurillard's conversation model. In this chapter, the teaching activity, the learning activity, the learning transaction and the relationship between them, is introduced. In detail, both the teaching activity and the learning activity are connected by the same purpose. An ILO is offered to represent the structure of the purpose.

3.3 Learning Transaction

This section aims at describing the teaching-learning activity in a learning transaction. The learning transaction (Figure 3.1) is defined as the consideration of a situation that the teacher and student are attempting to achieve the same purpose in the specific context (Gilbert & Gale, 2008). In other words, the student needs to achieve the purpose and the teacher needs to give the support for the student's achievement at the same time.

Figure 3-1 illustrates the learning transaction that is adapted from the E-Learning Systems Engineering (ELSYE) model. This model is inspired by Laurillard's conversation model that defines teaching-and-learning interaction and environment in higher education (Laurillard, 1993). The learning transaction model is comprised of the teaching activity and the learning activity.

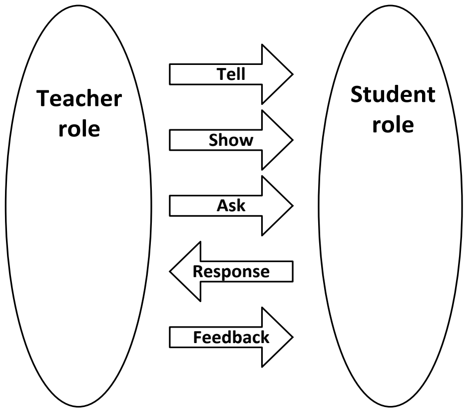


Figure 3-1: Adaptive Learning Transaction from ELSYE model (Gilbert & Gale, 2008)

3.3.1. Teaching Activity

Teaching activity is defined as an intentional activity of a teacher that has as its aim the bringing about of a learning activity (Hirst, 1971). The teaching activity is designed by a teacher, who has a role in teaching students how to achieve this purpose. The teaching of students is comprised of three parts: a teaching/learning purpose, a teaching material for representing pedagogical content knowledge, and a type of teaching activity.

First, the teaching/learning purpose is to identify exactly what the students are supposed to learn in the course; the teachers must be able to specify the purpose beforehand of what they want the student to do or to know at the end of teaching. For example, the student will be able to calculate heat gain and heat loss. In particular, the purpose could be represented by an intended learning outcome (ILO), which will be described in the next section.

Second, the 'pedagogical content knowledge' is knowledge about the actual subject matter that is to be learned or taught (Lafayette, 1993). The pedagogical content knowledge in teaching is sourced from the nature of the teacher's own knowledge of the material they teach (Even, R. and Tirosh, D., 1995). Several kinds of teaching materials are used to represent the pedagogical content knowledge or the subject matter such as an assignment in a book, an example in a video, a definition in a website, etc.

Third, there are four types of teaching activity: "showing", "telling", "asking" and "feedback" (Gilbert & Gale, 2008). Examples of teaching activity can be found in the telling of a definition, the showing of an example and the asking of questions or an assignment to the student. Once the student perceives the definition or the example from the teacher, they will use their cognitive ability to gain knowledge on his/her own and gives the response to the teacher. Lastly, the teacher will provide the feedback to the student for showing their reaction to a student's performance of the questions or the assignment.

Pedagogy has many meanings and is not easily defined (Kincheloe, 2005). According to Alexander (2004), pedagogy is "the act of teaching and the body of knowledge, argument and evidence in which (teaching) is embedded and by which particular classroom practices are justified". Leach and Moon (1999) defined pedagogy as "the practice that a teacher, together with a particular group of learners creates, enacts and experiences". Mortimore (1999) define pedagogy as "any conscious activity by one person designed to enhance the learning of another". Hence, pedagogy is the application of a teacher's experience to support a student's learning.

Teaching may start by negotiating intended learning outcomes (ILOs) and then supporting students in undertaking learning activities (Grow, 1991), and so pedagogy may be considered to be embedded in e-learning via the ILOs and the links between ILOs. These ILOs and their links comprise embedded learning paths, and may be used to match learning activities and pedagogical requirements (Al-Muhaideb & Menai, 2011).

In order to select an appropriate learning activity in e-learning, the self-directed student must generate their own engagement with a learning situation, apply their own knowledge, and perform self-evaluation. A student generates their engagement by understanding the ILOs and the embedded learning paths in the e-learning. The student then applies their own knowledge by matching ILOs with their own learning objectives and matching the embedded learning paths with their own learning paths. This matching is needed for self-evaluation in order to select appropriate learning activities.

3.3.2. Learning Activity

A learning activity is defined as an activity of a student by which the student aims to bring about the purpose "X", and achieves a new competence by using an existing competence (Hirst, 1971). In other words, using an existing competence, such as a student's cognitive ability for managing their own "response", is a learning activity whose main objective is the new acquisition of knowledge, skills and competences (Davydov, 1982; Hedegaard and Lompscher, 1999). The new competence is acquired by the student's own mind and every student learns in a unique manner.

This acquiring of new competence agrees with constructivist learning theories (Duffy and Jonassen, 1992). In constructivism, learning is defined as a change in the meaning constructed based on the individual's experience (Newby, 1996), and includes three parts: the interactions with the purpose to be achieved, the student's existing competence, and the environmental context. In detail, students can consider their understanding with others and various shared experiences as well, meaning that this individualistic process can still be influenced by other factors. Therefore, the environmental context and problematic situations are significant factors in constructivist learning (Savery and Duffy, 1995).

In summary, a teaching activity is the activity that a teacher provides for supporting the student's learning to achieve the stated purpose. In the design of a teaching activity, the teacher needs to decide on what teaching activity is appropriate for the student based on the student's existing competence, and its purpose. At the same time, the student is able to perceive various supporting experiences in a pedagogical context such as the teaching activities; for this reason, a student needs to consider which teaching activity is best suited for him or herself, in particular by using the selected teaching activity as a guideline to practice their own learning activity for achieving their desired purpose.

3.4 Intended Learning Outcome

As can be seen in the learning transaction, students need to achieve the purpose by their own experience, such as receiving the teaching information and/or feedback, and by their own cognitive ability, such as remembering/using the teaching information to complete the assignment. At the same time, a teacher has to provide instruction or feedback to learners, based on a student's existing competence and the purpose of the activities. Therefore, the teaching activity and learning activity are connected by the same purpose. Furthermore, the purpose of teaching and learning is similar and a clear statement of purpose is required as shown in figure 3-2.

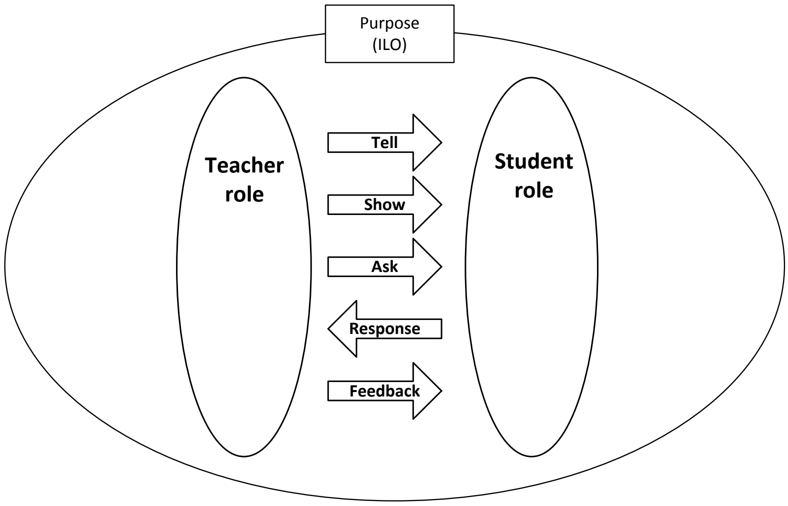


Figure 3-2: ELSYE model of a Learning Transaction (Gilbert and Gale, 2008)

The purpose of a teaching and learning activity is normally present as an Intended Learning Outcome (ILO) (Anderson, et al., 2005; Harden, 2002). The ILO is the statement of what the student is expected to know and be able to do at the end of an applied learning process. This statement identifies what the students must know or be able to do as a consequence of learning (Otte, 1992). At the same time, the ILO guides a teacher's intention to construct the obvious learning activities for a student. (Ramsden, 1992). The ILO must be clear, to support the delivery and assessment planning, in order that the students will be able to know what is happening and understand how to cope with their learning and assessment (Macdonald, 1999).

The general statement of the intended learning outcome is presented as, "By the end of the course, the student will be able to X where X is a performance" (Gilbert and Gale, 2008), where the performance X is the new behaviour resulting from the learning process, and it is represented by the learned capability and the learning outcome (Gagné, 1985). As shown in figure 3.3, the ILO consists of two primary elements: subject matter and capability, as described below.

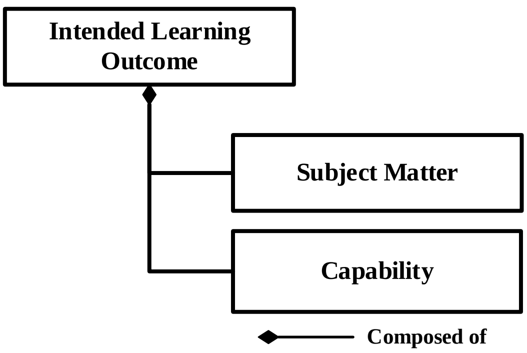


Figure 3-3: Composition of the Intended Learning Outcome (Sitthisak & Gilbert, 2010)

3.4.1. Implication of Subject Matter in Instructional Strategy

A set of determining interactions, which are needed for the student to acquire an explicit skill, knowledge or subject matter, is called the instructional strategy (Merrill, 1997). The subject matter is the data that is touched on in the instructional strategy, but it can also be uncoupled from the instructional strategy (Merrill et al., 1996). The construction of an instructional strategy comprises several instructional decisions such as choosing subject matter content and appropriate instructional transactions, as well as sequencing the subject matter content and instructional transactions. There are several types of instructional transactions. Similar subject matter can be combined with different instructional transactions, and similar instructional transactions can be combined with different subject matter. According to Merrill's component display theory (CDT) (Merrill, 1983), subject matter is classified into four kinds: fact, concept, procedure, and principle. Table 3-1, which follows, represents the definition of each kind of subject matter.

CDT Categories	Definition
Fact	Fact pair
Concept	Name of concept, X Superordinate concept class, Y Attribute An – value Vn pairs that classify objects, O An X is Y which has V1 on A1, V2 on A2, …
Procedure	Name of procedure, X Used in situation S To achieve a goal, G Via a set of steps, E Using tools T To X when S to achieve G, E using T
Principle	Name of principle, X Applied in situation S Involves cause-effect relations CERn Between objects or events, E The CERs observed between E in S are called X

Table 3-1: Definition of CDT Categories of Subject Matter (Gilbert and Gale, 2008)

3.4.2. Capability

In order to construct the ILO, the subject matter is not only one but also the measurement of performance to the acquisition of a new competence. This performance expresses the efficiency of the learning capability inside the student's mind. The learning capability is represented by the behaviour of the student in performing a learning activity. In instructional design, a teacher needs to determine and articulate the kinds of capabilities required in order to clarify their expectations to students (Kemp et al., 1994). On the other hand, a student has to know which learning capability is needed to bring about a new competence, the ILO for which will then have been achieved. Therefore, the state of capability is important for the construction of the ILO.

Normally, the expressing of capabilities is determined by using taxonomy such as Bloom's, and/or a revision of Bloom's. For example an ILO may state, "By the end of the course, the student will be able to produces cadmium orange from the colour wheel palette"; the capability in this example is "produces". According to Bloom's Taxonomy (Bloom, 1956), the learning outcomes can be classified as: cognitive (knowledge), affective (attitude), and psychomotor (skills). The cognitive domain (Bloom, 1956) involves knowledge and the development of intellectual skills. The Bloom's taxonomy has six major levels: remember, understand, apply, analyse, evaluate, and create. Each level of capability within revision of Bloom's taxonomy is expressed by a number of different learned capability verbs. Table 3-2 shows the learned capability verb for each level of Bloom's taxonomy in cognitive hierarchy.

The accomplishment of levels in Bloom's taxonomy is usually developed gradually. Each level of the taxonomy is based on the student's capability to achieve at all levels below it (Ferris and Aziz, 2005). Table 3-2 also shows the relationship between Bloom's taxonomy and Merrill's CDT via the student performance of Merrill's CDT (Remember, Use, and Find).

According to the evidence available, the ILO is the intermediate between the teaching activity and the learning activity via sharing of the subject matter. If student know exactly how an expert such as a teacher achieves the ILO by an expert's own knowledge, then it is possible to estimate the teaching activity's trustworthiness based on the expert's knowledge. Therefore, the students may be able to estimate how much they can rely on the teaching activity's trustworthiness by the student's own existing competence: this teaching activity's trustworthiness may be calculated by estimating the actual learning outcome that the student may gain after learning. The actual learning outcome is described more in the next section.

Merrill's CDT	Bloom's Taxonomy	Learned Capability Verb
Find	Synthesis	assemble, categorise, create, design, establish, formulate, generalise, integrate, organise
Use	Evaluation	appraise, argue, assess, contrast, criticise, evaluate, judge, justify, measure, resolve
	Analysis	analyse, break down, categorise, classify, compare, differentiate, distinguish, examine, test
	Application	apply, assess, change, construct, demonstrate, develop, experiment, operate, use
	Comprehension	associate, change, clarify, describe, explain, express, identify, indicate, report
Remember	Knowledge	collect, define, describe, enumerate, label, list, name, order, present, recognise, state

Table 3-2: Examples of verbs for each level of Bloom's taxonomy and Merrill's CDT (Merrill, 1983)

3.5 Intended Learning Outcome vs. Actual Learning Outcome

In this section the difference between the intended learning outcome (ILO) and the actual learning outcome is described. The ILO is the learning purpose separated from the actual learning outcome. The ILO is stated before involving the student in the pedagogical environment and it also influences the context of the pedagogical environment (Anderson et al., 2005; Harden, 2002, Hussey and Smith, 2003; Jenkins and Unwin, 2005). On the other hand, the achieved consequence of the student's actual capability after assessing the learning activity is called the actual learning outcome (Anderson et al., 2005, Hussey and Smith, 2003). Both the student’s actual learning outcome and the student’s actual capability are shown by the student who develops his/her own knowledge, attitude or skill that will then enable the ILO. The student’s actual learning outcome and the student’s actual capability result from the learning activity (Gagné, 1985); they could be right or wrong when compared with the ILO.

Assuming the ILO is stated by an expert, the actual capability is right if the student follows through the learned capability verb and object in the ILO. If the actual capability is right, then the actual learning outcome may be right. The actual learning outcome is right if its quality is agreed by the assessable behaviour of the ILO. Therefore, actual capability and the actual learning outcome could be right or wrong when compared with the ILO. The probability of achieving the right actual learning outcome will be high if the student follows through the learned capability verb and object in the ILO, and the actual learning outcome is described as the consequence of a student’s actual capability after assessing the learning activity. Therefore, an estimation of the actual learning outcome after learning is possible, if the intended learning outcome, teaching activity and the student’s actual capability is stated.

3.6 Summary

In this chapter, the learning transaction and the relationship between the teaching activity and the learning activity have been introduced. The basic relationship of the teaching activity and the learning activity is determined by the expected learning purpose that is defined in terms of the ILO. The ILO is a combined feature of capability and subject matter, and the ILO has been expressed as what the student should be able to achieve by the end of the course. The ILO plays an important role to connect the teaching activity and the learning activity together via knowledge of the subject matter. In the next chapter, it will be shown that the ILO has a crucial role for expressing the student’s prior competence as well as the student’s expectations in order to conceptualise trust.

Chapter 4 Students’ Uncertainty and Students’ Trust

4.1 Introduction

Chapter 3 defined a learning activity as a process of learning undertaken by students themselves or between the student and other people in a specific learning context. The creation or selection of a learning activity relates to an intended learning outcome (ILO). A student may have a state of anxiety and a lack of confidence in the E-learning activity, therefore developing student trust in learning activities is suggested in order to reduce a student’s uncertainty. This chapter is aimed at describing more about the student’s uncertainty in the learning transaction. The concept of trust in Chapter 2 is used to express the student’s trust for reducing the student’s uncertainty. Those topics are basic to arrive at a definition of student’s trust in a learning activity as shown in the last section.

4.2 Student’s uncertainty

4.2.1. Students’ uncertainty in a learning transaction

The cause of a state of uncertainty is a problem space, when an individual cannot solve a problem or fulfil a particular purpose by thinking alone. A state of uncertainty is defined as “a state of doubt in which the individual’s own state of knowledge, work space and cognition cannot fill the problem space by thinking, causing interaction with the world around it to obtain supplementary information” (Ingwersen, 1992, p.131). In learning, the uncertainty grows when a student, to an unprecedented and accelerating degree, is faced with new curricula. During the learning transaction, a student's uncertainty normally occurs in a student's affective states (Craig S. et al., 2004; Kaska P., 2008). A student's hesitation and lack of confidence is the main influence on a student's uncertainty. This uncertainty is increased by an inexpert teaching activity and is, for example, telling of low-quality teaching resources, showing incompetent support learning, the asking of inadequate questions and a lack of teacher's feedback, or assuming that the student is aware of the purpose, or ILO. The types of student uncertainty can be categorized as: an uncertainty in their own response in the learning activity; the student's uncertainty of telling/showing; and the asking and feedback involved in the teaching activity. Table 4-1 shows examples of student's uncertainty in a teaching activity and learning activity.

Student's uncertainty is defined as the feeling that students experience when they feel uncertain about themselves and their learning during a unit of learning such as in a course, a module, or a lesson. There are four events in the learning transaction (Figure 3-2): "tell-and-show", "ask", "response", and "give feedback". Table 4-1 shows the four types of student's uncertainty corresponding to these events.

- The first type, "student's uncertainty in student's own response" is the student's feeling that they have no clear understanding of the existing state of their own competence and their uncertainty about improving their competence (Talbert & McLaughlin, 1993). This uncertainty occurs during the "response" event.
- The second type, "student's uncertainty in telling/showing" is uncertainty during the "tell-and-show" event, when the student does not have much subject matter knowledge, and has little experience to drawn on in order to gain entry to complex subject matter (Federal Aviation Administration, 2009).
- The third type, "student's uncertainty in asking in teaching" is uncertainty during the "ask" event, when a teacher's questions may be beyond or outside the student's understanding (Yang, 2006).
- The fourth type, "student's uncertainty in feedback in teaching" is uncertainty when the feedback in the "feedback" event may not align with student's understanding of the intended learning outcome (Robinson, 2011).

Student’s uncertainty in…	Description
student’s own response (learning activity)	Students doubt their ability. They cannot realise the amount of competence they already possess and cannot compare with the required competences, therefore, they cannot realise how big is the gap in competences required for achieving the ILO.
telling/showing (teaching activity)	Students cannot assess the subject matter knowledge and teaching presentation method of the teaching activity by themselves.
asking in teaching (teaching activity)	Students do not have confidence in the question, and do not know whether it will support them in their purpose or not.
feedback in teaching (teaching activity)	Students cannot assess the correctness of feedback by themselves.

Table 4-1: Types of student uncertainty

4.2.2. Reducing Student’s Uncertainty by Trust

As shown in the previous chapter, the situation of student uncertainty occurs where autonomous individuals, such as students, have to perform individual tasks or activities. At the same time, students, who are limited in terms of their capabilities, perform their learning activities by themselves based on a number of provided teaching activities. Consequently, teaching activities for students cannot guarantee the outcome of their learning, and a degree of uncertainty occurs. However, teaching agents can help students reduce their uncertainty by providing trustworthy teaching activities or recommending trustworthy learning activities that are appropriate for them. Hence, selecting a teaching/learning activity from a number of possible teaching/learning activities requires decision making under uncertainty.

A student’s uncertainty can be reduced by increasing the student’s trust in both the activity and resources that are inherent in the learning transaction (Barnett, 2007). Trust assists students in learning activities by using their knowledge, which was acquired in prior transactions, to assess the degree of uncertainty that is related with the learning activity, such as the subjective probability that a learning transaction with the learning activities will be successful. As can be seen, the emergence of trust in the learning transaction develops to replace the uncertainty. Therefore, it is important to understand trust and how student assess trust, before the meaning of a student's trust is defined in a learning transaction.

4.3 Defining student's trust

This section conceptualises how and why a student makes a particular decision to trust in a learning activity under specific circumstances. The conceptualisation is grounded by general theories of trust, learning theories, and the learning transaction, and covers the following aspects:

- A student is challenged with an ambiguous learning activity in a specific pedagogical situation. This learning activity can lead to a learning experience perceived to be beneficial (utility/profit/positive) or harmful (loss/negative).
- A teaching agent has behaviour that will support a student by recommending an appropriate learning activity and material to a student.
- After the student's expectation of an intended learning outcome or a desired learning outcome (dLO) is set up, the student is willing to trust the learning activity based on a positive expected value of the learning activity's properties. This positive expected value could also be considered as the perceived usefulness of the learning activity itself.
- However, a student's prior competences/knowledge and a student's trust propensity also influence the willingness to trust the learning activity. The student's trust propensity is descriptive for an individual person according to their cultural background, past experiences and personality types. The student's prior competences are represented by the set of prior or familiar learning outcomes (fLO) that are denoted as the student's existing knowledge.
- A student can derive trust from the trustworthiness information of a learning activity. The trustworthiness of a learning activity can be determined as the properties of a learning activity under certain conditions of the dLO. This research categorises trustworthiness based on the integrity, competence and benevolence framework inspired by the classification of Mayer et al. (1995).

As can be seen in the situation of trust from a student's perspective, a student's trust in the learning activity is the degree of trust that a student has when making a decision to trust the learning activity in a specific pedagogy context. Consequently, the decision making involved for a student to trust is the prediction of the possible suitability of the learning activity based on the following:

- The student own opinion: the student's prediction based on the student's trust perception of a teaching activity's trustworthiness, and the student's assumption to trust.
- External opinion: the student's prediction based on the reputation information of a learning activity, where the information sources may come from word-of-mouth or a social relationship.

With the above analysis of the situation of student trust in a learning activity, in this research define a student's trust is defined as:

> *A student's trust in a learning activity is the student's own assumption to believe in the learning activity's trustworthiness, based on the student's own desired learning outcome in a given pedagogical context.*

Students' trust theories were applied for constructing the questionnaire. This questionnaire was used to examine students' trust, as shown in the following chapters.

4.4 Summary

There exists an extensive range of scientific literature on trust – a fact that highlights the significant role of the concept – and this literature is the basis for defining students' trust in the learning transaction context. This defining of students' trust is used to build the model for E-learning situations in the next chapter.

Chapter 5. Learning Outcome-based Trust (LOT) model

5.1 Introduction

Chapter 4 addressed the issue of the student's uncertainty, and the need for student's trust for reducing a student's uncertainty. Student's trust is defined as:

> *A student's trust in a learning activity is the student's own assumption to believe in the learning activity's trustworthiness, based on the student's own desired learning outcome in a given pedagogical context.*

The concepts of trust, the definition of student's trust and the concept of the ILO in the previous chapter are the basis for discussing the student's trust model, and the model of student's trust based on ILOs is proposed in this chapter. This chapter is organised as follows: first, the antecedents and their information sources of a student's trust in E-learning are discussed. Second, the three antecedents of student's trust are discussed the assumption of trust, the perception of trustworthiness, and the pedagogical context. These three antecedents will be combined into a calculation of student's trust in Chapter 6.

5.2 Antecedents of Student's Trust & Information Sources in E-Learning

Chapter 2 has presented the antecedents of student's trust that are used to assess trust value. There are three antecedents of trust: the student's assumption to trust, the student's perception of trustworthiness, and the pedagogical context. According to the existing research, there are various information sources of trust's antecedents for use in the computation of a trust model, as shown in Table 5-1.

Table 5-1 lists the various information sources used to assess trust according to a number of existing studies. The information sources are classified into three areas.

"Assumption to trust" consists of two sources: the trustor's propensity to trust, and the trustor's direct experience. The propensity to trust moderates the effect of trustworthiness attributes on the decision to trust. The trustor's direct experience is the information that occurred after the trust barrier was overcome and the trustor started to trust the trustee.

"Perception of trustee's trustworthiness" consists of three sources: witness information, sociological information, and third-party certificates. Witness information is the information that an individual receives from a second individual about a third one. Witness information is also called word-of-mouth. Schillo et al. (2000) show how witness information can be reliably used to reason against lying individuals and to estimate trust. Yu et al. (2004) built an acquaintance model based on witness information to provide trustworthy ratings to individuals. Sociological information is extracted from the social relations between individuals in the community. The study of social relationships between individuals in a society can be used for calculating trust degree. Third-party certificates are used for authentication, which a trusted organization creates, publishes, and revokes. A trusted third-party certificate authority is used to establish trust as a strategy to convince consumers that the certificated web sites are trustworthy.

"Context" of trust is given by one source, the integration of rules and policies. There are a set of trustor or trustee roles to entities, a set of relations between the entities, and a set of situations where trust exits. Trustors may give different weights to the different antecedents during evaluation of degree of trust. The different weights depend on the rule or policy of the trustor. To establish trust, an organization could publish explicitly its rules and policies, providing a context for interpersonal trust or for trust between organizations. For example, in web services, a set of policies can be published using WS-Policy specification in order to establish trust between two entities.

Antecedents of trust	Information sources	Studies
Assumption to trust	Propensity to trust (e.g. student's trust propensity)	Gill, et al (2005); Van Dyne et al. (2000).
	Direct experience (e.g. student's experience, student's competence)	Egger et al. (2001); Gefen et al. (2003);
Perception of trustee's trustworthiness	Witness information (e.g. word of mouth)	Schillo et al. (2000); Yu et al.(2004)
	Sociological information (e.g. the opinion of a student's parent)	Moyano (2012); Sabater & Sierra (2001);
	Third-party certificate (e.g. the university rankings of the Times higher education world reputation rankings)	Cho & Swami (2009); Wang & Emurian, (2005)
Context	Rules and Policies (e.g. Key Performance Indicators (KPI) for teachers)	Arsanjani, et al.(2007); Jeffries et al. (2000);

Table 5-1: Information Sources of Antecedents in a Trust Model

However, some information sources may not exist, or be insufficient for reasoning about students' trust in learning activities. For example, the following situations will possibly happen:

- The student may never have experience about the learning purpose (ILO) or the recommended learning activity; hence the student's experience cannot be used.
- The student may not able to find any witness information, sociological information or third-party certificate.
- Lack of precise learning guidelines or policies.

The examples of situations show the trust model needs more than one information source to assess a degree of trust. The trust model uses all of the information sources shown in Table 4-1, but it may still fail in assessing trust if all of the above situations happen at the same time. For this reason, alternative information sources of trust may be based on the learning path. To construct the student's model based on the ILOs, the types of ILO are defined. Five types of ILO and their symbols are defined in Table 5-2.

A learning path is a sequence of learning outcomes that enable a student to reach their learning objective (Williams & Rosenbaum 2004). A teacher usually provides learning paths and associated learning activities, such that students make connections with prior and new competences. In self-directed learning, a student performs most of the teacher role themselves and develops their own learning paths as may be suited to their prior knowledge and learning purposes.

The ILO types were identified by the analysis of a learning path. A typical learning path is illustrated in Figure 5-1. A learning path (LP) ends with an ILO that is the student's desired learning outcome, and hence this type of ILO is identified as a "dLO". A LP characteristically starts with a prior learning which the student already possesses, and hence this starting type of ILO is identified as "pLO", the student's prior learning. Intermediate ILOs in the LP connect a pLO with a dLO, and hence are identified as "cLO", consequent, connecting, or prerequisite ILOs. Finally, certain ILOs in the LP may correspond with the ILOs implicit in one or other learning activity, and hence those ILOs are designated "fLOs", as they facilitiate the ILO concerned.

Types of ILO	Descriptions
Student's desired learning outcome (dLO)	dLO is a learning purpose that is stated by the student under the specific pedagogical context.
Student's familiar learning outcome or Student's prior learning outcome (pLO)	pLO is a student's prior knowledge or student's prior competences that a student has achieved in past experiences.
Consequent ILO (cLO)	cLO is an ILO that connects the dLO and the pLO.
Facilitating ILO (fLO)	fLO is a facilitating ILO in each learning activity.
Learning Path (LP)	LP is a sequence of ILOs or a set of cILO from pLO to achieve dLO.

Table 5-2: Five types of ILO

It may be useful to consider how particular instances of these types of ILO were derived in practice from a LP. There are 5 steps:

Step 1. Identification of student's decided learning outcome (dLO). A dLO was identified by matching a relevant ILO node in the ILOs diagram to the student's learning objective. An ILO diagram was constructed by experts, which outlined the experts' knowledge where ILO nodes represent knowledge units and edges represent relationships among knowledge units.

Step 2. Identification of student's prior learning outcome (pLO). A pLO was identified by matching a relevant ILO node in the ILO diagram to the student's prior knowledge.

Step 3. Identification of learning path (LP). A LP was identified by selecting an appropriate path of nodes and edges (ILOs and relationships) from the candidate learning paths implicit in the ILO diagram. The set of candidate learning paths were established from those ILO nodes and edges in the ILOs diagram that connected dLOs and pLOs.

Step 4. Identification of consequent learning outcome (cLO). A cLO was identified in the LP selected in Step 3. All ILOs between the dLO and the pLO in LP were cLOs.

Step 5. Identification of facilitating learning outcome (fLO). An fLO was identified by matching a relevant ILO node in the LP to the learning objective or the implicit ILO of the learning activity.

An example is shown in Figure 5-1. The learning purpose (dLO) is ILO3. ILO4 is the student's prior learning outcome (pLO) in the learning path. ILO1 and ILO2 are consequent ILOs (cLO) in the learning path. ILO2 is also a facilitating (fLO) because it matches the relevant learning activity on this learning path for the example student concerned.

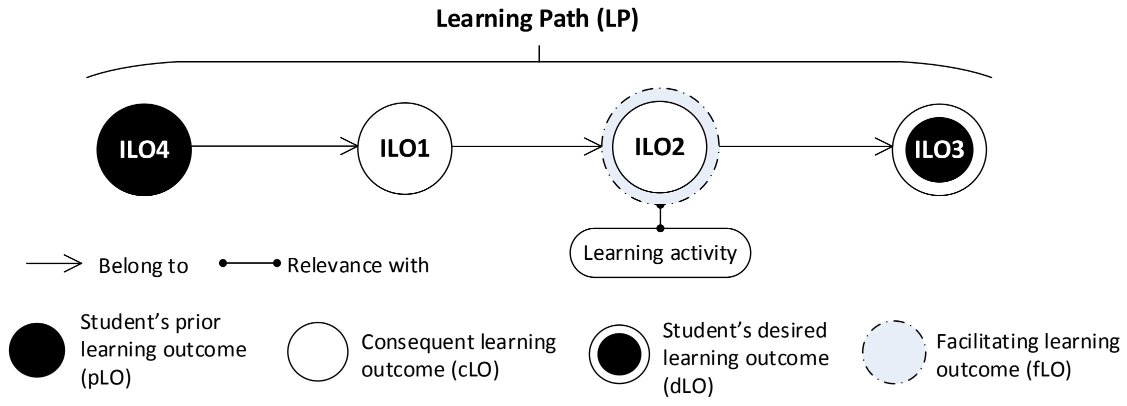


Figure 5-1: Example of how to assign roles to individual nodes in a learning path

As described in Chapter 3, the ILO is composed of the capability and subject matter. The subject matter specifies what the student wants to know and the capability specifies what the student is able to do by undertaking the learning activity. A student's desired learning outcome (dLO) is the learning purpose of a learning activity. In this research, the learning path (LP) is defined to represent a sequence of the learning path to achieve dLO. The LP is constructed by an expert relying on a direct acyclic graph of ILOs (Tangworakitthaworn et al., 2013). In other word, the learning path (LP) could be referred to for representing the knowledge structure of an expert on the achieving dLO. The usage of ILOs as a source of trust will be shown in the next section.

5.3 Learning Outcome-based Trust (LOT) Model

The new conceptual students' trust model is called the Learning Outcome-based Trust (LOT) model. It is used to denote the antecedents of trust and how antecedents affect students' trust in E-learning. This conceptual students' trust model is the foundation of assessing students' trust in learning activities, which will be extended in Chapter 6. The discussion of the students' trust theories and the definition of students' trust, as provided in Chapter 4, is the basis for constructing the conceptual students' trust model, as is shown in Figure 5-2. The antecedents of the students' trust model can be grouped into three categories: students' assumption to trust, students' trust perception of a learning activity's trustworthiness, and the pedagogical context. The details of each antecedent and how to measure it relies on using the concept of ILO as described below.

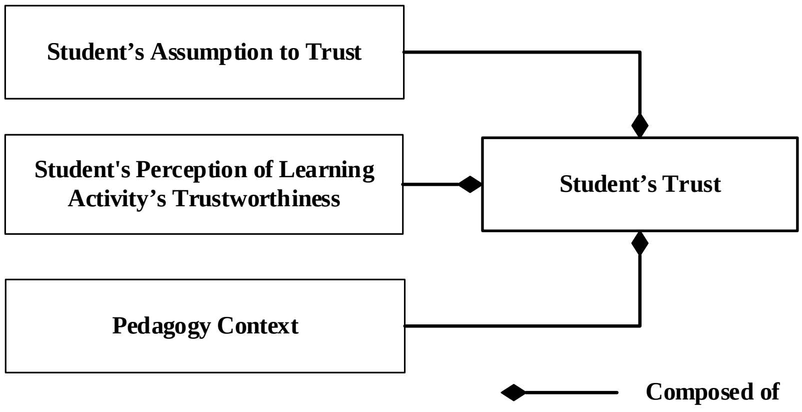


Figure 5-2: Conceptual model of a student's trust

5.3.1 Student's Assumption to Trust

Students have to choose an appropriate learning activity in order to acquire or improve their technical skills or new subject knowledge. They need to develop their own opinions and make a decision to trust any new information themselves. Therefore, students need some notion of trust so they can estimate the trustworthiness of a learning activity. The notion of trust arises from their trust propensity and their prior learning outcome, as described in Chapter 2. The conceptual sub-model of a student's assumption to trust, which shown in Figure 5-3, comprised of:

Measurement of Student's Propensity to Trust

The student's trust propensity is the estimation of the student position on the 'propensity to trust' scale. This is measured by the student's completion of a questionnaire, which is based upon a measure used by Mayer and Davis (1999) and derived from Rotter's (1967) original trust scale.

The student's trust propensity is important in estimating trust, especially when there is little or no information about the trustworthiness of a learning activity. The trust propensity from all students that have successfully completed the learning activity is used to weigh the trust value of an activity (see the algorithm in Chapter 6).

Measurement of Student's prior learning outcome

Most of the time, the prior learning outcome (pLO) of a student is not enough to engage the new learning purpose or use it to bridge new learning. Students may face difficulty in decision-making to trust in a learning activity that will hopefully engage new knowledge. More potential of a student's pLO to the learning activity means an increase in student's trust in the learning activity. Therefore, an analysis is needed of how much of a student's pLO is potentially relevant for acquiring new knowledge. The teaching agent in E-learning should recognise the knowledge schema for understanding students' background knowledge, and use the knowledge schema to bridge between students' prior competence and new learning.

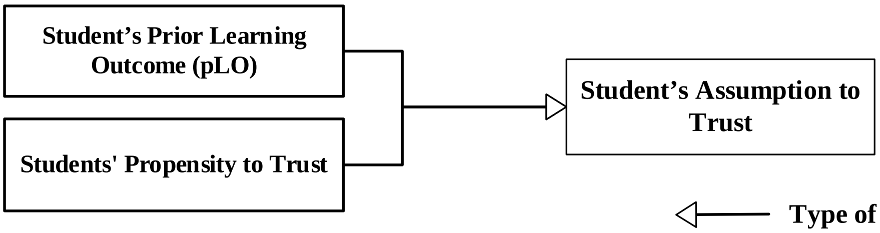


Figure 5-3: Conceptual sub-model of a student's Assumption to trust

5.3.2 Trustworthiness of a Learning Activity

Past research has suggested that trust from a student's perspective is their willingness to believe and have confidence in a learning activity, such that the learning activity will support them to achieve their learning purpose or ILO (Corrigan and Chapman, 2008). Moreover, if students can perceive the trustworthiness of an activity, the trustworthiness of that activity will increase and more students will perceive its greater value as a learning activity. The learning activity must have the three properties in order to give evidence about its trustworthiness: benevolence, competence, and integrity. The conceptual sub-model of student's perception of trustworthiness shown in Figure 5-4. Some properties of a learning activity's trustworthiness can be derived based on the learning path (LP), the student's desired learning outcome (dLO), and the facilitating ILO (fILO) of each learning activity as shown below:

Integrity

Integrity of learning activity is the property that shows how much the learning activity relates with an acceptable set of principles to achieve the student's desired learning outcome (dLO), where a principle is the cause-effect relationship that is observed between events (objects) in a situation (Gilbert & Gale, 2007). In other words, integrity as a property of a learning activity is seen in terms of its reliability and consistency with a learning path to achieve the student's dLO. The learning path is rooted on the principles of ILO Diagram (Tangworakitthaworn et al., 2013). Integrity is perceived as a property of the learning activity, demonstrating that the learning activity adheres to a set of principles that the student finds acceptable. The integrity of a learning activity can be measured by calculating the relationship between the learning activity and the learning path's principles, and where they are most related.

Competence

Competence is the perception that the learning activity has potential to fulfil the student's desired learning outcome in the specific context, where the context was scoped by a learning path. Competence is shown by providing the appropriate learning activity or materials for facilitating a student to achieve the dLO. The competence property of a learning activity could be measured calculating the relevance between a students' dLO within the learning path.

The European e-Competence Framework (e-CF) was developed to support a common understanding of competences, skills, and proficiency levels across ICT supply institutions and individuals in the European ICT community (CEN, 2014). For example, the e-CF can identify what is to be learnt and the possible learning paths for various ICT roles; or can support institutions to identify possible learning paths for competence development.

In this research, student's trust is conceptualised as a relationship between subject matter and capability as expressed in an ILO and student's prior or desired competence. The e-CF does not represent a competence as an outcome which involves subject matter and related capability, and is unable to represent the relationships between these components and the "level of competence" on which the e-CF is focused. In particular, the competence levels of e-CF bridges teaching and qualifications, but this is not the direction of this research.

Two general competence or competency frameworks for organizing a collection of skills are the IMS Reusable Definition of Competency or Educational Objective (IMS-RDCEO), and the HR-XML Consortium competencies schema. Both describe what an individual needs to know and be able to do in order to perform tasks effectively.

The IMS-RDCEO specification "defines an information model for describing, referencing, and exchanging definitions of competencies" (IMS, 2002). IMS-RDCEO offers a model of competence that can be shared across different learning systems. The model also helps in assessing competencies.

The HR-XML Specification (HR-XML Consortium, 2011) has been developed to mainly address the needs of human resource management in and across organisations. HR-XML offers the same elements as IMS-RDCEO, and also offers features to record data used to verify competence achievement with ratings and weights.

According to Sitthisak et al. (2007), there are some problems with both frameworks. For example, IMS-RDCEO does not support machine processability, while HR-XML lacks the ability to specify which elements of a competency hierarchy are mandatory and which are optional. In this research, an application which deals with competences needs machine processability and the ability to compare competences. Therefore, the conceptual model of intended learning outcomes was chosen as the model for representing student's competence and the properties needed in learning activities.

Benevolence

Benevolence of a learning activity is the property that shows how much the learning activity has a fulfilling connection with students. The learning activity shows the connection via the relationship between it and the students' prior knowledge. In other words, benevolence is the belief that the learning activity is suitable for students' prior knowledge or competence, and a learning activity is benevolent if it is provided in such a specific context. The benevolent property of a learning activity is measured by weighing the relevance between the student's prior learning outcome (pLO) within the learning path.

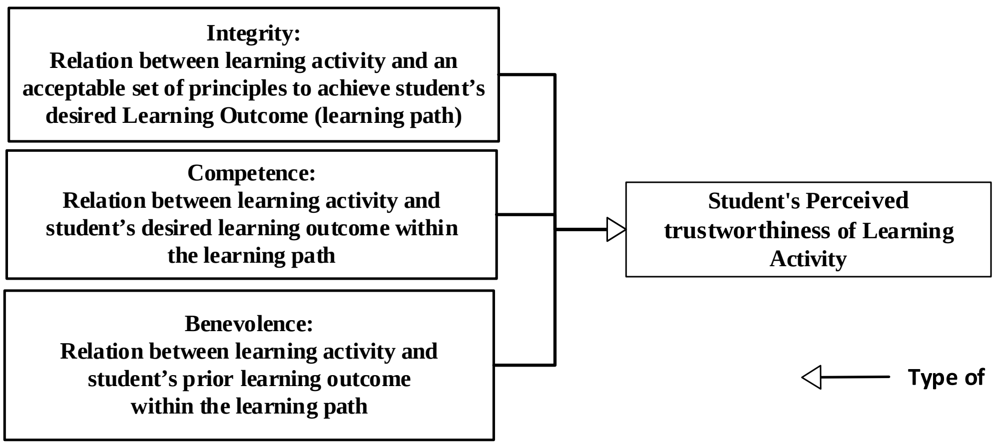


Figure 5-4: Conceptual sub-model of Student's Perception of Trustworthiness

5.3.3 *The Pedagogical Context*

Literature has shown that trust formation can be improved by using context data (Jøsang 2005, Trbovich & Patrick, 2004). The student's trust model is enhance by considering the pedagogical context for enriching trust estimation functions with contextual information. This research defines the pedagogical context as information that can be used to characterise the situation of a person or an object in a pedagogical environment.

Two approaches to defining context were reviewed in the literature. Moschkovich & Brenner (2000) defined context as "the relationship between a setting and how participants interpret that setting, including the meaning of practices". This research followed this definition by characterising its setting as the practice of self-directed learning, including intended learning outcomes and associated learning activities, such that its pedagogical context was defined as the relationship between the setting and how students interpreted that setting during self-directed learning.

A number of researchers argued that the aspects of context comprises what, whom, where, and when (Dybå at el., 2012; Johns, 2006; Sillince, 2007). This approach fits naturally with the concerns of this research, in that trust involves consideration of what, whom, where, and when. Hence, these aspects shown in Figure 5-5 were used to categorize the pedagogical context as follows:

- What? – What a student expects or wants to achieve. This expectation is represented as the desired learning outcome (dLO).
- Whom? – Distinguishing the properties of a student by recognising how much knowledge a student already knows that is represented as the prior intended learning outcome (pLO).
- Where? – Recognising where the potential of the student could be by distinguishing how much prior knowledge that student needs to achieve. The prior knowledge is represented as the stage between pLO and dLO. This stage is denoted by a set of consequent ILOs (a set of cILO).
- When? – Identifying the readiness of a student's prior competence to accept the knowledge in the learning activities at each stage, recognising which stage a student should be performing next, when a student is ready to learn each learning activity that is represented as the gap between fILO and pLO. This recognised stage is one member of the learning path (LP), except pLO.

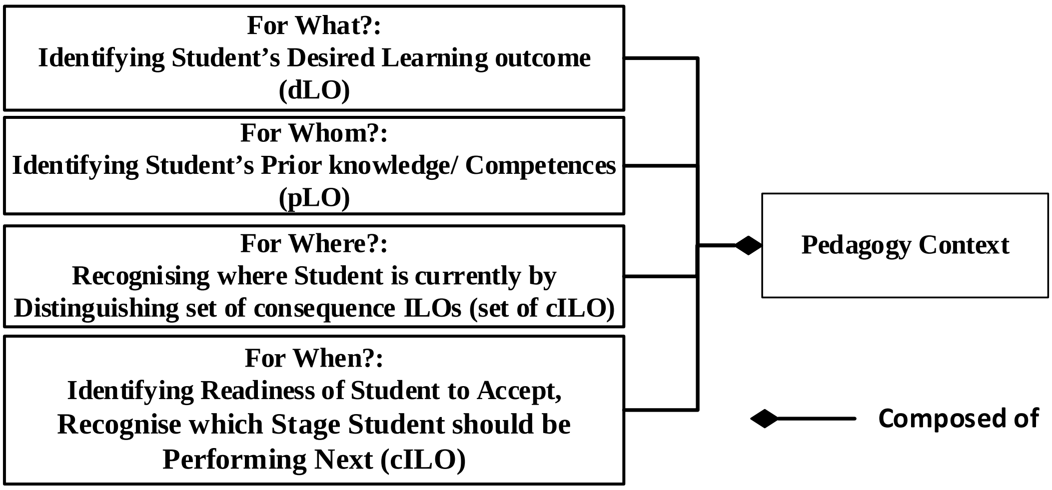


Figure 5-5: Conceptual sub-model of the Pedagogy Context

5.4 Summary

In this chapter, the proposed students' trust model in E-learning is introduced. The antecedents of student's trust include: student's assumption to trust, information on the trustworthiness of a learning activity, and the pedagogical context. The antecedents of trust can be derived based on the student's desired learning outcome (dLO), the student's prior ILOs (pLO), the facilitating LO (fLO) of each learning activity, and the schema of the learning path (LP).

- The dLO is a learning purpose that is stated by the student under the specific pedagogical context.
- The pLO is the student's prior learning outcome that a student has achieved in past experiences.
- The fLO is the facilitating intended learning outcome in each learning activity.
- The cLO is an ILO that comes after dLO in time. The cLOs connects the dLO and the pLO in the learning path (LP); the learning path (LP) is the sequence of a set of cILO to achieve the desired learning outcome (dLO).
- The LP can be presented by the direct acyclic graph ILOs with dLO as the goal node and the student's prior ILOs (pLO) as the root node.

The next chapter focuses on calculating the degree of students' trust based on this proposed students' model and its procedure of assessing trust. This procedure is used to combine the three antecedents of students' trust to calculate the degree of students' trust.

Chapter 6 Algorithm of the LOT model

6.1 Introduction

Chapter 5 proposed that the student's trust conceptual model is called the LOT model and its antecedents are called the student's assumption to trust, the trustworthiness of the learning activity, and the pedagogical context. This chapter proposes how the concept of students' trust is interpreted into an algorithm or procedure for calculating a degree of trust, whereas the learning path serves as an explicit source of information about trustworthiness. This chapter also describes the method to analyse a learning activity, calculating the degree of trustworthiness in that learning activity, and calculating the degree of trust. These calculation methods or the algorithm was created to apply the LOT model in order to predict the degree of student's trust in the phase of validation.

The methodology to apply, verify, and validate the LOT model was:

a. The LOT model was embedded in an application (the LOT application) as described in Section 6.3. The LOT application calculates the degree of student's trust in a learning activity.
b. The LOT application was built using PHP, JavaScript, and MySQL Database, and was verified with test data and its operational behavior was observed as explained in Section 7.3.3.

The LOT model was validated through the LOT application in two experiments. Pilot studies were performed before the experiments to ensure logical presentation of the LOT model's parameters through the LOT application. Two experiments were conducted to evaluate the ability of the LOT model to reliably measure the degree of trust in a learning activity (T_{LOT}), and compare it with the degree of trust expressed by a student

(T_{STU}). Each experiment used different Trust Dilemmas. The detail of experimental design is shown in Section 7.2 and the evaluation of the LOT model is shown in Section 8.2 in detail.

6.2 Generating Learning Situations

The learning situations were created for testing the application of the LOT model. There are two knowledge domains for experiments on two trust dilemma: (1) the Entity Relationship Diagram (ERD) domain, and (2) the Basic First Aid burn domain. The learning path is an explicit source of information about trustworthiness. Table 6-1 shows the pedagogical context detail in the LOT conceptual model as referred in Section 5.3.3, and compared to the LOT calculation model.

Pedagogical Context in the LOT conceptual model	**Pedagogical Context in the LOT calculation model**	
	Learning situation for Experiment 1 (Trust Dilemma I)	**Learning situation for Experiment 2 (Trust Dilemma II)**
Who is the trustor?	The trustor in student role, distinguishing the characteristics of a student by prior/prior knowledge (pLO) and the propensity to trust	The trustor in student role, distinguishing the characteristics of a student by prior knowledge and the propensity to trust
What does the student expect or want to achieve?	The student want to create a simple ERD, and is the student's desired learning outcome (dLO)	The student want to classify burns depending on their severity as either first-, second- or third-degree, and is the student's desired learning outcome (dLO)
Where do the reliable principles fit in the student's pLO and the student's dLO?	The expert whole learning path for creating the ERD, which shows the sequence of principles that fits in pLO and dLO	The expert whole learning path for classifying burns depending on severity, which shows the sequence of principles that fits in pLO and dLO
When would such principles be reasonable for the student?	The student is ready to learn about the principle when it relates with the student's prior/prior learning outcome (pLO)	the student is ready to learn about the principle when it relates with the student's prior/prior learning outcome (pLO)

Table 6-1: Comparison between Pedagogical Context in the LOT conceptual model and the LOT calculation model of Experiment 1 and Experiment 2

To test the LOT model, the learning path is created by an expert relying on a direct acyclic graph of ILOs. The direct acyclic graph of ILOs represent connections between the student's prior competence (pLO) and the student's desired competence (dLO). The ILOs in the graph represent the principles that student have to learn for achieving their dLO.

6.3 Calculating the degree of student's trust in a learning activity

Based on the proposed students' trust model, this section shows the procedure for calculating students' trust in a learning activity. There are four main steps: formalising the context of students' trust, calculation of the degree of trustworthiness in a learning activity, gathering a degree of students' assumption to trust, and the calculation of the degree of trust as shown in Figure 6-1. The procedure outlined in Figure 5-1 is described below.

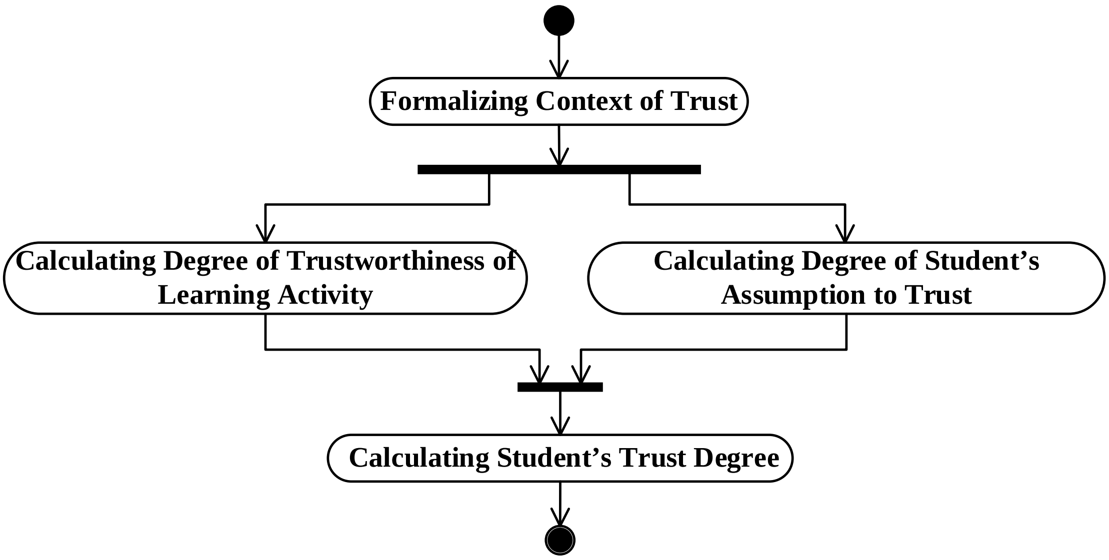


Figure 6-1: Procedure of assessing student's trust

6.3.1. Formalising the context of student's trust

Chapter 2 shows that the trustor trusts the trustee with respect to certain contexts where the trustor's information is used or the trustor's actions are applied. For example, a student (trustor) may trust an advisor in healthcare (trustee) about diabetes care but doesn't trust a financial advisor (trustee). For that reason, the formalising of the context of student's trust is the major first step of the trust model. The context of students' trust is related to the pedagogical context. The pedagogical context represents all the components external to the student within an instructional environment for delivering a meaningful learning activity to the student. These are the features that influence and define what, when, where, and with whom individual students learn from a learning activity.

As shown in Chapter 5, the components within the student's trust in the specific pedagogical context can be captured using the ILOs. In Table 5-2 and Figure 5-5, there are four components of pedagogy context that are derived by five types of ILO:

- The student's desired learning outcome (dLO) is represented as the learning purpose of the student or the intended learning outcome that the student is expected to achieve,
- The student's prior learning outcome (pLO) is represented as the student's prior knowledge or competence,
- The facilitating ILO (*fLO*) is used for facilitating the constructive alignment of a learning activity and its content,
- The consequent ILO (*cLO*) obtains the continuing learning activity that is used to connect the student's prior knowledge to the learning purpose,
- The learning path (LP) is a sequence of the intended learning outcomes or a schema of ILO or a set of cLO that is derived based on the expert's knowledge.

Since the study of student's trust models is still very much in its early stages, a simple linear equation can be used to formalise the student's trust models. In this research, the student's trust is formed using a linear equation because of the need for both simplicity and practicability in modelling students' trust in a learning activity. The student's trust is formalised as Equation (1):

$$StudentTrust(dLO_n, pLO_n, PT_n, KW_n, fLO_m) = TW_{LA}(dLO_n, pLO_n, fLO_m) + AT_{STU}(PT_n, KW_n) \quad (1)$$

Given "n" is the student (STU) and "m" is the learning activity (LA), a trustor is defined as a student who expresses a desired learning outcome (dLO_n), prior knowledge (pLO_n), their level of prior knowledge (KW_n), and their propensity to trust (PT_n). The trustee is defined as the learning agent who provides the learning activity that implies the facilitating learning outcome (fLO_m). In Equation (1), "*StudentTrust*" is a function of the independent variables dLO_n, pLO_n, KW_n, PT_n, and fLO_m to estimate a degree of student's trust. The independent variables in Equation (1) were formalised based on three antecedent of trust using the conceptual model of student's trust which was shown in the Figure 5-2. Equation 1 expresses "*StudentTrust*" as the sum of the student's perception of trustworthiness and the student's assumption to trust:

- Trustworthiness properties of the learning activity (TW_{LA}) are a function of the three trustworthiness properties: integrity, competence, and benevolence. The calculation of trustworthiness was shown in detail on Section 6.3.2.
- The assumption to trust (AT_{STU}) is a function of the student's information about their level of prior knowledge (KW_n) and their propensity to trust (PT_n). The calculation of assumption to trust was shown in detail on Section 6.3.3

Equation (1) also means that the learning activity *m* has satisfied trustworthiness (TW_{LA}), then the student *n*, who has his/her own assumption to trust (AT_{STU}), will trust that the learning activity *m* will engage him/her to achieve the *dLO*. The evaluation of the trustworthiness of the learning activity (TW_{LA}) and students' assumption to trust (AT_{STU}) will be explained in the next sections.

6.3.2. Calculating the degree of trustworthiness of a learning activity

Trustworthiness is a multifaceted construct that captures the properties of the learning activity. A trustworthy learning activity is proposed to have three properties: benevolence, competence, and integrity. The proposed calculation of all properties is described below. Moreover, the research investigated two calculation methods for calculating the degree of trustworthiness of a learning activity: Method A is the method that applied the expert whole learning path, and Method B is the method that applied the trustor learning path. The summary of calculations of Method A and Method B is shown in Table 6-2.

The trustworthiness of a learning activity is calculated according to the degree to which the learning activity's implied ILO fits the identified learning path. Learning paths may be identified in two ways. In method A, the learning path is identified by the teacher. In method B, the learning path is identified by the student. These two methods are of interest because they represent the two main study methods encountered by a student in learning.

Functions to calculate the degree of trustworthiness of a learning activity (LA)		The method for calculating LOT model applied					
		Method A			Method B		
		Integrity (I_{LOTA})	Benevolence (B_{LOTA})	Competence (C_{LOTA})	Integrity (I_{LOTB})	Benevolence (B_{LOTB})	Competence (C_{LOTB})
1	Calculating how much LA and the desired learning outcome match, based on Merrill's capability verb	-	-	Y	-	-	Y
2	Calculating how much LA and the desired learning outcome match, based on Bloom's capability verb	-	-	-	-	-	Y
3	Calculating how much LA and the desired learning outcome match, based on the Merrill's subject matter type	-	-	Y	-	-	Y
4	Calculating how much the keywords of LA and the keywords of the desired learning outcome match	-	-	Y	-	-	Y
5	the number of hops between LA to the desired learning outcome in the learning path devised by the number of the hops between the student's prior leaning outcome to the desired learning outcome in the learning path	-	-	Y	-	-	-
6	Finding the sub-path in the learning path where the start node is the student's prior leaning outcome and the end node is the desired learning outcome, Counting the hops between LA to the desired learning outcome	-	-	-	-	-	Y
7	Finding the sub-path in the learning path where the start node is the student's prior leaning outcome and the end node is the desired learning outcome. Pulsing +1 If the learning activity exists in the sub-path.	-	-	-	-	-	Y
8	Calculating how much LA and the student's prior learning outcome match, based on Merrill's capability verb	-	Y	-	-	Y	-
9	Calculating how much LA and the student's prior learning outcome match, based on Bloom's capability verb	-	-	-	-	Y	-
10	Calculating how much LA and the student's prior learning outcome match, based on the Merrill's subject matter type	-	Y	-	-	Y	-
11	Calculating how much the keywords of LA and the keywords of the student's prior learning outcome match	-	Y	-	-	Y	-
12	Degree Of Numbers of Hops V1 (Nodes)	-	Y	-	-	-	-
13	Degree Of Numbers of Hops V2 (Nodes)	-	-	-	-	Y	-
14	Finding the sub-path in the learning path where the start node is the student's prior leaning outcome and the end node is the desired learning outcome, Pulsing +1 If the learning activity exists in the sub-path	-	-	-	-	Y	-
15	Finding the most similar node in the learning path to the learning activity. Calculating how much LA and the most similar node match, based on Merrill's capability verb	Y	-	-	Y	-	-
16	Finding the most similar node in the learning path to the learning activity. Calculating how much LA and the most similar node match, based on Bloom's capability verb.	-	-	-	Y	-	-
17	Finding the most similar node in the learning path to the learning activity. Calculating how much LA and the most similar node match, based on the Merrill's subject matter type.	Y	-	-	Y	-	-
18	Finding the most similar node in the learning path to the learning activity. Calculating how much the keywords of LA and the keywords of the most similar node match.	Y	-	-	Y	-	-
19	Pulsing +1 if the LA exists in the learning path	Y	-	-	-	-	-
20	Finding the sub-path in the learning path where the start node is the student's prior learning outcome and the end node is the desired learning outcome. Pulsing +1 If the learning activity exists in the sub-path.	-	-	-	Y	-	-

Table 6-2: Summary of function for calculating trustworthiness in learning activity in Method A is the method that applied the expert whole learning path, and Method B is the method that applied the trustor learning path.

Integrity

Integrity shows the quality of honesty in the learning agent, together with indicating truthfulness and fairness in dealing with students via the learning activity. The learning agent has to give the truth of the learning activities, and the learning activities have to be consistent with what the student is expecting. The determination of the integrity of the learning activity is based on the following two ideas:

- Recognising the consistency of the learning activity by weighing a possibility correspondence among the learning activity and the student's expectation. This consistency of the learning activity is used to confirm that the learning agent and the student have the same purpose.
- Recognising the truthfulness of the learning activity by weighing the completeness of the subject matter content by comparison with the subject matter content given by an expert, such as a teacher. This completeness is used to calculate the truthfulness of the learning agent and the accuracy of the learning activity.

For these reasons, integrity could be considered in two steps: the weighing of the consistency of the learning activity, and the truthfulness of the learning activity. First, the degree of correspondence between the learning activity and the student's expectation is weighed depending on a set of rules. These rules are derived based on the match between the presentation form of the learning activity and the capability and subject matter content in a student's expectation of ILO.

For example, given the four learning activities:

(a) A learning activity that feeds back to the student for answering the question of using the logical model concept to classify for database warehouses,

(b) A learning activity that tells the student about the definition of the logical model,

(c) A learning activity that asks the student to use the logical model concept to classify for database warehouses,

(d) A learning activity that shows the student about the example of the logical model.

According to dLO structure and Merrill taxonomy (1974) and Table 3-2, the verb "express" is classified into the capability as "Use". According to Table 3-1, the words "logical model" are classified into the subject matter as "Concept". According to Table 6-3, a consistent learning activity has to act in the same way as "asking" and "feedback", and the presentation form of the learning activity has to perform in the same way as "classify". Therefore, the two possible consistent learning activities that correspond to dLO are (c) and (a).

Therefore, the consistency of the learning activity could be calculated by weighing the possible correspondence between dLO and fLO. Consistency is equal to the degree of correspondence:

$$consistent(dLO_n, fLO_m) = correspond(dLO_n \leftrightarrow fLO_m) \quad (2)$$

where $correspond$ is a measure of correspondence between dLO and fLO. The produce of the correspondence function is the value of consistency, $consistent(dLO_n, fLO_m)$.

Second, the truthfulness of the learning activity is simply the quality of being truthful in the learning activity. The truthfulness is observed to identify aspects of weakness requiring improvement, and aspects of fineness that could serve to refine the learning activity. The learning activity will be considered to be truthful based on the following aspects:

- Clarification of the position in the learning path of the learning activity (fLO),
- Retrieving the relevant subject matter content within the pedagogical context of the course, and aligning the way in which the subject matter contents integrate with each other,
- The selecting of learning materials that are relevant to the subject matter content,
- Creating opportunities for asking and feedback when the student needs the interaction,
- The teacher interacts with the students by creating opportunities for question/answer.

dLO structure		Primary presentation form of the learning activity			
Subject matter	Capability	Tell definition	Show example	Ask/ Feedback	
				for example	for definition
Fact	Remember		Fact pair	Fact name	
Concept	Remember	Concept definition	Example	Name	State Definition
	Use			Classify	
	Find			Explore categories	Invent definition
Procedure	Remember	Activity definition	Demonstration	Rehearse	State steps
	Use			Demonstrate	
	Find			Explore procedures	Device procedure
Principle	Remember	Proposition definition	Explanation	Explain	State cause-effect relationships
	Use			Predict	
	Find			Explore problems	Discover principle

Table 6-3: Correspondence between the learning activity and dLO.
(Adapted from summary of 23 CDT learning acts, Gilbert & Gale, 2008)

Hence, the completeness or truthfulness of the learning activity could be calculated by comparing the similarity between the properties of the learning activity based on the learning path (LP). LP may be the suggestion of an expert, such as a teacher or the learning plan from students themselves.

$$Completeness(LP_n, fLO_m) = sim(LP_n, fLO_m) = \frac{\mathrm{V(LP)} \cdot \mathrm{V(fLO)}}{\|V(LP)\|\|V(fLO)\|} \tag{3}$$

Given V is the function for converting the ILO structure to vector, which comprises of the vector of capability and the vector of subject matter content. The V(dLO) and the V(LP) are two vectors of the dLO and the LP, the cosine similarity, cos(θ), is represented using a dot product and magnitude as $sim(LP_n, fLO_m)$.

Cosine similarity is a common similarity measure applied to text documents, such as in several information retrieval applications (Baeza-Yates, 1999) and clustering (Larsen & Aone, 1999). This research used cosine similarity as a function for identifying

the fLO role in a learning path. The fLO is that ILO in a learning path that has the most similarity with the ILO implied in the learning activity. Similarity was determined by using cosine similarity between the implied ILO of the learning activity and the ILOs in the learning path. Cosine similarity generates a metric that measures relationship of the ILO of the learning activity to all the ILOs in the learning path.
The completeness value of the learning activity.

$$I(dLO_n, LP_n, fLO_m) = sum(consistent(dLO_n, fLO_m), Completeness(LP_n, fLO_m)) \quad (4)$$

Therefore, the degree of trustworthiness of the learning activity (fLO_m) is based on integrity. The degree of trustworthiness is calculated by summing the value of the consistent learning activity and the completeness value of the learning activity as shown in expression (4).

An example of a dLO is “create simple ERD”. This ILO, in common with all other ILOs, comprises a capability type, a subject matter type, and the keywords of the subject matter. In this example, the capability type of “create” is “Find”. The subject matter type of “create ERD” is “procedure”. The subject matter keywords are “Entity”, “relationship”, and “diagram”.

“V” is a function of an ILO which constructs a three-dimensional vector of the ILO components. In this example, V(“Create simple ERD”) is [Find, Procedure, {Entity, Relationship, Diagram}]. Table 6-4 illustrates the ILOs and the V(ILO) for ILOs comprising an example learning path.

The example learning path (LP) is ILO4, ILO1, ILO2, and ILO3: “Describe logical model”, being a pLO; “Interpret ERD” and “Design simple ERD”, being a cLOs; and “Create simple ERD”, being a dLO. The function “V” of a learning path is a matrix of the V(ILO) for each learning path component. In this example, V(LP) is:

$$\begin{bmatrix} \text{Remember,} & \text{Concept,} & \{\text{logical, model}\} \\ \text{Use,} & \text{Concept,} & \{\text{Entity, Relationship, Diagram}\} \\ \text{Find,} & \text{Concept,} & \{\text{Entity, Relationship, Diagram}\} \\ \text{Find,} & \text{Procedure,} & \{\text{Entity, Relationship, Diagram}\} \end{bmatrix}$$

Type of ILO in learning path (LP)	ILO statement		Three dimensions for constructing vector		
	ID	Description	Capability Type	Subject Matter Type	Keywords
pLO	ILO4	Describe logical model	Remember	Concept	logical, model
cLO	ILO1	Interpret ERD	Use	Concept	Entity, Relationship, Diagram
cLO	ILO2	Design simple ERD	Find	Concept	Entity, Relationship, Diagram
dLO	ILO3	Create simple ERD	Find	Procedure	Entity, Relationship, Diagram

Table 6-4: ILO Description in the learning path and their dimensions for constructing vector.

An example of a learning activity is, "Draw a data model for the entities present in a patient billing system". The ILO for this learning activity is identical, being "Draw a data model for the entities present in a patient billing system". When this ILO is in a learning path, it would be an fLO. The corresponding "V" function of this fLO is [Find, Concept, {Data model, entities}].

ILO of learning activity LA033		Three dimensions for constructing vector		
LA ID	ILO Description of Learning activity (LA)	Capability Type	Subject Matter Type	Keywords
LA033	Draw a data model for the entities present in a patient billing system.	Find	Concept	Data model, Entities

Table 6-5: Example of ILO of learning activity and its dimensions for constructing vector.

In this research, CDT was used only for designing ILO structures. In Table 6-5, the type of capability and the type of subject matter of the ILO relating to LA033 was derived from Component Display Theory (CDT) (Merrill, 1983). As shown in Table 3-2, the verb in the ILO statement refers to student capability, and may be classified on the capability dimension: Find, Use, and Remember. Some verbs may be classified on more than one level. For example, "Draw" could be classified at both Find and Use levels. According to CDT, "Use" generally involves cognitive operations on existing or known materials, while "Find" involves the generation or discovery of new materials. For this reason, the ILO of LA033 was assigned the "Find" level because it requires the student to generate a new data model.

The calculation of similarity between the fLO and each ILO in the learning path is shown in Table 6-6. There are three steps in the calculation: (1) Match the capability type between ILOs, (2) Match the subject matter type between ILOs, and (3) Match the keywords between ILOs.

Type of ILO	ILOs in learning path	Steps in calculation			Example of Calculating the similarity between ILOs
		Match capability type btw ILOs	Match SM type btw ILOs	Match keywords btw ILOs	
pLO	ILO4	0	1	0	(0+1+0)/3 = 0.33
cLO	ILO1	0	1	0.5	(0+1+0.5)/3 = 0.5
cLO	ILO2	1	1	0.3	(1+1+0.3)/3 = 0.78
dLO	ILO3	1	0	0.3	(1+0+0.3)/3 = 0.4

Table 6-6: Example of calculation of similarity between ILO of learning activity with all ILO in the learning path.

The following scenario gives more understanding about integrity in a learning activity and how to calculate it. The scenario concerns a student who wonders whether she can trust a learning activity: "Mary is a student who has some knowledge about the logical model, and desires to learn how to draw an ER diagram. Mary visits the self-study database course to select a trustworthy learning activity for herself. The self-study database course comprises the learning activities and their ILOs. All ILOs are based on the IM4 data modelling course of the ACM Computing Curriculum standardised (Lunt et al., 2008) as shown in Appendix E. Mary is curious about the learning activity 'LA033', and whether to trust it. Mary intuitively estimates the likelihood that LA033 can be trusted. Mary searches for signs in LA033 when deciding whether to trust it."

The LOT model proposed integrity as one of the signs of a learning activity's trustworthiness. In the scenario, the LOT model considers the integrity of LA033. LA033 has integrity when it relates to some ILO nodes in Mary's learning path. Assume that Mary accepts Figure 5-1 as her learning path (Table 6-4 shows the details of ILOs in this path). Mary's learning path connects what she desires to learn, "Creating simple ERD" (ILO3), to her prior knowledge, "Describing logical model" (ILO4). ILO4 is the start node because it is the initial learning outcome that is required for ILO3, according to the IM4 data modelling course of the ACM Computing Curriculum standardised (Lunt et al., 2008). Therefore, ILO4 would be the student's prior knowledge or the prerequisite for "Creating simple ERD" (ILO3).

Cosine similarity was applied to estimate the match between two strings by computing the cosine of the angle between their vectors. Strings were encoded as follows:

1) The vector space was based on the 26 English letters of the alphabet. The frequency of each letter is shown within the vector. For example, the strings "Entities" and "Entity" of LA033 (Table 6-5) and ILO2 (Table 6-4) have the letter frequencies as shown in Table 6-7.

Dimension of strings	**English alphabet**																									
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
Entities	-	-	-	-	2	-	-	-	2	-	-	-	-	1	-	-	-	-	1	2	-	-	-	-	-	-
Entity	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	1	-

Table 6-7: the construction of vectors from two words: "Entities" and "Entity" based on the English alphabet.

2) The dimension for the two example strings "Entities" and "Entity" is (e,i,n,s,t,y). Thus, their vectors are: (2,2,1,1,2,0) for "Entities" and (1,1,1,0,2,1) for "Entity".

A full example of the calculation of cosine similarity and how to use cosine similarity in this research is shown in Appendix F.

Benevolence

Chapter 5 showed that benevolence is a characteristic of a trustworthy learning activity. Benevolence is a visible characteristic in how a learning agent cares for the students. The learning agent shows its care about students by the desire of an appropriate learning activity to express kindness and concern. The learning agent expresses its concern by trying to know the students and their expectations. When a student expects to achieve his/her desired learning outcome (*dLO*), the learning agent tries to know the student by determining which prior competences the student has achieved, expressed as the prior learning outcome (*pLO*). The learning agent expresses the kindness by uncovering the student's prior learning outcome and builds the learning activity as a correlation between the prior competences and new competences. For these reasons, it is essential to calculate the benevolence of a learning agent through the correlation between the student's prior learning outcome and the learning activities. A high correlation is an opportunity to increase student's trust.

As shown in Chapter 3, the ILO structure is related directly to the competence of the student, and is the learning purpose for each competence. The ILO structure is also used as the medium between the learning activity and the learning activity. The ILO structure can facilitate the constructive alignment of the learning activity, and is called the facilitating ILO (*fLO*) in this research. Therefore, the learning activity is produced based on the *fLO*, and the learning material is retrieved based on the subject matter content in the *fLO*. The benevolence could be calculated by finding the correlation between the student's prior learning outcome (*pLO*) and the facilitating ILO (*fLO*).

Defining the student's prior learning outcome is represented as the graph of *pLOs*. The learning activities and learning materials are retrieved by the learning agent based on the capabilities and subject matter contents in the graph of *fLOs*. Hence, the benevolence could be calculated by finding a correlation between *pLOs* and *fILOs*. Given the correlation function is:

$$B(pLO_n, fLO_m) = corr(G(pLO_n), G(fLO_m)) \tag{5}$$

Where $corr$ is the correlation function between two vectors. The produce of the correlation function is the matrix of correlation $C_{ij}(fLO_n, fLO_m)$. Therefore, the degree of trustworthiness of the learning activity (fLO_m) is based on benevolence. The degree of trustworthiness is arrived at by calculating the correlation between the *pLO* vector and the *fLO* vector as shown in expression (5). The correlation function will be investigated fully in future work.

"G" is a function to convert an ILO to a vector for calculating degree of benevolence. The vector G(ILO) comprises four dimensions: (1) capability type, (2) subject matter type, (3) keywords, and (4) position in learning path. Table 6-8, illustrates an example G(fLO), being [Find, Concept, {Entity, Relationship, Diagram}, 3], and an example G(pLO), being [Remember , Concept , { logical, model }, 1]

Type of ILO	Components of function G(…)			
	Capability Type	**Subject Matter Type**	**Keywords**	**Position in learning path**
fLO	Find	Concept	Entity, Relationship, Diagram	3
pLO	Remember	Concept	logical, model	1

Table 6-8: Example components of function G(…).

Competence

Benevolence is often not enough to produce trust. Expertise is required when the student is relying on the competence of the learning agent. For example, the student may feel the care of the learning agent, but if the learning agent lacks competence, then a student's trust will become weaker. In Chapter 5 it was shown how competence is the characteristic of a trustworthy learning activity. In this research, the competence of a learning agent is described as demonstrating that the learning agent can sustain a learning activity. This learning activity guides a student to achieve his or her desired learning outcome (*dLO*).

The learning activity is guidance that arranges the appropriate content or the learning material for the student. The competent learning agent needs to provide the learning activity based on the student's desired learning outcome (*dLO*). Consequently, the competence of the learning agent is related to the learning activity and composed of a combination of content, or the learning material. In other words, factors that influence the competence of the learning agent are the learning activity and its content. For this reason, the competence of the learning agent is evaluated according to how the learning agent aligns the learning activity and the subject matter content, to provide superior functionality for the student. In this research the alignment of a learning activity and its content is represented as the facilitating ILO structure (*fILO*). The student's desired learning outcome is represented by the *dLO* structure. Hence, the competence of the learning agent could be calculated by finding the similarity between the data in the *dLO* structure and the data in the *fILO* structure. For instance, if the similarity between the data in the *dLO* structure and the data in the *fILO* structure is high, then the competence of the learning agent is also high:

$$C(dLO_n, fILO_m) = sim(dLO_n, fILO_m) = \frac{\mathrm{V(dLO)}\cdot\mathrm{V(fILO)}}{\|V(dLO)\|\|V(fILO)\|} \quad (6)$$

Given V is the function for converting the data in the ILO structure to a vector, which comprises of the vector of capability data and the vector of subject matter content data. The *V(dLO)* and the *V(fILO)* are two vectors of the dLO data and the *fILO* data, the cosine similarity, cos(θ), is represented using a dot $\mathrm{V(dLO)} \cdot \mathrm{V(fILO)}$ and magnitude as $\|V(dLO)\|\|V(fILO)\|$. Therefore, the degree of trustworthiness of the learning activity $(fILO_m)$ is based on competence. The degree of trustworthiness is arrived at by calculating the similarity value between the dLO structure and the $fILO$ structure as shown in expression (3). From Table 6-4, the data of the example dLO is [Find, Procedure, {Entity, Relationship, Diagram}].

In summary, the result of the trustworthiness function $TW(dLO_n, fILO_m, LP)$ is the set of the degree of trustworthiness. The set of the degree of trustworthiness is calculated based on the four properties of trustworthiness of the learning activity as shown in expression (8):

$$TW_{LA}(dLO_n, fILO_m, LP) = \{B(fLO_n, fILO_m), C(dLO_n, fILO_m), I_{ij}(dLO_n, LP_n, fILO_m)\} \quad (7)$$

The degree of trustworthiness in the learning activity is an aggregated value from the degree of integrity, the degree of competence and the degree of benevolence, and is calculated as follows:

$$Degree\ of\ Trustworthiness = w_i I + w_c C + w_b B \quad (8)$$

Where I = Degree of Integrity, C = Degree of Competence, B = Degree of Benevolence, w_i = significance weighting of Integrity, w_c = significance weighting of Competence, and w_b = significance weighting of Benevolence.

In this research, all weights were set to 1 by default for all equations, because of the difficulty in estimating more exact weights for trust and trustworthiness over different times and various situations. Future work is needed to identify ways to calculated more exact weights to better fit the equations with different times and various situations.

6.3.3. Calculating the degree of students' assumption to trust

In Chapter 5 it was shown that the student's assumption to trust influences the willingness to trust the learning activity. The student's assumption to trust arises from the student's propensity to trust and the student's prior knowledge/competence. Propensity to trust is based on individual instinct, which is measured by the student's completion of a questionnaire based upon Mayer and Davis (1999) and Rotter's (1967) trust scale. The degree of a student's prior knowledge/competence is also gathered from the questionnaire. The gathered degree of student's prior knowledge/competence will be used to find the position of the student's prior/prior learning outcome (pLO) in the learning path, which is a component for calculating the degree of trustworthiness.

In summary, according to expression (1), $AT_{STU}(PT_n, KW_n)$ represents the 'student's assumption to trust' function that calculates the degree of 'assumption to trust. Thus, the degree of 'assumption to trust' is an aggregated value from the degree of the student's propensity to trust (PT) and the student's level of prior knowledge (KW).

$$Degree\ of\ Assumption\ to\ trust = w_{kw}KW + w_{pt}PT \qquad (9)$$

Where, w_{kw} = significance weighting of KW and w_{pt} = significance weighting of PT.

Discussion on propensity to trust

The discussion below shows the reason why the degree of student's assumption of trust is calculated based on two measurements: the propensity to trust and the student's prior learning outcome, for which the details of both are shown above.

If the students have a similar degree of propensity to trust and a similar prior/prior learning outcome, then they will possibly have a similar assumption to trust. According to previous studies in Chapter 5, if the students possibly have a similar assumption to trust, then they will possibly decide to trust in the learning activity to same degree. In addition, if the student does not have relevant knowledge about the learning activity, it is highly possible he or she can decide to trust in a learning activity, based on their assumptions to trust. Students' assumptions to trust are collected from those who have encountered the learning activity before.

For example, assume John, Mary and Max are students in the database course. John and Mary are studying in the MSc Software Engineering programme and they both have the same high propensity to trust. Max is studying in the MSc Wireless Communications programme and he has a low propensity to trust. In the previous two weeks of the database course, Mary and Max have both drawn the logical model but they chose different learning activities for facilitating them.

During the third week of the database course, John is expected to draw the logical model. Therefore, John has to choose the appropriate learning activity for supporting his learning. However, John is a new student of this database course and has never had knowledge about the logical model. At that time, there is no information about trustworthiness available for John to estimate the trustworthiness of the learning activities. John only has Mary and Max to be his information sources for choosing the appropriate learning activity. John has to estimate the degree of trust in each learning activity by himself, and this estimation is based on his assumption of trust. According to his assumption of trust, John has a high possibility of choosing the same learning activity that Mary has chosen, because the correlation between the prior knowledge/competence and the propensity to trust of John and Mary are more than the correlation between John and Max.

For the above reason, we suggests the method for calculating the degree of student's assumption of trust should be based on two measurements: the propensity to trust and the student's prior knowledge/competence.

6.3.4. Calculating the degree of students' trust

This section shows the calculation of the degree of student's trust by using the degree of trustworthiness of the learning activity (TW_{LA}) and the degree of students' assumption to trust (AT_{STU}), and is calculated as follows:

$$Degree\ of\ student's\ trust\ in\ learning\ activity = w_{kw}KW + w_{pt}PT + w_i I + w_c C + w_b B$$

Where w_{kw} = significance weighting of KW and w_{pt} = significance weighting of PT, w_i = significance weighting of integrity (I), w_c = significance weighting of competence (C), and w_b = significance weighting of benevolence (B).

6.4 Summary

The calculation of student's trust is introduced in this chapter. The proposed calculating student's trust consists of four steps:

Step 1: Formalising the context of students' trust

Step 2: Calculating the degree of trustworthiness of the learning activity

Step 3: Calculating the degree of students' assumption to trust

Step 4: Calculating the degree of students' trust

Therefore, the calculation of the students' degree of trust is based on the context correlation value, the degree of trustworthiness of the learning activity and the students' assumption to trust.

Chapter 7 Construction of a Student's Trust Application

7.1 Introduction

The purpose of this chapter is to translate the LOT model requirements and experiment design into a technical design that will be used to develop the LOT model application.

7.2 Experiment design

To make the experiment significant it needs to work on a real learning situation and learning context. In order to evaluate the LOT model, three experimental studies were conducted:

7.2.1. Experiment 1 – Students' trust when information about trustworthiness was ambiguous

The first experiment was to evaluate the LOT models for predicting students' trust in the trust dilemma where the information about trustworthiness was ambiguous (Trust Dilemma I). Two LOT models were evaluated: (1) the LOT model applying Method A, which is the method that applies the expert whole learning path, and (2) the LOT model applying Method B, which is the method that applies the trustor learning path. The precision of LOT models was evaluated by comparing with the baseline model, which is the questionnaire based on students' trust theories. The detail of the methodology for evaluating the LOT model is shown in Chapter 8.

Two parts were constructed in this experiment: (1) constructing application of the LOT model applying Method A and Method B, which is described in the next section,

(2) constructing the online questionnaire for collecting actual students' trust data on the trust dilemma when information about trustworthiness was ambiguous. The trust dilemma in this experiment concerned a learning situation where the learning path was not shown. The detail of constructing the online questionnaire is described in Chapter 8. The experiment was performed in the Entity Relationship Diagram domain: participants were asked to assume the role of a student who wants to learn how to create a simple the Entity Relationship Diagram. The learning path needed for calculating the degree of trustworthiness was created based on the ILO diagram. Figure 7-1 shows the ILO diagram of the IM4 data modelling module (Tangworakitthaworn et al., 2013), proposed by the ACM Special Interest Group on IT education (Lawson et al., 2006).

In the e-learning design process, an ILO diagram facilitates the instructional designers or the teachers in their analysis of the learning outcomes, learning strategies, learning materials, and assessment methods of a course or module. An ILO diagram can be used as the intermediary tool to facilitate information exchange between the instructional designers and e-learning developers. In self-education, an ILO diagram can provide a visualization of learning content for students (Tangworakitthaworn et al., 2014). In this research, the learning path, which is the information source of trust, was extracted from the ILO diagram. The ILO diagram in Figure 7-1 was for experiment 1 and the ILO diagram in Figure 7-2 was for experiment 2.

There are three uses of the LOT model: (1) to embed the ILO diagram as the information source of trust, (2) to generate the learning path as the policy or strategy for calculating a degree of trustworthiness in learning activity, and (3) to calculate a degree of student's trust based on the student's assumption to trust and the degree of trustworthiness in a learning activity. For these uses, the LOT model is ideally implemented as a LOT application using languages such as SQL, JavaScript, and PhP. The Educational Modelling Language (EML) or IMS Learning Design do not support reasoning about or calculating trust. Neither EML nor IMS-LD can represent the properties needed by the LOT model in its calculations

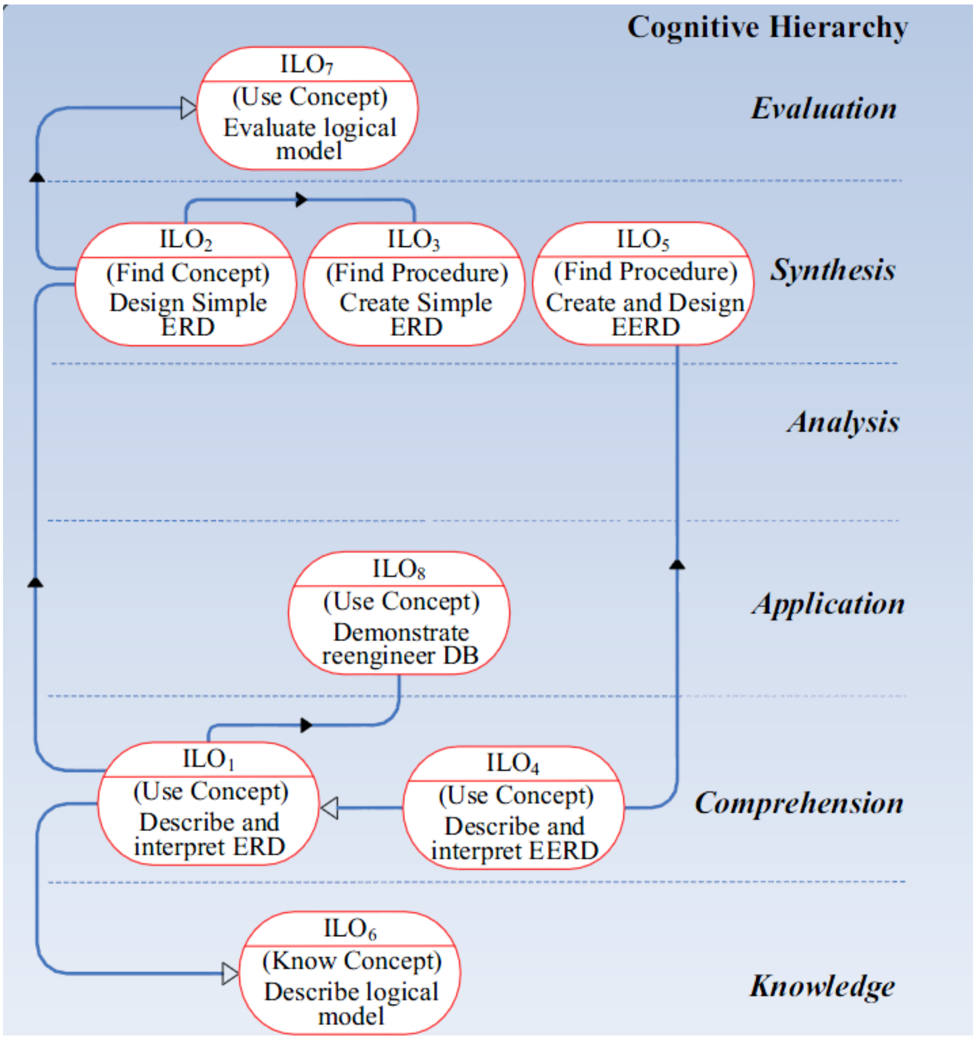


Figure 7-1: ILO diagram of the IM4 data modelling module (Tangworakitthaworn et al., 2013)

7.2.2. Experiment 2 – Students' trust when information about trustworthiness was clear

The second experiment was to evaluate the LOT model for predicting students' trust in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II). Two LOT models were evaluated: (1) the LOT model applying Method A, which is the method that applies the expert whole learning path, and (2) the LOT model applying Method B, which is the method that applies the trustor learning path. The precision of LOT models was evaluated by comparing with the baseline model, which is the questionnaire based on students' trust theories. The detail of the methodology for evaluating the LOT model is shown in Chapter 8.

Two parts was constructed in this experiment: (1) constructing application of the LOT model applying Method A and Method B, (2) constructing the online questionnaire for collecting actual students' trust data on the trust dilemma when information about trustworthiness was clear. The trust dilemma in this experiment concerned a learning situation where the learning path was shown. The detail of constructing the online questionnaire is described in Chapter 8. The experiment was performed in the basic first aid burns domain. The participants were asked to assume the role of a student who wants to learn how to classify burns depending on their severity as either first-, second- or third-degree. The learning path needed for calculating the degree of trustworthiness was created based on the ILO diagram. Figure 7-2 shows the ILO diagram concerning basic first aid burns, and was constructed using three nurse teachers as experts.

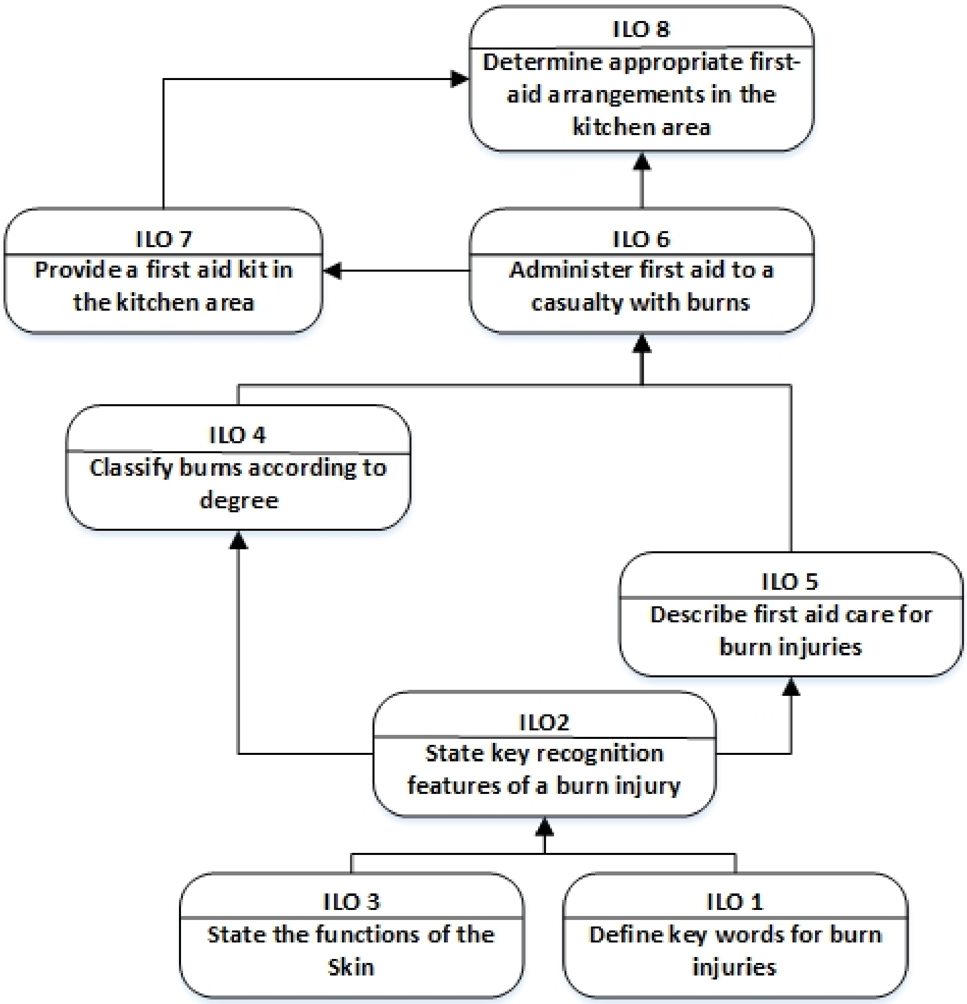


Figure 7-2: the ILO diagram concerning basic first aid burns.

7.2.3. *Experiment 3 – Investigation on students' perceived trustworthiness*

The third experiment was to investigating whether the student's perceived trustworthiness of a learning activity was influenced by the antecedents to trust from the LOT model in both Trust Dilemma I and Trust Dilemma II. If the set of student's perceived trustworthiness of a learning activity corresponds with the set of antecedents to trust from the LOT model, therefore it was influenced. The detail of the methodology is shown in Chapter 8.

7.3 Constructing application of the LOT model applying Method A and Method B

The user requirements for the LOT application were derived from an analysis of three aspects of the intended system. First, the required inputs to the application were analysed, such as user ratings about their prior knowledge, and propensity to trust. Second, the required outputs were analysed, such as the path of ILOs as illustrations of learning paths, the degree of trustworthiness, and the degree of trust. Third, the associated user interfaces were analysed for these inputs and outputs. This methodology conforms to a conventional system analysis in the software engineering of an application.

The LOT application was needed to conduct the experiments reported in this research, and as such user participation in its development was neither appropriate nor required.

To make the experiment significant it needs to work on a real learning situation and learning context. The used-case diagram shows a unit of functionality provided in the learning situation. The actor in the LOT is a student who interacts with a teaching agent. Moreover, to check whether the LOT application conforms to specifications, the verification was performed to ensure the program logic is complete and correct, and to ensures program processes are as designed in a used-case diagram.

7.3.1. *Design of the LOT model application*

The used-case diagram indicates the requirements and the design specifications of the LOT model to calculate the degree of a student's trust in the learning activity. In Figure 7-3 shown the used-case diagram of LOT model applying the expert whole learning path. Figure 7-4 shown the used-case diagram of LOT model applying the student's learning path. In order to analyse the degree of trust, the student has his/her own desired learning outcome, and fills in the prior knowledge form, the propensity to trust form, giving his/her degree of trust in the learning activity. The program will calculate the degree of student's trust based on LOT model. The LOT model is examined by comparing the degree of students' trust from the students and the degree of trust from the LOT model. The used-case specifications and related user interfaces are shown in Appendix A.

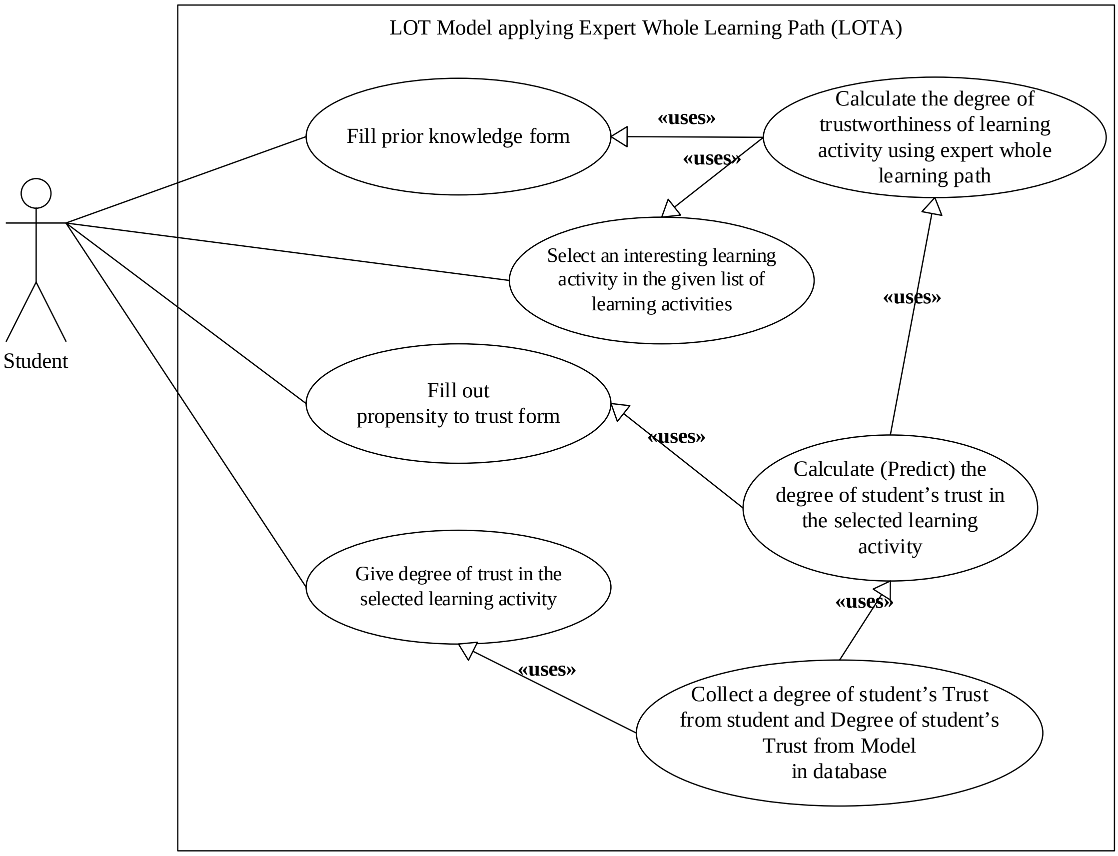


Figure 7-3: Used-case diagram of LOT model applying the expert whole learning path

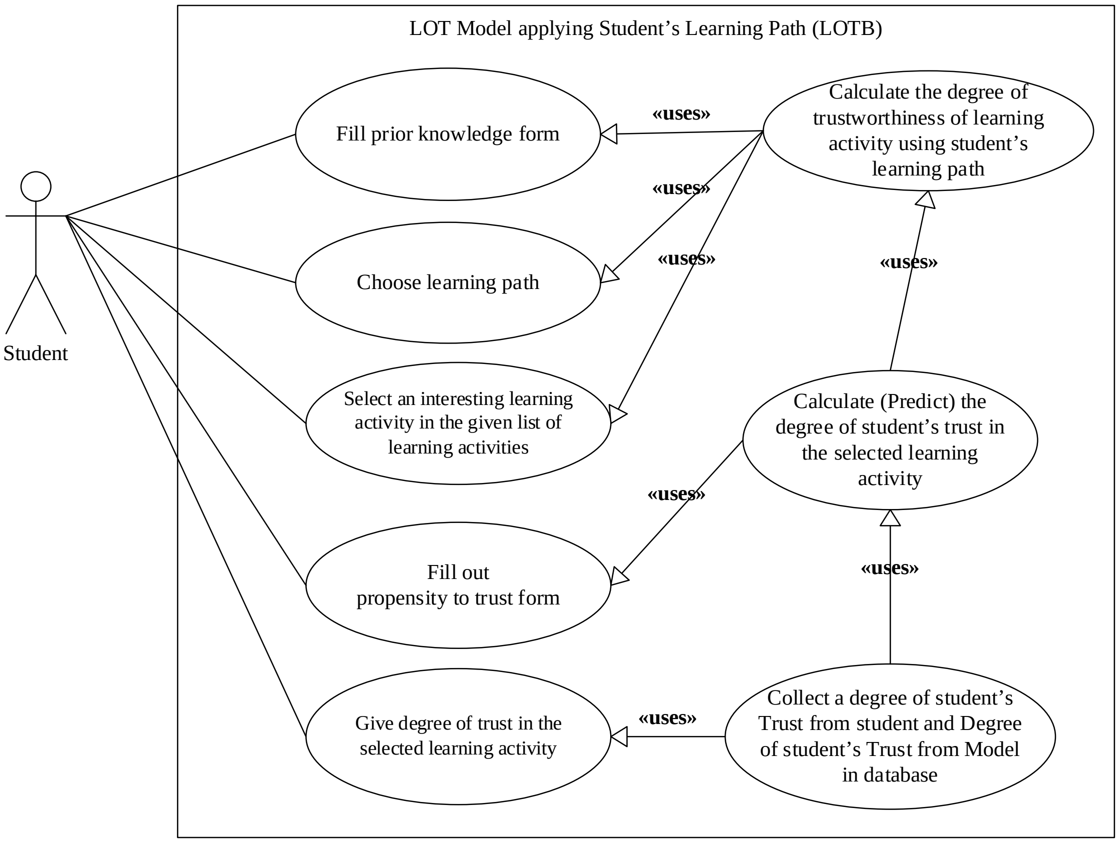


Figure 7-4: Used-case diagram of LOT model applying the student's learning path

7.3.2. Data model of the LOT model application

The entity diagram of student's trust was designed based on the concept of ILO diagram. Two ILO diagrams were selected to be the source of the learning context for our two experiments. Learning context is defined as 'the circumstances in which, or conditions that surround, the learning' (Baseed et al., 2007). Regarding the circumstances, this was stated as having the capability to do something. The ILO diagram was the source of learning context, for the reasons that the ILO consists of two primary elements, subject matter and capability (Sitthisak and Gilbert, 2010). The ILO diagram is a directed acyclic graph for connecting the ILOs that students have to do for achieving the desired learning outcome. Moreover, the ILO diagram was used to connect the students and the learning activity in the learning situation. The entity diagram of student's trust was show in Figure 7-5.

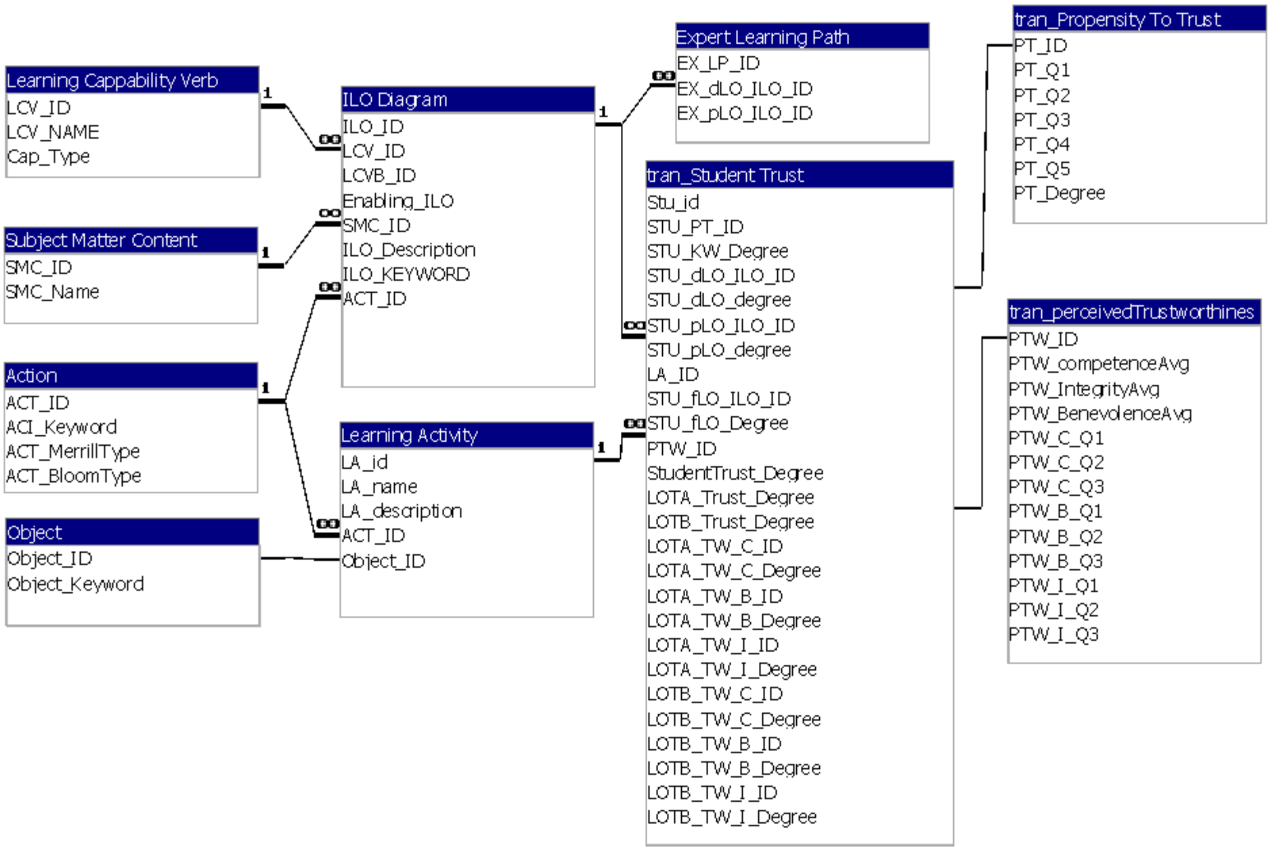


Figure 7-5. Entity Diagram of student's trust

7.3.3. Verification of the LOT model application

Verification attempts normally try to utilise existing structure where practicable (e.g., Davis, 1984). Verification deals with building the model correctly, and the structure is either obtained from the calculation process of the LOT model or from the information representation of the LOT model. The methods in each used case were verified to determine whether they meet the specified requirements for that phase, to ensure that the LOT model application is being constructed according to the requirements and design conditions. In other words, we try to answer the question "Are we constructing the LOT model Application correctly?" by ensuring that the processes of the LOT model application meet the LOT conceptual model needs, as shown in Chapter 5 and Chapter 6. The method for verifying the LOT model application is divided into three parts: (1) the check-list of evaluation items was conducted for verifying the LOT model application. This check-list was developed based on the eight attributes of Boehm et al. (1978) for describing the quality of a software product: intrinsic code quality, freedom from problems in operation, usability, installability, documentation for intended users, portability, maintainability and extendibility, and “fitness for use” implicit conventional user needs are satisfied. The detail of checklist. (2) Piloting review for verifying user interfaces and their related processes. (3) Creating and executing test cases by simulating the controller of the LOT model application along the test cases. The verifier supported that the LOT model application is implemented as planned and described in the used-case design and the LOT conceptual model.

7.4 Summary

The Entity Relationship diagram and the used-case scenario were demonstrated to explain the requirements and the design specifications of LOT model application. The Entity-Relationship diagram was used to represent all of the data entities and their relationships, which is required to apply the LOT model. The used-case model was used for capturing requirements about function, input details, output details, processing, and the student details. The LOT Model application was verified to ensure that the application was being built according to the requirements and design specifications.

Chapter 8 Research Methodology

8.1 Introduction

The research was conducted in three phases. The concept of student's trust and student's perceived trustworthiness were studied in Phase 1. The antecedent to trust and the intended learning outcome structure were obtained to propose the Learning Outcome-based Trust (LOT) model, was evaluated in Phase 2. The antecedents to trust and trustworthiness were studied in Phase 3. Before the experiments were conducted, piloting and designing the optimal sample size for the experiment was a top priority.

8.2 Research Objective

Tables 8-1 to 8-6 show the objectives of this study, their research questions and brief methodologies to answer. Table 8-1 shows the summary of the methodology for integrative students' trust theories and the LOT model of this research. Tables 8-2 and 8-3 show the summary of the methodology for evaluation of the LOT model in the trust dilemma that was ambiguous. Tables 8-4 and 8-5 show the summary of the methodology for the evaluation of the LOT model in the trust dilemma that was clear. Table 8-6 shows the methodology for the exploration of perceived trustworthiness.

Phase 1: Integrative Student's Trust Theories and the LOT model					
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of the methodology**
1	To develop a trust model for students' trust in the learning activity	RQ1	How do students measure trust in a learning activity?	Proposing students' trust theories to describe the properties of antecedents to trust and the relationship between the antecedents to trust and students' trust	• Systematic Review about trust and learning activity in E-learning and learning. • Proposing the students' trust theories
		RQ2	How can properties of a learning activity that influence trust be measured?		
2	To apply a trust model for calculating students trust in the learning activity	RQ3	How is students' trust calculated?	Proposing LOT model, its conception model, its metric and its implementation	• Constructing the conceptual LOT model • Specifying functional specification of LOT model • Implementing inference software for LOT model • Verify the inference software for LOT model

Table 8-1: Summary of methodologies to answer in Phase 1

Phase 2: Evaluation of the LOT model (Part 1)						
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of Methodology**
3	To validate students' trust theories in Trust Dilemma I (Chapter 9)	RQ4	Did the students agree that the trustworthiness properties of the learning activity influenced their decision to trust when they were in Trust Dilemma I?	• Conducting the questionnaire based on the predictor variables of the students' trust theories • Verifying whether the trustworthiness properties of the learning activity influenced the students' decision to trust • If the mean students' perceived trustworthiness > 4 (neutral) that means they agree that the trustworthiness properties of the learning activity influenced the placing of their trust	• Designing the questionnaire for validating students' trust theories in Trust Dilemma I (a) Defining the Learning Scenario (b) Identifying potential participants and sample size (c) Deciding how to collect replies (d) Designing the questionnaire • Pilot test • Analysing data (a) Reliability analyses (b) Answering RQ4: Verifying the students' perceived trustworthiness by one sample t-test (c) Answering RQ5: Validating students' trust theories using multiple regression
		RQ5	Did the questionnaire based on the students' trust theories predict the students' trust in Trust Dilemma I?	• Conducting the questionnaire based on the predictor variables of the students' trust theories • Validating whether the questionnaire can predict students' trust • The questionnaire can predict students' trust if there are relationships between the predictor variables and students' trust • If the questionnaire can predict students' trust then the students' trust theories are valid	
4	To investigate the relationship between the students' trust theories and the students' trust in Trust Dilemma I (Chapter 9)	RQ6	What was the main variable in the questionnaire that related to students' trust in Trust Dilemma I?	If the student's trust is determined by its linear relationship with the set of variables, the main variable is the one that best explains variations in the students' trust	• Analysing by multiple regression

Table 8-2: Summary of methodologies to answer in Phase 2, Part 1

Note: Trust Dilemma I is the situation in which the information about trustworthiness was ambiguous.

Phase 2: Evaluation of the LOT model (Part 2)					
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of Methodology**
5	To validate the LOT model for predicting students' trust in Trust Dilemma I (Chapter 9)	RQ7	Did the LOT models predict the students' trust in Trust Dilemma I?	• The LOT models are valid if they can predict students' trust • The LOT models can predict students' trust if there are relationships between the predictor variables and students' trust	• Experimenting on the LOT model applying Method A and the LOT model applying Method B in Trust Dilemma I • Validating the LOT model applying Method A and the LOT model applying Method B using multiple regression • Investigating the relationship between the LOT model and students' trust using multiple regression
6	To investigate the relationship between the LOT model and the students' trust in Trust Dilemma I (Chapter 9)	RQ8	What was the main variable that influenced students' trust in Trust Dilemma I?	If the student's trust is determined by its linear relationship with the set of variables, the main variable is the one that best explains variations in the students' trust	
7	To evaluate the performance of the LOT models in comparison with the students' trust theories in Trust Dilemma I (Chapter 9)	RQ9	In Trust Dilemma I, How well did the LOT models perform to predict students' trust in comparison with the questionnaire based on the students' trust theories?	Comparing the performance of the LOT model applying Method A, the LOT model applying Method B, and the questionnaire based on the students' trust theories	• Conducing F-ratio to compare the performance of the LOT model against the questionnaire based on the students' trust theories

Table 8-3: Summary of methodologies to answer in Phase 2, Part 2

Note: Trust Dilemma I is the situation in which the information about trustworthiness was ambiguous. The LOT model applying Method A applies to the expert whole learning path. The LOT model applying Method B applies to the trustors' path.

Phase 2: Evaluation of the LOT model (Part 3)					
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of Methodology**
8	To validate students' trust theories in Trust Dilemma II	RQ10	Did the students agree that the trustworthiness properties of a learning activity influenced their decision to trust when they were in Trust Dilemma II?	• Conducting the questionnaire based on the predictor variables of the students' trust theories • Verifying whether the trustworthiness properties of the learning activity influenced the students' decision to trust • If the mean students' perceived trustworthiness > 4 (neutral) that means they agree that the trustworthiness properties of the learning activity influenced the placing of their trust	• Designing the questionnaire for validating students' trust theories in Trust Dilemma II (e) Defining the Learning Scenario (f) Identify potential participants and sample size (g) Deciding how to collect replies (h) Designing the questionnaire • Pilot test • Analysing data (d) Reliability analyses (e) Answering RQ4: Verifying the students' perceived trustworthiness by one sample t-test (f) Answering RQ5: Validating students' trust theories using multiple regression
		RQ11	Did the questionnaire based on the students' trust theories predict the students' trust in Trust Dilemma II?	• Conducting the questionnaire based on the predictor variables of the students' trust theories. • Validating whether the questionnaire can predict students' trust. • The questionnaire can predict student's trust if there are relationships between the predictor variables and students' trust. • If the questionnaire can predict students' trust then the students' trust theories valid.	
9	To investigate the relationship between the students' trust theories and the students' trust in Trust Dilemma II	RQ12	What was the main variable in the questionnaire that related to students' trust in Trust Dilemma II?	If the student's trust is determined by its linear relationship with the set of variables, the main variable is the one that best explains variations in the students' trust	• Applying multiple regression

Table 8-4: Summary of methodologies to answer in Phase 2, Part 3

Note: Trust Dilemma II is the situation in which the information about trustworthiness was clear.

Phase 2: Evaluation of the LOT model (Part 4)					
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of Methodology**
10	To validate the LOT model for predicting students' trust in Trust Dilemma II	RQ13	Did the LOT models predict the students' trust in Trust Dilemma II?	• The LOT models are valid if they can predict students' trust • The LOT models can predict students' trust if there are relationships between the predictor variables and students' trust	• Experimenting on the LOT model applying Method A and the LOT model applying Method B in Trust Dilemma I • Validating the LOT model applying Method A and the LOT model applying Method B using multiple regression • Investigating the relationship between the LOT model and students' trust using multiple regression
11	To investigate the relationship between the LOT model and the students' trust in Trust Dilemma II	RQ14	What was the main variable that influenced students' trust in Trust Dilemma II?	If the student's trust is determined by its linear relationship with the set of variables, the main variable is the one that best explains variations in the students' trust	
12	To evaluate the performance of LOT models in comparison with the students' trust theories in Trust Dilemma II	RQ15	In Trust Dilemma II, How well did the LOT models perform to predict students' trust in comparison with the questionnaire based on the students' trust theories?	Comparing the performance of the LOT model applying Method A, the LOT model applying Method B, and the questionnaire based on the students' trust theories	• Conducing F-ratio to compare the performance of the LOT model against the questionnaire based on the students' trust theories

Table 8-5: Summary of methodologies to answer in Phase 2, Part 4

Note: Trust Dilemma II is the situation in which the information about trustworthiness was clear. The LOT model applying Method A applies the expert whole learning path. The LOT model applying Method B applies the trustors' path.

Phase 3: Exploration of perceived trustworthiness					
Objectives		**Research Questions (RQs)**		**How to Answer RQs**	**Stages of Methodology**
13	To validate the relationship between the antecedents to trust and the students' perceived trustworthiness in Trust Dilemma I	RQ16	Did the antecedents to trust relate with the students' perceived trustworthiness in Trust Dilemma I?	• Finding basis vectors for two sets of variables (between the set of antecedents to trust and the set of students' perceived trustworthiness) such that the correlation between the projections of the variables onto these basis linear combinations is mutually maximized • The relationship between two sets of variables are valid if there are at least one pair of linear combinations that is statistically significant • The pair of linear combinations, which is statistically significant, explained the relationship between the set of antecedents to trust and the set of students' perceived trustworthiness	Conducing canonical correlation analysis (CCA) (Hotelling, 1936) for Trust Dilemma I and for Trust Dilemma II. CCA was conducted to find pairs of linear combinations that maximise the correlation between two linear composites.
14	To investigate the relationship between the antecedents to trust and the students' perceived trustworthiness in Trust Dilemma I	RQ17	How did the antecedents to trust relate with the students' perceived trustworthiness in Trust Dilemma I?		
15	To validate the relationship between the antecedents to trust and the students' perceived trustworthiness in Trust Dilemma II	RQ18	Did the antecedents to trust relate with the students' perceived trustworthiness in Trust Dilemma II?		
16	To investigate the relationship between the antecedents to trust and the students' perceived trustworthiness in Trust Dilemma II	RQ19	How did the antecedents to trust relate with the students' perceived trustworthiness in Trust Dilemma II?		
17	To investigate whether the learning path influenced the students' perceived trustworthiness	RQ20	Did the learning path influence the students' perceived trustworthiness?	• If the correlation coefficient of Trust Dilemma I is not statistically significant but the correlation coefficient of Trust Dilemma II is statistically significant then learning path tended to influenced the students' perception of trust	
18	To investigate whether the learning path influenced the students' trust	RQ21	Did the learning path influence the students' trust?	• Comparison between the mean students' trust in Trust Dilemma I and Trust Dilemma II • If the mean students' trust of Trust Dilemma II is higher than the mean students' trust of Trust Dilemma I, then the learning path influenced the students' trust	Conducting one-way analysis of covariance (ANCOVA) for comparing the degree of students' trust between the two Trust Dilemmas

Table 8-6: Summary of methodologies to answer in Phase 3

Note: Trust Dilemma I is the situation in which the information about trustworthiness was ambiguous. Trust Dilemma II is the situation in which the information about trustworthiness was clear

8.3 Phase 1: Integrative Students' Trust Model

In Phase 1, the students' trust theory, which is an approach to evaluate students' decision to trust, has been proposed to answers RQ1 and RQ2 (Chapter 3). We have conducted a systematic review of published studies (Chapters 2 and 3) investigating the Students' Trust Model called the LOT model (Chapter 3) to answer RQ3. There are four stages as referred to in Table 8-1, which were explained in detail in Chapter 4 and Chapter 5. The verification of the LOT model was shown in Chapter 5 to confirm the computer program and implementation of the LOT model are correct.

The LOT model was proposed to calculate the degree of student's trust in a learning activity. In developing the LOT model, more than one development method would provide for more detailed and comprehensive information about the trust dilemma in a learning situation. Moreover, use of more than one method would increase validity in the research findings. There were three possible methods to develop the LOT model:

- Literature review: to review the existing research about trust, placing trust, trustworthiness in e-learning, education, and learning activity.
- Experts' opinion: experts such as teachers are asked for their opinions about trust, trust in learning activity, and the properties of trustworthy learning activity.
- Students' opinion: students are asked to provide their opinion about trust, trust in learning activity, and the properties of trustworthy learning activity.

Firstly, in addressing the calculation of student's trust in learning activity, various terms have been needed to defined and analyse such as "trust", "trustworthiness", and "learning activity". Having unidentified terms in a passage will impede experts' or students' understanding. Therefore, the literature review was the first method in the development of the LOT model. Secondly, experts' opinions were used to confirm the literature review and the resulting LOT model. Lastly, the best role for student opinion was considered to be during the validation phase of the LOT model development. Students were not directly involved in the initial development of the LOT model, but were involved in its subsequent validation

8.4 Phase 2: Evaluation of LOT model

In Phase 2, the LOT model verification and validation was planned to evaluate by the students. The overview of Phase 2 is shown in Tables 8-2 to 8-5. The validation of the LOT model was conducted for the proof that the LOT model in a specific Trust Dilemma obtains an acceptable range of precision.

> Precision is defined as, "the ability of the LOT model to reliably measure the degree of trust in a learning activity (T_{LOT}), when compared with the degree of students' trust (T_{STU})". Higher precision is achieved if T_{STU} is high than if T_{LOT} is high. Higher precision is achieved if T_{STU} is low than if T_{LOT} is low.

There are four sub-sections to evaluate the LOT model: (1) the validation of students' trust theories in Trust Dilemma I and Trust Dilemma II; (2) the investigation of the relationship between the students' trust theories, and the students' trust in Trust Dilemma I and Trust Dilemma II; (3) the validation of the LOT model for predicting students' trust in Trust Dilemma I and Trust Dilemma II, and (4) the evaluation of performance of the LOT models in comparison with the students' trust theories in Trust Dilemma I and Trust Dilemma II.

8.4.1. Validating student's trust theories in Trust Dilemma I & Trust Dilemma II

This sub-section was aimed to explain the methodology to answer research questions RQ4, RQ5, RQ10 and RQ11, as stated in Table 8-2 and Table 8-4. There are five stages of the methodology for validating students' trust theories in both Trust Dilemma I and Trust Dilemma II.

8.4.1.1. Designing the questionnaire for validating student's trust theories in Trust Dilemma I and Trust Dilemma II

This stage shows the questionnaire design for validating students' trust theories in Trust Dilemma I and Trust Dilemma II. The students' trust theories are valid if the questionnaire, that was constructed based on the predictor variables of the students' trust theories, can predict students' trust. There are four steps to place the questionnaire:

(a) Defining the Learning Scenario and Indicators of Trust Dilemmas

In order to validate the LOT model, the experiments were conducted using scenario-based questionnaires. The scenarios were constructed by emphasizing the relevance of self-directed learning when e-learning is involved. E-learning initiatives support students wanting to acquire knowledge and arrange their own learning without being constrained by time and place. E-learning allows self-directed students to tackle the course at their own pace and to design their own learning paths. However, self-directed students, who take responsibility for their own learning, could raise questions about trustworthiness before placing trust in the provided learning activities.

The scenarios asked the participant to imagine themselves as a self-directed student needing to learn something. The student was encouraged to use their initiative in (1) diagnosing their learning needs, (2) formulating learning outcomes, (3) choosing appropriate learning strategies, and (4) selecting activities for learning. These initiatives are exactly those which would be undertaken by any student engaged in e-learning.

The student's trust theories are the principles that explain how a student makes the decision to trust in a learning activity. For validating the students' trust theories, the Trust Dilemma is needed as the learning scenario in which students' trust theories are applied.

In this research, a **Trust Dilemma** is a learning scenario in which a student has to make a decision to trust in a learning activity. According to Chapter 3, the Trust Dilemma could be separated into two types; therefore, two learning scenarios were designed to shows what the two types of Trust Dilemmas look like. The descriptions of the Trust Dilemmas and the learning scenario to represents Trust Dilemma I and Trust Dilemma II is shown in Table 8-7.

	Descriptions	**Learning Scenarios in the questionnaire**
Trust Dilemma I	A situation in which the information about trustworthiness is ambiguous	There is no learning path shown in the learning scenario in which a student has to make a decision to trust.
Trust Dilemma II	A situation in which the information about trustworthiness is clear	There is a learning path shown in the learning scenario in which a student has to make a decision to trust.

Table 8-7: Descriptions of Trust Dilemmas and their learning scenarios

The learning scenario for Trust Dilemma I was designed in the knowledge domain about the Entity Relationship diagram. The learning path in Trust Dilemma I was applied from the ILO diagram of Tangworakitthaworn et al. (2013). Trust Dilemma I was stated in the knowledge domain about an Entity Relationship Diagram. Trust Dilemma II was stated in the knowledge domain about a basic first aid burn. The learning path in Trust Dilemma II was developed by an expert.

There are four indicators according to the entities in the Trust Dilemma (Chapter 3) and are shown in Table 8-8. In order to construct the Trust Dilemma, The population and sample were identified. The trust objective was indicated by the students' desired learning outcome (dLO): a learning path is used to set the scope of the context of trust based on the students' dLO. A list of learning activities was presented based on the learning path.

Entity in the student's trust theories	**Indicators**	**Description of Indicators in Trust Dilemma I**	**Description of Indicators in Trust Dilemma II**
Trustor	Student	The participants were asked to assume to be 1st year students in Software Engineering having to learn about drawing an Entity Relationship Diagram (Figure 8-2)	The participants were asked to assume to be students wanting to learn about the classification of burns (Figure 8-3)
Trust objective	Desired learning outcome (dLO)	Create a simple Entity Relationship Diagram	Classify burns depending on their severity
Context of trust	Learning path	Learning path was not shown to students in this Trust Dilemma	Learning path in Figure C-11 was shown to students in this Trust Dilemma
Item in which trust was placed	Learning activity	The list of learning activities in Figure C-5, were shown to students in this Trust Dilemma	The list of learning activities in Figure C-12 were shown to students in this Trust Dilemma

Table 8-8: The summary of indicators and their descriptions of Trust Dilemmas

(b) Identify potential participants and sample size

The potential participants were identified after all the entities for stating the Trust Dilemmas were indicated. The potential participants for Trust Dilemma I were identified from postgraduate students or academic staff in Computer Science at the University of Southampton. The populations for Trust Dilemma II were identified from postgraduate students or academic staff.

This research identified the minimum sample size to ensure that the quality of the study was based on the central limit theorem. According to the central limit theorem (Urdan, 2010), the sampling distribution of the mean will be normally distributed, despite the distribution of scores in the sample with a reasonably large sample size. The estimate tends to be reasonable when the sample size ≥ 30. When the number of participants is larger, the sampling distribution of the sample mean becomes more normal and more reasonable. Although the outcomes were skewed, the sample size was large enough that the estimates still had normal distributions.

In order to validate the students' trust theories in Trust Dilemma I, the first experimental study was conducted. It was approved by the Ethics Committee under the reference number ERGO/FPSE/ 10192. The second experimental study was conducted for Trust Dilemma II under the reference number ERGO/FPSE/12407. The number of participants for both experiments was estimated by using the G*Power tool with 5% level of significance (critical P-Value), 0.5 of the effect size, and 0.95 of the statistical power.

G*Power (version 3.1.2) was used to estimate the required sample sizes. The research question concerned the relationship of students' trust to the antecedents to trust. Thus, linear multiple regression was selected for sample size analysis. The parameters were:

- Effect size |p| set to 0.45. This was a large effect size and chosen because a large effect would be appropriate for the findings to have practical importance.
- Alpha level (α) was set at 0.05 by convention. It is the probability of a Type I error, that is, the risk of declaring a significant result when in fact there was no such significance in the population.
- The desired statistical power was set at 0.80. While there were no prior studies that have investigated the relationship of students' trust to the antecedents to trust, it was considered acceptable to set a Type II error rate of 0.20, that is, the risk of failing to find a significant relationship when in fact one actually exists.

- The number of predictors in LOT model is 5.

The output value from G*Power was a total simple size equal to 35 as shown in Figure 8-1.

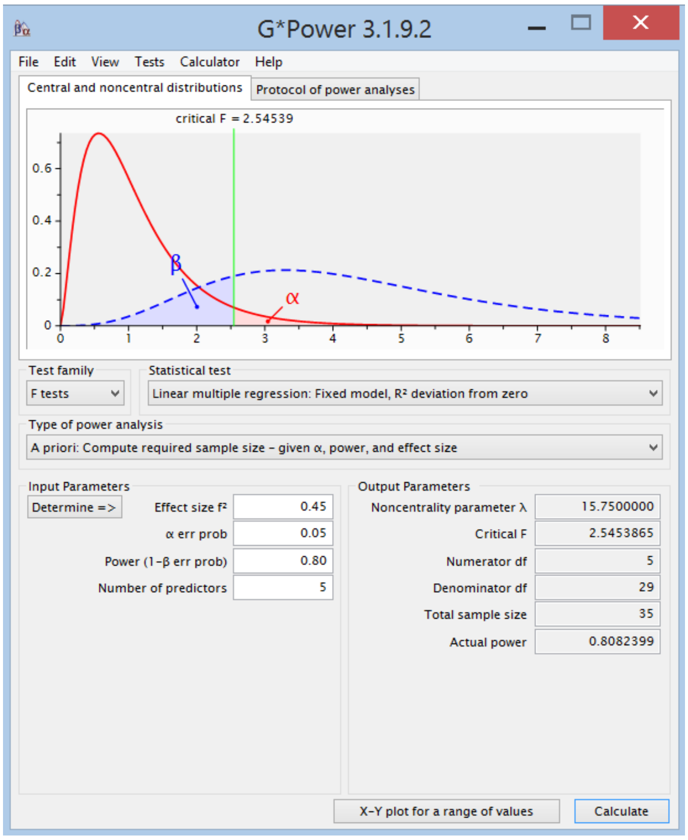


Figure 8-1: G*Power display of a compromise sample size analysis

The background knowledge required by potential participants was identified after all the entities for stating the Trust Dilemmas were finalised. The potential participants for Trust Dilemma I were identified as postgraduate students or academic staff in Computer Science at the University of Southampton. The potential participants for Trust Dilemma II were identified as postgraduate students or academic staff. Trust Dilemma I was used in Experiment 1 and Trust Dilemma II was used in Experiment 2.

Participants were volunteers from the population of potential participants as shown in Table 8-9. There were 37 participants in Experiment 1 and 51 participants in Experiment 2. Two participants of Experiment 2 participated in Experiment 1 previously, through Experiment 2 was conducted almost 4 months later. The background knowledge and propensity to trust of participants are shown in Table 8-10 and Table 8-11

Experiment	Potential participants	Sample Size	Background Knowledge	Propensity to Trust	Note:
Experiment 1 using Trust Dilemma I (Table 8-8)	The postgraduate students or academic staff in Computer Science	37	The questions asked whether participants have knowledge about drawing E-R Diagrams.	Propensity to Trust questions estimates participants' general willingness to trust other people.	Two participants of Experiment 2 participated in Experiment 1 though Experiment 2 was conducted almost 4 months later.
Experiment 2 using Trust Dilemma II (Table 8-8)	The postgraduate students or academic staff in various school.	51	The questions asked whether participants have knowledge about basic first aid for burns.		

Table 8-9: The summary of participants' details in the experiments

Table 8-11 shows that an independent samples t-test failed to reveal a statistically significant difference between the mean of participants' background knowledge in Experiment 1 (Mean = 0.57, SD = 0.23) and that in Experiment 2 (Mean = 0.59, SD = 0.24), t (86) = -0.41, p = 0.68. Also, an independent samples t-test failed to reveal a statistically significant difference between the mean of participants' propensity to trust in Experiment 1 (Mean = 0.52, SD = 0.12) and that in Experiment 2 (Mean = 0.56, SD = 0.12), t (86) = -1.3, p = 0.2. This implies that there are no differences in the participants between the two experiments.

Background Knowledge	Experiment 1		Experiment 2	
	N	%	N	%
Not at all familiar (1)	4	10.8	7	13.7
Not very familiar (2)	11	29.7	13	25.5
Familiar (3)	13	35.1	10	19.6
Mainly Familiar (4)	5	13.5	18	35.3
Highly Familiar (5)	4	10.8	3	5.9
	37	100	51	100
Propensity to Trust	**Experiment 1**		**Experiment 2**	
	N	%	N	%
Rarely (1)	0	0	0	0
Sometimes (2)	6	16.2	7	13.7
Often (3)	25	67.6	33	64.7
Very Often (4)	5	13.5	10	19.6
Always (5)	1	2.7	1	2.0
	37	100	51	100

Table 8-10: Frequencies and percentages of participants' background knowledge and propensity to trust

	Group Statistics				t-test for Equality of Means		
	Experiment	N	Mean	SD	t	df	p
Background Knowledge	1	37	0.57	0.23	-0.41	86	0.68
	2	51	0.59	0.24			
Propensity to Trust	1	37	0.52	0.12	-1.30	86	0.20
	2	51	0.56	0.12			

Table 8-11: Independent t-tests on participants' background knowledge and propensity to trust between two experiments

The aim of the experiments was to assess how well the LOT model calculated the degree of trust in a learning activity in a variety of learning situations. Accordingly, situations were presented in two domains and with two different participant backgrounds, one for each experiment. Any comparison between these experiments was not a main matter of attention.

The comparison between the experiments, about why there were differences in their results, was an additional interest. It was possible that the learning path was the reason for the difference in results because both groups of participant had the same level of prior knowledge and propensity to trust (as shown in Table 8-11, while only Experiment 2 showed the learning paths and Experiment 2 had higher of trustworthiness than Experiment 1. This analysis is not certain because there is no equivalence regarding domains and participant knowledge between the two experiments.

(c) Deciding how to collect replies

An email with the meeting invitation was sent to all randomly-selected participants, and the email's title describes the survey topic. Brief information for the participants was indicated in the body of the email. The potential participants were informed who is initiating the study, what the researcher is interested in doing with the study results, where they can do the study and how the study was to be processed. The email also provided the researcher's contact information including: name, phone number and email address. The study's URL was presented as a link at the end of the email. If the potential participants wanted to take part in the study, they could then directly access the study online by using the study's URL. Table 8-12 shows the experiment design in summary.

	Experiment 1	**Experiment 2**
Scenario	Trust Dilemma I – when information about trustworthiness was ambiguous. Detail of Trust Dilemma I is shown in Table 8-7 and 8-8.	Trust Dilemma II - when information about trustworthiness was clear. Detail of Trust Dilemma II is shown in Table 8-7 and 8-8.
Aim of research	To investigate the LOT model using Method A & B. Detail of Method A & B were shown in Section 6.X.	
Main research question	Does the LOT model validly predict students' trust in Trust Dilemma I?	Does the LOT model validly predict students' trust in Trust Dilemma II?
Variables	The dependent variables were shown in Table 8-11.	The dependent variables were shown in Table 8-21.
Sample size	The number of participants for both experiments was estimated by using the G*Power tool with 5% level of significance (critical p-Value), 0.5 effect size, and 95% statistical power. As a result, 34 participants (N=34) were required. The detail of sample size calculations are shown in Section 8.4.1.1 (b)	
Participant Selection	The participants were randomly assigned from the postgraduate students or academic staff in Computer Science. They had knowledge about ERD diagrams.	The participants were randomly assigned from the postgraduate students or academic staff in various academic departments. They had knowledge about basic first aid and burns.
	Note: Some participants (2 people) of Experiment 2 previously participated in Experiment 1, though Experiment 2 was conducted almost 4 months later. The participant selection was shown in 8.4.1.1 (a)	
Participant Assignment	1. The participants were asked to enter the study online by using the study's URL in the invitation email. 2. The participants were asked to read the participant information carefully and discuss it with others if they wished. The participants could ask the researcher if there was anything unclear or if the participants would like more information. The participant information is shown in Appendix III. 3. If the participants agreed to take part of this research study, the participants were asked to sign a consent form and the instructions for using the LOT application was shown after this. The consent form is shown in Appendix III. 4. The participants were asked to read the instructions on how to use the LOT application. The instructions are shown in Appendix IV. 5. The participants were asked to read a scenario, which asked them to assume they were students in the scenario. The scenarios are shown in Appendix V. 6. The participants were asked to use the LOT application. There were four steps in using the LOT application. An example of use of the LOT application is shown in Appendix VI.	

Table 8-12: Brief of experiment design

(d) Designing the questionnaire

Design of the questionnaire can be split into two steps: Firstly, constructing the question items by connecting them with the variables in the students' trust theories and the research questions. The question items for each of the variables in students' trust theories are shown in Table 8-13. The research questions RQ4, RQ5, RQ10 and RQ11 were connected by the question items in Table 8-14. Secondly, constructing the Trust Dilemmas by creating learning scenarios, in which the participants assume to be the students who have to make the decision to trust in a learning activity. Figure 8-2 shows detail of the learning scenario for Trust Dilemma I, and Figure 8-3 and Figure 8-4 show detail of the learning scenario for Trust Dilemma II.

The 9-items scale of information about the trustworthiness of the learning activity was developed based on the idea that students tend to trust when they perceived the information about how the learning activity correlates with their expectations and their desired learning outcome. In other word, the learning activity could be trusted when it is presented in a learning path aimed at achieving the desired learning outcome. The students' trust is the expectation that their learning path will be aided by the learning activity.

Luhmann (1988) says that trust implies a form of commitment to positive expectations. Carrington (1982) defined trust as a concomitant expectation that another entity in a trust dilemma will reciprocate and had declared this expectation crucial for the desired outcome of achieving mutual cooperation. Zand (1972) supports the idea that expectation of the desired outcome is one of the vulnerability aspects of trust. The trustors' willingness to trust in a specific context occurs when the trustor's positive expectations of the intentions of the trustee are met. (Castelfranchi & Falcone, 2010; Chopra & Wallace, 2002; Mayer et al., 1995; Riegelsberger et al., 2004; Rousseau et al., 1998). Therefore, trust is an individual decision, based upon optimistic expectations about the desired outcome of an uncertain event. For this reason, students' perceived trustworthiness of the learning activity depends upon available information about the learning activity. After that, they apply critical thinking to this information to measure how the learning activity relates to their expectations and desire to trust. They will not trust if they perceive that they will be worse off to achieve the desired learning outcome, and their trust does not fulfil their expectations.

Predictor variables in students' trust theories		Question items for each variable in students' trust theories	Source
Students' assumption to trust	Students' propensity to trust (PT_{STU})	Please choose an item in the dropdown lists that best fit your opinion (rating by a five point scale ranging from "Rarely", "Sometimes", "Often", "Neutral", "Very Often", and "Always"): • I tend to trust other people • I tend to count upon other people • I tend to have faith in humanity • I feel the people tend to be reliable • In general, I feel people tend to care about the well-being of others	Items were derived from the instruments of Gefen (2000) and Gefen & Straub (2004).
	Students' prior knowledge (KW_{STU})	How much prior knowledge do you have on this subject? Please give level of familiarity (rating by a five point scale ranging from "Not at all familiar", "Not very familiar", "Familiar", "Mostly familiar", and "Highly familiar")	New measure
Students' perception of the trustworthiness properties of the learning activity: • Students' perceived Integrity (PI_{STU}) • Students' perceived Benevolence (PB_{STU}) • Students' perceived Competence (PC_{STU})		The 9-items scale for gathering the students' perception of trustworthiness properties of the learning activity are shown in Table 8-14	New measure

Table 8-13: The question items for each variables in student's trust theories

For using the learning path as the source of information about the trustworthiness of a learning activity, the 9-items scale of information about trustworthiness was developed, based on the learning path concept for measuring perceived trustworthiness. The 9-items scale is also adapted from the trusting beliefs scale by McKnight et al. (2002a, 2002b), and Mayer et al. (1995). Perceived trustworthiness includes three dimensions, competence, benevolence and integrity: (1) Competence refers to the trustees' ability to fulfil the trustors' expectations. In this research, fulfilment of the trustors' expectations is replaced by the degree to which of the learning activity to connect with the desired learning outcome. (2) Benevolence means that the trustee is interested in the trustors' well-being. In this research, interest in the trustors' well-being is represented as the degree to which a learning activity to connect with the students' prior knowledge. (3) Integrity denotes that the trustee follows a set of desirable principles. In this research, following a set of desirable principles is replaced by the degree to which a learning activity is integrated with the learning path.

Table 8-14 shown the set of question items that connect with RQ4, RQ5, RQ10 and RQ11. The set of question items that connect with RQ4 and RQ10 were generated in order to measure how much the students perceived the trustworthiness properties of a learning activity while making the decision to trust. The set of question items that connect with RQ5 and RQ11 were generated in order to measure how much actual degree of trust students desired in the learning activity. This actual degree of trust is called the student's trust degree that will be used to answer the research question RQ5 and RQ11.

Three example questions are discussed in order to illustrate the questionnaire items. The question, "Please rate you opinion, 'I tend to trust other people', on the five point scale ranging from "Rarely", "Sometimes", "Often", "Very Often", and "Always" was derived from the from the instruments of Gefen (2000) and Gefen & Straub (2004). This question measures the student's propensity to trust, and the student's reply is used by the LOT application to estimate the student's trust in the given learning activity.

The question, "How much prior knowledge do you have on this subject?" was a new measure of the student's prior knowledge, and is used by LOT application.

The question, "Please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the following statements […] 'It identifies what I need to learn to achieve my desired learning outcome'" was a new measure of the student's perception of trustworthiness, based on competence, and similarly is used by the LOT application.

Research questions	Description of research questions	Question items in the questionnaires
RQ4 and RQ 10	Did the students agree that the trustworthiness properties of a learning activity influenced their decision to trust when they were in Trust Dilemma I and Trust Dilemma II?	Please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the following statements (rating by a seven point scale ranging from "Strongly Disagree", "Disagree", "Slightly Disagree", "Neutral", "Slightly Agree", "Agree", and "Strongly Agree")
	• The trustworthiness properties of a learning activity based on Competence	• It identifies what I need to learn to achieve my desired learning outcome
		• It involves the keywords that I need to know to achieve my desired learning outcome
		• It involves the capability verb that relates with what I need to do to achieve my desired learning outcome
	• The trustworthiness properties of a learning activity based on Benevolence	• It helps me learn new knowledge to extend my prior knowledge
		• I know how it would help me achieve my desired learning outcome
		• It allows me to apply my prior knowledge.
	• The trustworthiness properties of a learning activity based on Integrity	• It challenges me to develop my skills.
		• It connects my prior knowledge with my desired learning outcome
		• It increases confidence for achieving my desired learning outcome after the learning activity had been completed.
RQ5 and RQ 11	Did the questionnaire based on the students' trust theories predict the students' trust in Trust Dilemma I and Trust Dilemma II? (The question item was needed to ask the students how much the degree of students' trust that they place in a learning activity, and used the degree of students' trust to answer this research question)	How much do you trust the interested learning activity to help you achieve your desired learning outcome? (rating by a five point scale ranging from "Not at all trusted", "Not very trusted", "Trusted", "Mostly trusted", and "Highly trusted")

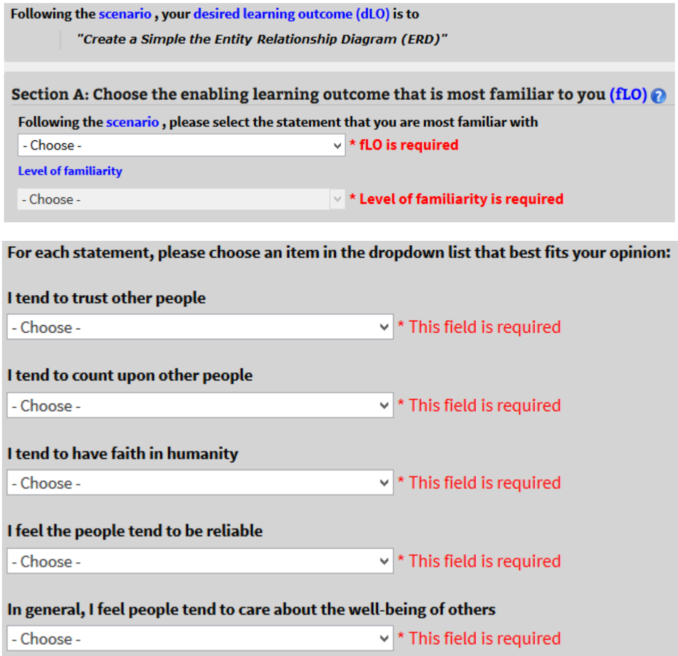
Table 8-14: The summary of question items and research questions for validating students' trust theories in Trust Dilemma I and Trust Dilemma II

Learning scenario in Questionnaire of Trust Dilemma I

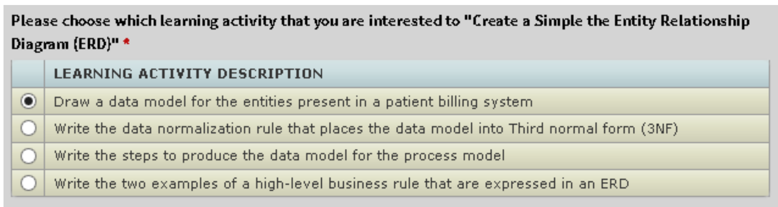
(The students were in the learning scenario in which information about trustworthiness is ambiguous)

Please assume you are a 1st year student in Software Engineering at the University of Gryffindor. You need to draw an Entity Relationship Diagram (ERD) for your homework. You do not have knowledge about ERDs. You know about logical models. You have to learn how to draw an ERD yourself.

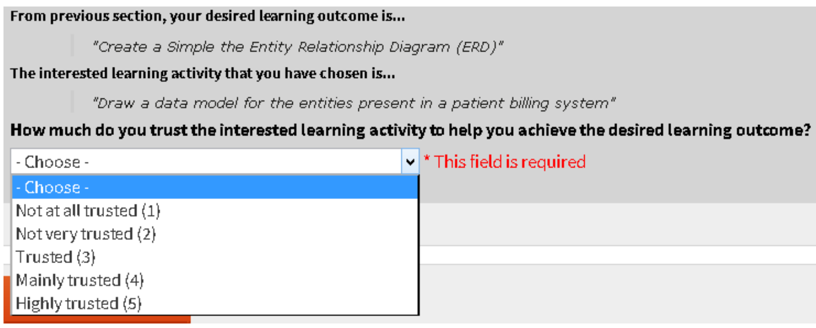
(Before the students were asked to give the information about their prior knowledge and propensity to trust)



Please choose which learning activity that you are interested to "Create a simple Entity Relationship Diagram (ERD)" (The list of learning activities is shown in the figure below)



(The students were asked to rate how much they trust the selected learning activity)



(Next, the students were asked to give the reason why they trust the selected learning activity based on the trustworthiness properties of the learning activity as shown in Figure 8-4)

Figure 8-2: Detail of the learning scenario for Trust Dilemma I

Learning scenario in Questionnaire of Trust Dilemma II

(The students were in the learning scenario in which information about trustworthiness is clear)

We would like you to imagine that you want to learn about the classification of burns. The classification depends on severity as either first, second or third degree. (Before the students were asked to give the information about their prior knowledge and propensity to trust)

Please assess how much you know about the prerequisites knowledge for classifying burns. There are 3 prerequisites as shown below. * This field is required

P1	**Prerequisite 1: Define key words for burn injuries**						
	DO NOT KNOW WELL	1 ○	2 ○	3 ○	4 ○	5 ○	KNOW VERY WELL
P2	**Prerequisite 2: State key recognition features of a burn**						
	DO NOT KNOW WELL	1 ○	2 ○	3 ○	4 ○	5 ○	KNOW VERY WELL
P3	**Prerequisite 3: State the functions of the skin**						
	DO NOT KNOW WELL	1 ○	2 ○	3 ○	4 ○	5 ○	KNOW VERY WELL

Please choose an item in the dropdown lists that best fit your opinion:

I tend to trust other people

- Choose - * This field is required

I tend to count upon other people

- Choose - * This field is required

I tend to have faith in humanity

- Choose - * This field is required

I feel that people tend to be reliable

- Choose - * This field is required

In general, I feel people tend to care about the well-being of others

- Choose - * This field is required

(The Learning Part shown in the figure below were stated before the lists of learning activities were shown)

Please choose an appropriate learning path which matches your abilities and leads you to learn about classification of burns. * This field is required

Your desired learning outcome (dLO) is "Classify burns depends on severity". The table on the left shows some possible learning paths (LP) to support your learning about the classification of burns. For example, if you choose LP1 that means you prefer to learn only one prerequisite P2 (State key recognition features of a burn) before learning about your desired learning outcome (dLO) (Classify burns depending on severity)

	LP ID	LEARNING PATH (LP)
○	LP1	P2 → dLO
◉	LP2	P1 → P2 → dLO
○	LP3	P3, P1 → P2 → dLO

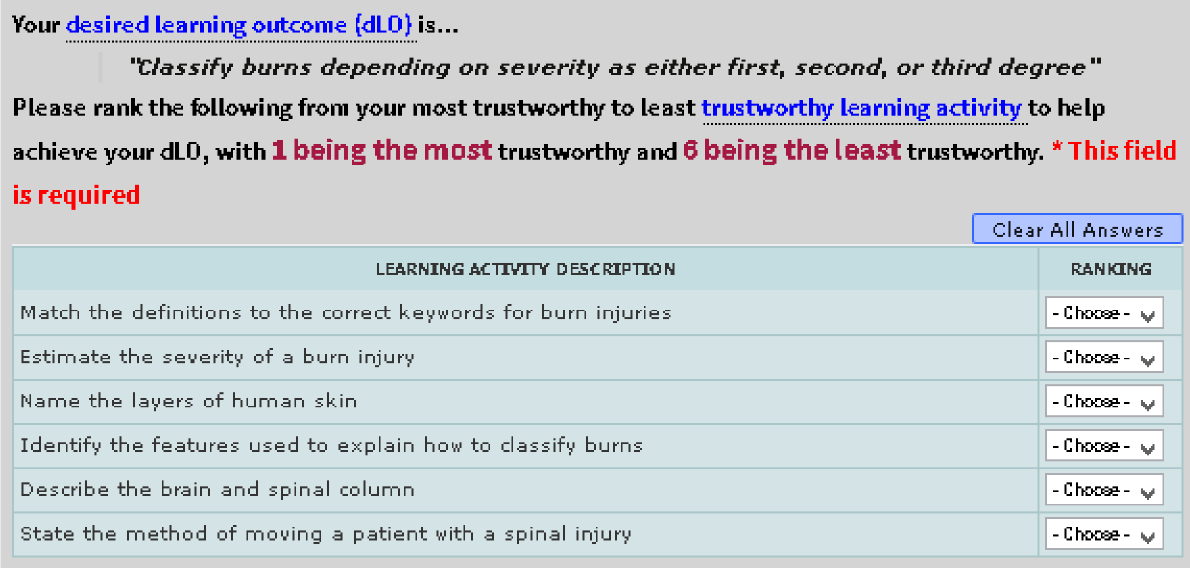
	DESCRIPTION
P1	Define key words for burn injuries
P2	State key recognition features of a burn
P3	State the functions of the skin
dLO	Classify burns depends on severity as either first, second, or third degree

Figure 8-3: Detail of the learning scenario for Trust Dilemma II

Learning scenario in Questionnaire of Trust Dilemma II (continued)

(The students were in the learning scenario in which information about trustworthiness is clear)

Please rank the following from your most trustworthy to least trustworthy learning activity. A trustworthy learning activity means that you can rely on that learning activity to provide an opportunity for achieving your desired learning outcome or dLO, with 1 being the most trustworthy and 6 being the least trustworthy. (The list of learning activities is shown in the figure below)



Your desired learning outcome (dLO) is...

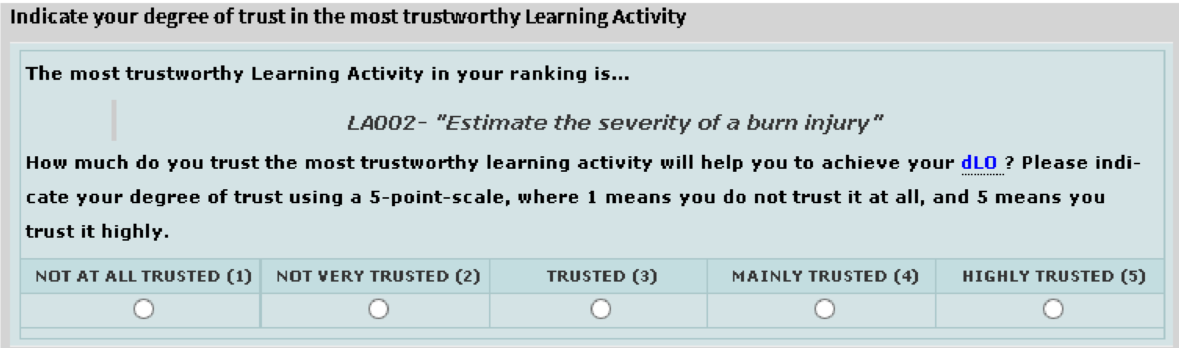
"Classify burns depending on severity as either first, second, or third degree"

Please rank the following from your most trustworthy to least trustworthy learning activity to help achieve your dLO, with **1 being the most** trustworthy and **6 being the least** trustworthy. * This field is required

Clear All Answers

LEARNING ACTIVITY DESCRIPTION	RANKING
Match the definitions to the correct keywords for burn injuries	- Choose -
Estimate the severity of a burn injury	- Choose -
Name the layers of human skin	- Choose -
Identify the features used to explain how to classify burns	- Choose -
Describe the brain and spinal column	- Choose -
State the method of moving a patient with a spinal injury	- Choose -

(The students were asked to rate how much they trust the selected learning activity.)



Indicate your degree of trust in the most trustworthy Learning Activity

The most trustworthy Learning Activity in your ranking is...

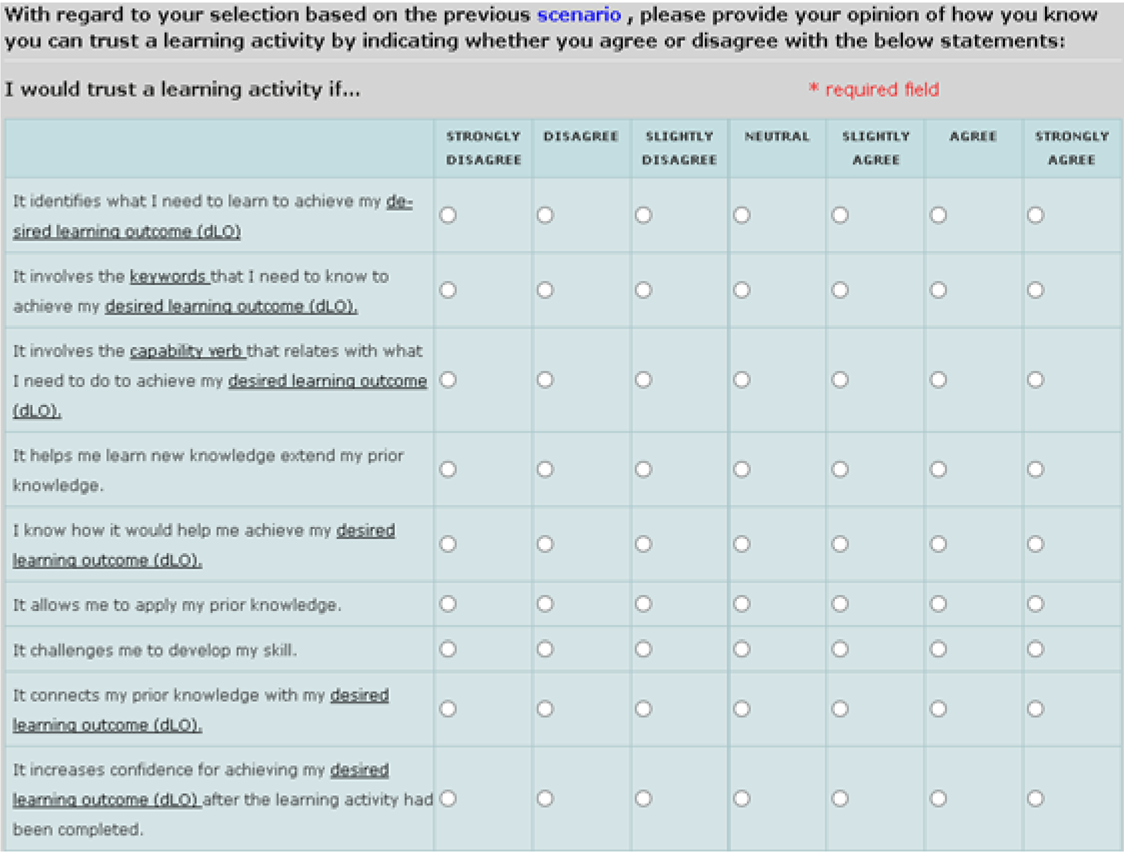
LA002- "Estimate the severity of a burn injury"

How much do you trust the most trustworthy learning activity will help you to achieve your dLO ? Please indicate your degree of trust using a 5-point-scale, where 1 means you do not trust it at all, and 5 means you trust it highly.

NOT AT ALL TRUSTED (1)	NOT VERY TRUSTED (2)	TRUSTED (3)	MAINLY TRUSTED (4)	HIGHLY TRUSTED (5)
○	○	○	○	○

(Next, the students were asked to give the reason why they trust the selected learning activity based on the trustworthiness properties of the learning activity. Figure 8-4 shows the set of questions for this part)

Figure 8-4: Detail of the learning scenario for Trust Dilemma II (continued)



With regard to your selection based on the previous scenario , please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the below statements:

I would trust a learning activity if... * required field

	STRONGLY DISAGREE	DISAGREE	SLIGHTLY DISAGREE	NEUTRAL	SLIGHTLY AGREE	AGREE	STRONGLY AGREE
It identifies what I need to learn to achieve my desired learning outcome (dLO)	○	○	○	○	○	○	○
It involves the keywords that I need to know to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It involves the capability verb that relates with what I need to do to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It helps me learn new knowledge extend my prior knowledge.	○	○	○	○	○	○	○
I know how it would help me achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It allows me to apply my prior knowledge.	○	○	○	○	○	○	○
It challenges me to develop my skill.	○	○	○	○	○	○	○
It connects my prior knowledge with my desired learning outcome (dLO).	○	○	○	○	○	○	○
It increases confidence for achieving my desired learning outcome (dLO) after the learning activity had been completed.	○	○	○	○	○	○	○

Figure 8-5: The set of questions that were used for asking the students to give the reason why they trust the selected learning activity based on the trustworthiness properties of the learning activity

8.4.1.2. Running Pilot Studies

Pilot studies were conducted before carrying out the main survey for Trust Dilemma I and Trust Dilemma II. Five postgraduate students who understand the knowledge domain were asked to participate through the online questionnaires. The students' pilot group evaluated whether the questions and the whole questionnaire effectively capture the topic under the research objective. The three instructors checked the questionnaires for common errors like confusing or leading questions. The pilot studies aim to check: (1) Does each question measure the degree of students' trust? (2) Do the participants understand all the words? (3) Do the participants interpret the questions in the way the research expected? (4) Are the response choices appropriate for the questions? (5) Does the range of response choices for each question actually work? (6) Do the participants correctly follow the instructions? (7) Does it create a positive impression that motivates people to respond? Do the questions lead to confusion for the participants? (9) How long does the questionnaire take to complete? The interface of pilot studies is shown in Appendix B.

8.4.1.3. Analysing Data

This stage is concerned with taking the data that has been gathered in the main survey and examining it to gain understanding that will support the valid students' trust theories. There are three parts: the reliability analyses, verifying whether the students' perceived trustworthiness influenced their decision to trust, and validating the students' trust theories using multiple regression. As shown in Appendix D, the distribution is clearly non-normal (skewed), but the sample size of 36 and 50 is reasonably large, which is considered sufficiently large (Urdan, 2010). The regression may be used even if the data is non-normal, because by the central limit theorem the sample mean will be approximately normally distributed for large n.

(a) Reliability analyses

Reliability analyses were performed before performing the data analysis. Cronbach's alpha (John & Soto 2007) was conducted to report the reliability of the measures that were used in the questionnaires. A reliability coefficient of .70 or higher is considered acceptable in several social science research (Creswell, 2014). In several social science research considered acceptable a reliability coefficient of .70 or higher (Creswell, 2014).

Cronbach's alpha was used to evaluate the reliability of the items in the questionnaires. The items were developed to measure the antecedents to trust in a learning activity. The items were separated into two groups: (1) items for students' assumption to trust, and (2) items for students' perception of trustworthiness properties of a learning activity. Items for students' assumption to trust asked the participants to input their information about propensity to trust and prior knowledge. Items for students' perception of trustworthiness asked the participants to evaluate how their perception of integrity, benevolence, and competence influenced the trust they placed in the learning activity.

The items of the questionnaire for Experiment 1 are shown in Table 8-15. The items for Experiment 2 are shown in Table 8-16. A reliability coefficient of .70 or higher was considered acceptable (Creswell, 2014). Table 8-15 shows that all items of antecedents to trust in Trust Dilemma I reflected a high internal consistency with reliability coefficients higher than or equal to .70, and Table 8-16 shows that all the items of antecedents to trust in Trust Dilemma II reflected a high internal consistency with reliability coefficients higher than .70.

Experiment 1 using Trust Dilemma I				
	Variables & items for Students' assumption to trust			
	Variables	**Abbreviation**	**Question items in the questionnaires** Please choose an item in the dropdown lists that best fit your opinion (rating by a five point scale ranging from "Rarely", "Sometimes", "Often", "Very Often", and "Always"):	**Cronbach 's Alpha**
	Students' propensity to trust (PT_{STU_TDI})	$PT_{STU}01$	• I tend to trust other people	0.70
		$PT_{STU}02$	• I tend to count upon other people	
		$PT_{STU}03$	• I tend to have faith in humanity	
		$PT_{STU}04$	• I feel the people tend to be reliable	
		$PT_{STU}05$	• In general, I feel people tend to care about the well-being of others	
	Students' prior knowledge (KW_{STU})		Please give level of familiarity with the statement that you are most familiar with (rating by a five point scale ranging from "Not at all familiar", "Not very familiar", "Familiar", "Mostly familiar", and "Highly familiar")	Not applicable
	Variables & items for Students' perception of trustworthiness properties of learning activity			
	Variables	**Abbreviation**	**Question items in the questionnaires** Please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the following statements (rating by a seven point scale ranging from "Strongly Disagree", "Disagree", "Slightly Disagree", "Neutral", "Slightly Agree", "Agree", and "Strongly Agree")	**Cronbach 's Alpha**
	Competence (PC_{STU_TDI})	$PC_{STU}01$	• It identifies what I need to learn to achieve my desired learning outcome	0.88
		$PC_{STU}02$	• It involves the keywords that I need to know to achieve my desired learning outcome	
		$PC_{STU}03$	• It involves the capability verb that relates with what I need to do to achieve my desired learning outcome	
	Benevolence (PB_{STU_TDI})	$PB_{STU}01$	• It helps me learn new knowledge to extend my prior knowledge	0.87
		$PB_{STU}02$	• I know how it would help me achieve my desired learning outcome	
		$PB_{STU}03$	• It allows me to apply my prior knowledge.	
	Integrity (PI_{STU_TDI})	$PI_{STU}01$	• It challenges me to develop my skills.	0.87
		$PI_{STU}02$	• It connects my prior knowledge with my desired learning outcome	
		$PI_{STU}03$	• It increases confidence for achieving my desired learning outcome after the learning activity had been completed.	

Table 8-15: The Cronbach's alpha for all items of antecedents to trust in Trust Dilemma where information about trustworthiness was ambiguous (Trust Dilemma I)

Experiment 2 using Trust Dilemma II				
	Variables & items for Students' assumption to trust			
	Variables	**Abbreviation**	**Question items in the questionnaires** Please choose an item in the dropdown lists that best fit your opinion (rating by a five point scale ranging from "Rarely", "Sometimes", "Often", "Very Often", and "Always"):	**Cronbach 's Alpha**
	Students' propensity to trust (PT_{STU_TDII})	$PT_{STU}01$	• I tend to trust other people	0.76
		$PT_{STU}02$	• I tend to count upon other people	
		$PT_{STU}03$	• I tend to have faith in humanity	
		$PT_{STU}04$	• I feel the people tend to be reliable	
		$PT_{STU}05$	• In general, I feel people tend to care about the well-being of others	
	Students' prior knowledge (KW_{STU})		Please assess how much you know about the prerequisites knowledge that best known to you (rating by a five point scale ranging from "Do Not know well", "Not very know", "know", "Mostly know", and "Know very well")	Not applicable
	Variables & items for Students' perception of the trustworthiness properties of the learning activity			
	Variables	**Abbreviation**	**Question items in the questionnaires** Please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the following statements (rating by a seven point scale ranging from "Strongly Disagree", "Disagree", "Slightly Disagree", "Neutral", "Slightly Agree", "Agree", and "Strongly Agree")	**Cronbach 's Alpha**
	Competence (PC_{STU})	$PC_{STU}01$	• It identifies what I need to learn to achieve my desired learning outcome	0.91
		$PC_{STU}02$	• It involves the keywords that I need to know to achieve my desired learning outcome	
		$PC_{STU}03$	• It involves the capability verb that relates with what I need to do to achieve my desired learning outcome	
	Benevolence (PB_{STU})	$PB_{STU}01$	• It helps me learn new knowledge to extend my prior knowledge	0.80
		$PB_{STU}02$	• I know how it would help me achieve my desired learning outcome	
		$PB_{STU}03$	• It allows me to apply my prior knowledge.	
	Integrity (PI_{STU})	$PI_{STU}01$	• It challenges me to develop my skills.	0.74
		$PI_{STU}02$	• It connects my prior knowledge with my desired learning outcome	
		$PI_{STU}03$	• It increases confidence for achieving my desired learning outcome after the learning activity had been completed.	

Table 8-16: The Cronbach's alpha for all items of antecedents to trust in Trust Dilemma where information about trustworthiness was clear (Trust Dilemma II)

(b) Verifying the students' perceived trustworthiness

The verification of the question items of predictor variables of the students' trust theories is needed for confirming they be able to reasonably measure the degree of students' trust. Table 8-11 shows the summary of verification method for each of the predictor variables.

Predictor variables in Student's Trust Theories		**Verification Method for Each Predictor Variables**
Students' assumption to trust	Students' propensity to trust (PT_{STU})	All the questions were adapted from the existing items that were tested by previous studies about antecedents to trustworthiness as shown in Chapter 3.
	Students' prior knowledge (KW_{STU})	
Students' perception of trustworthiness properties of learning activity: • Students' perceived Integrity (PI_{STU}) • Students' perceived Benevolence (PB_{STU}) • Students' perceived Competence (PC_{STU})		• The questions were proposed by the researcher • Find previous research to refute or suggest ways of testing the questions • Verifying a question by piloting, gathering data and examining whether the students' perceived trustworthiness influenced the students' decision making to trust by one Sample t-test.

Table 8-17: Summary of verification method for predictor variables of student's trust theories in Trust Dilemma I and Trust Dilemma II

The research questions RQ4 and RQ10 were answered by conducting one-sample t-test in SPSS. The one-sample t-test was used to test whether there is a statistically significant difference between the sample mean and a fixed value. In this sub-section the one-sample t-test was conducted for comparing the mean student's agreement with a single number that is 4 (Neutral agree). The students show that they agree if the mean student's agreement in Trust Dilemma I or Trust Dilemma II > 4 (Neutral). If students agree then the students' perception of the trustworthiness properties of a learning activity is verifiable to measure the students' trust degree. In this part, the questions were verified by the p-value. If the p-value or significance level is less than the prescribed $\alpha = 0.05$, it means there is a reliable difference between the mean number of students who agree with the trustworthiness properties compared with 4-Neutral.

(c) Validating student's trust theories using multiple regression

To answer the research questions RQ5 and RQ11, the degree of students' trust were collected. If the questionnaire, which is constructed based on the predictor variables of the students' trust theories, can predict the degree of students' trust then the students' trust theories are valid.

In this research, the multiple regression was conducted by using SPSS. It was aimed to develop a prediction model that consists of one dependent versus multiple predictors. The prediction model that was conducted by fifteen questions based on the students' trust theories is called the students' trust questionnaire (STQ) model. In other words, the STQ model was conducted to validate whether the initial fifteen questions (or five dependent variables) can predict the degree of students' trust (predictor variables). The research questions RQ7 and RQ13 were answered by conducting a multiple regression model in Table 8-18.

Predictor variables in multiple regression model for STQ model		
Trust Dilemma I	Students' assumption to trust:	Students' propensity to trust (PT_{STU})
		Students' prior knowledge (KW_{STU})
	Students' perception of trustworthiness properties of a learning activity	Students' perceived Integrity (PI_{STU})
		Students' perceived Benevolence (PB_{STU})
		Students' perceived Competence (PC_{STU})
	Regression model for STQ in TD I: $T_{STU} = f(PT_{STU}, KW_{STU}, B_{STU}, I_{STU}, C_{STU})$ Experiment Result shown in Section 9.3	
Trust Dilemma II	Students' assumption to trust:	Students' propensity to trust (PT_{STU})
		Students' prior knowledge (KW_{STU})
	Students' perception of trustworthiness properties of a learning activity:	Students' perceived Integrity (PI_{STU})
		Students' perceived Benevolence (PB_{STU})
		Students' perceived Competence (PC_{STU})
	Regression model for STQ in TD I: $T_{STU} = f(PT_{STU}, KW_{STU}, B_{STU}, I_{STU}, C_{STU})$ Experiment Result shown in Section 11.3	

Table 8-18: Predictor variables of multiple regression models for the students' trust questionnaire (STQ) model in Trust Dilemma I and Trust Dilemma II

Giving *Y* the actual degree of students' trust, the STQ model predicted the degree of students' trust by giving *Y'*. The correlation between *Y'* and the actual *Y* value is also called the multiple correlation coefficient (R). R shows a degree of how well the degree of students' trust can be predicted by the set of predictor variables of the students' trust theories. R^2 was interpreted as the proportion of the degree of students' trust variance that can be explained by the predictor variables of the students' trust theories. The R^2 for multiple regression is used to consider an effect size using the rule of thumb that 0.196 $\leq R^2 < .13$ is small; $.13 \leq R^2 < .26$ is medium; and $.26 \geq R^2$ is large (Cohen, 1988).

To analyse whether this prediction model performs significantly better than chance, the test for statistical significance of R was needed. Lack of statistical significance shows that the multiple correlation could well be due to chance. The statistical significance of the correlation can be tested with the F statistic. This research performs the test at the 0.05 significance level, if the R is significant then there is a relationship between the set of predictor variables and the students' trust. Both the multiple correlation R and the testing of statistical significance of R are required for validating and evaluating the performance of the predictor model.

8.4.2. Investigating the relationship between the students' trust theories and the students' trust in Trust Dilemma I and Trust Dilemma II

The multiple regression was conducted in this sub-section to estimate the relationship that exists between each dependent variable and the predictor variables. In other words, the multiple regression was conducted to determine the effect of each of the predictor variables on a dependent variable, controlling the effects of all other predictor variables. The ability of any single predictor variable is explained by the simple correlation coefficients, and the statistical significance of the correlation can be tested using the F-test. The SPSS was shown the result of simple correlation coefficients or a table with correlation coefficients between the dependent variable and all independent variables separately, and between all independent variables. If the simple correlation coefficient of any predictor is significant then it means the predictor has improved the ability to predict of the predictor model.

8.4.3. Validating the LOT model and investigate the relationship between the LOT model and the students' trust in Trust Dilemma I and Trust Dilemma II

To answer the research questions RQ7 and RQ13, two multiple regression models were conducted as shown in Table 8-19. The dependent variable of all multiple regression models was the degree of students' trust. The records of degree of students' trust, which was collected in sub-section 6.4.1, were used as the values of the dependent variable.

<table>
<tr><th></th><th colspan="2">Predictor variables of multiple regression model for the LOT model applying Method A (LOTA)</th><th colspan="2">Predictor variables of multiple regression model for the LOT model applying Method B (LOTB)</th></tr>
<tr><td rowspan="6">Trust Dilemma I (TD I)</td><td rowspan="2">Students' assumption to trust:</td><td>Students' propensity to trust (PT_{STU})</td><td rowspan="2">Students' assumption to trust:</td><td>Students' propensity to trust (PT_{STU})</td></tr>
<tr><td>Students' prior knowledge (KW_{STU})</td><td>Students' prior knowledge (KW_{STU})</td></tr>
<tr><td rowspan="3">There are three type of trustworthiness properties of the learning activity that are analysed by LOT model applying Method A:</td><td>Integrity (I_{LOTA})</td><td rowspan="3">There are three type of trustworthiness properties of the learning activity that are analysed by LOT model applying Method B:</td><td>Integrity (I_{LOTB})</td></tr>
<tr><td>Benevolence (B_{LOTA})</td><td>Benevolence (B_{LOTB})</td></tr>
<tr><td>Competence (C_{LOTA})</td><td>Competence (C_{LOTB})</td></tr>
<tr><td colspan="2">Regression model for LOTA in TD I:
$T_{LOTA} = f(PT_{STU}, KW_{STU}, B_{LOTA}, I_{LOTA}, C_{LOTA})$
Experiment Result shown in Section 9.4.1</td><td colspan="2">Regression model for LOTB in TD I:
$T_{LOTB} = f(PT_{STU}, KW_{STU}, B_{LOTB}, I_{LOTB}, C_{LOTB})$
Experiment Result shown in Section 9.4.2</td></tr>
<tr><td rowspan="6">Trust Dilemma II (TD II)</td><td rowspan="2">Students' assumption to trust:</td><td>Students' propensity to trust (PT_{STU})</td><td rowspan="2">Students' assumption to trust:</td><td>Students' propensity to trust (PT_{STU})</td></tr>
<tr><td>Students' prior knowledge (KW_{STU})</td><td>Students' prior knowledge (KW_{STU})</td></tr>
<tr><td rowspan="3">There are three type of trustworthiness properties of the learning activity that are analysed by LOT model applying Method A:</td><td>Integrity (I_{LOTA})</td><td rowspan="3">There are three type of trustworthiness properties of the learning activity that are analysed by LOT model applying Method A:</td><td>Integrity (I_{LOTB})</td></tr>
<tr><td>Benevolence (B_{LOTA})</td><td>Benevolence (B_{LOTB})</td></tr>
<tr><td>Competence (C_{LOTA})</td><td>Competence (C_{LOTB})</td></tr>
<tr><td colspan="2">Regression model for LOTA in TD II:
$T_{LOTA} = f(PT_{STU}, KW_{STU}, B_{LOTA}, I_{LOTA}, C_{LOTA})$
Experiment Result shown in Section 11.4.1</td><td colspan="2">Regression model for LOTB in TD II:
$T_{LOTB} = f(PT_{STU}, KW_{STU}, B_{LOTB}, I_{LOTB}, C_{LOTB})$
Experiment Result shown in Section 11.4.2</td></tr>
</table>

Table 8-19: Predictor variables of multiple regression models for the LOT model applying Method A and Method B in Trust Dilemma I and Trust Dilemma II

In each multiple regression model, two predictor variables of STQ model, the students' propensity to trust and students' prior knowledge, were used in all multiple regression models for the LOT model. Three predictor variables about the trustworthiness properties of a learning activity of the LOT model were gathered by the LOT model applying Method A and the LOT model applying Method B. All multiple regression was conducted by using SPSS to validate whether the LOT model can predict the degree of students' trust. The validation was performed at the 0.05 significance level, if the R is significant then there is a relationship between the set of predictor variables of the LOT model and the students' trust. Both the multiple correlation R and the testing of statistical significance of R are required for validating and evaluating the performance of the predictor model.

8.4.4. Investigate the relationship between the LOT model in Trust Dilemma I and Trust Dilemma II

This sub-section was aimed to answer the research questions RQ8 and RQ14 that are stated in Table 8-3 and Table 8-5. The effect of each of predictor variables of the LOT model on students' trust were explained by controlling the effects of all other predictor variables. The methodology of this sub-section is the same as sub-section 6.4.2.

8.4.5. Evaluating performance of the LOT models in comparison with the students' trust theories in Trust Dilemma I and Trust Dilemma II

This sub-section aims to explain the methodology to answer the research questions RQ9 and RQ15 as stated in Table 8-3 and Table 8-5. The LOT models were evaluated by comparing the performance prediction of the LOT models with the STQ model. The value R^2 is a measure of how well the data fits a linear regression model. R^2 is a simple way to compare the performance of regression models. The different performance of two regression models, such as the old model and the new model, was calculated by conducing F_{change} ratio (Field, 2013). The equation is as follows:

$$F_{change} = \frac{(\mathrm{N} - k_{new} - 1)R^2_{change}}{k_{change}(1 - R^2_{new})}$$

Given N = the number of subjects, k_{new} = the number of predictors in the new model, k_{change} = the change number of predictors, R^2_{change} = the change in models, and

R^2_{new} = the R^2 of new model, R^2_{change} is significant at the .05 level. If F_{change} ratio < Critical F value then the two models are not significantly different. Otherwise, the model that has higher values R^2 shows that the model fits the data better.

8.5 Phase 3: Exploration of perceived trustworthiness

In Phase 3, studies of the experiments were conducted to investigate the interrelationship among sets of variables between the set of antecedents to trust and the set of perceive trustworthiness. If the relationship was found, this means the set of antecedents to trust can predict the set of perceive trustworthiness.

This section studies the relationship between the students' perceived trustworthiness and the antecedents to trust that were proposed in the LOT model. To answer the research questions RQ16 to RQ19, two canonical correlation analyses were conducted. Figure 8-6 shows the canonical correlation analysis (CCA) was conducted by using three steps (1) constructing a linear combination (canonical variates) of the predictors set and a linear combination of the dependents set. (2) Deriving the canonical function that is the weight for each set of linear combinations. (3) Measuring the relative contribution of each of the variables (eg. PI_{STU} and PB_{STU}) to their canonical functions.

In other words, CCA constructed the canonical functions between two linear composites (canonical variates). In this research CCA constructed the canonical functions between canonical variates from the set of predictor variables of antecedents to trust and the set of dependent variables of students' perceived trustworthiness. The pairs of canonical variates, which are statistically significant, explained the relationship between the set of antecedents to trust and the set of students' perceived trustworthiness. Wilks's lambda and the chi-square test are used to test the statistically significant canonical correlation. If the chi-square statistic corresponding to Wilks's lambda is statistically significant it is concluded that there is a relationship between the set of predictor variables and the set of dependent variables.

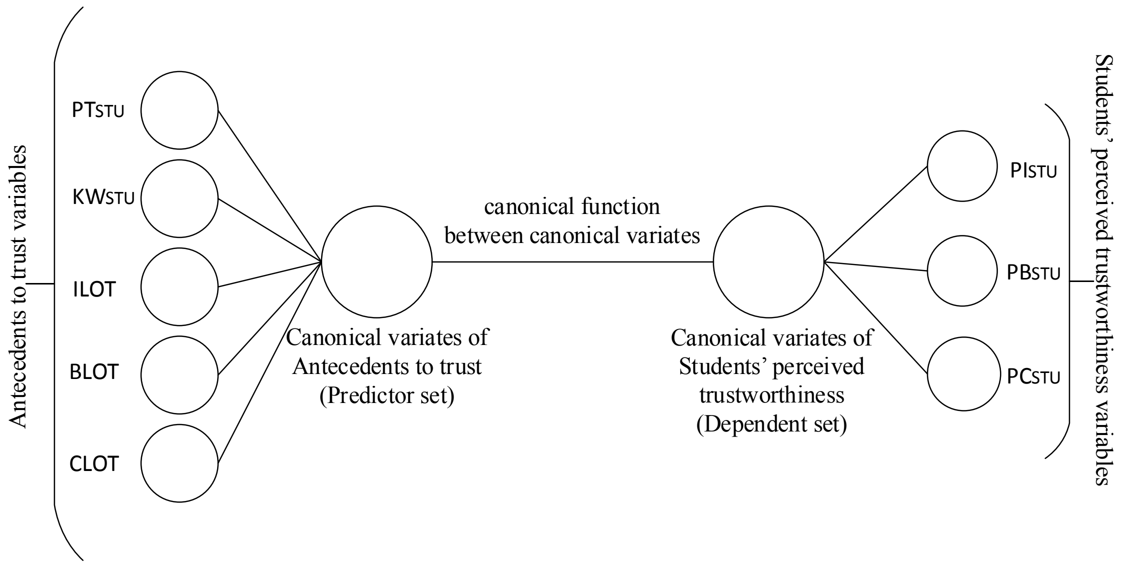


Figure 8-6: The canonical correlation analysis (CCA) between canonical variates from the set of predictor variables from antecedents to trust and the set of dependent variables from students' perceived trustworthiness

The canonical function was analysed based on two values: Canonical correlation value and Canonical loading value. Canonical correlation value is a bivariate correlation value between the two canonical variates on a canonical function. Canonical loading value is a linear correlation value between the variables and its respective canonical variates. It can be interpreted like a factor loading in assessing the relationship contribution of each variable to each canonical function. In other words, the canonical correlation value is the correlation value between the canonical variates, not the correlation with individual variables, while the loadings show the correlations value between the individual variables and their canonical variates.

8.6 Summary

This chapter shows the summary of methodologies for this research. There are divided to three phases. Firstly the LOT model was constructed based on the systematic literature method. Secondly, the LOT model and its calculation methods were evaluate by using the multiple regression analysis. If the LOT model works well, it can predict students' trust. Lastly, the relationship between the antecedents to trust and the perceived trustworthiness was studied by using canonical correlation analysis.

Chapter 9 Experiment Results: When Information About Trustworthiness Was Ambiguous

9.1 Introduction

This chapter reports on the experimental validation of students' trust theories, and the LOT models in Trust Dilemma I are shown. The relationship between the theories or models and the students' trust was investigated.

9.2 Results for trustworthiness properties of a learning activity when the information about trustworthiness was ambiguous

Section 6.3.2 discussed the perceived trustworthiness of a learning activity, and three types of trustworthiness properties were suggested. The conjecture is stated as follows:

> If the three types of trustworthiness properties – integrity (PI_{STU}), benevolence (PB_{STU}), and competence (PC_{STU}) – influence the students' decision to trust, then the average rating of the students who perceive these trustworthiness properties is greater than 4 (Neutral).

One-sample t-test was conducted to verify the influence of three types of trustworthiness on students' decision to trust.

The null and alternative hypotheses are:

H_0: $\mu = 4$: The average rating of students' perceived trustworthiness = 4

H_1: $\mu > 4$: The average rating of students' perceived trustworthiness > 4

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
PI_{STU}	35	5.78	.79	.13
PB_{STU}	35	5.60	.91	.15
PC_{STU}	35	5.73	.79	.13

One-Sample Test

	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	p-value	Mean Difference	Lower	Upper
PI_{STU}	13.3	34	< .001	1.77	1.50	2.04
PB_{STU}	10.5	34	< .001	1.61	1.30	1.92
PC_{STU}	13.0	34	< .001	1.73	1.46	2.01

Figure 9-1: The results of one-sample t-test for comparing students' agreement rating mean to 4 (Neutral) in Trust Dilemma I

Figure 9-1 shows results of one sample t-test analysis. The mean of students who perceived PI_{STU} (M = 5.78, s = .79), PB_{STU} (M = 5.6, s = .91), and PC_{STU} (M = 5.73, s = .79) was significantly different from 4, $p < .0001$. Therefore, H_0 was rejected because the mean agreement scores are significantly different from 4. There is sufficient evidence to conclude that the students who agree that perceived integrity (PI_{STU}), benevolence (PB_{STU}) and competence (PC_{STU}) influence their decision to trust, because the mean agreement scores are significantly higher than 4 (Neutral).

9.3 Results for students' trust theories where the information about trustworthiness was ambiguous

Chapter 4 proposed two antecedents to trust in students' trust theories: the student's assumption to trust and the students' perception of trustworthiness. The questionnaire based on students' trust theories (STQ) and a survey was done to formulate the students' trust theories. Survey data was collected from participants and analysed. The data analysis aims to (1) validate students' trust theories, (2) investigate the relationship between antecedents to trust and the students' trust in a trust dilemma where the information about trustworthiness was ambiguous. Therefore, a conjecture is stated as follows:

> If the student's trust theories are valid in Trust Dilemma I, at least one of the predictor variables of the antecedents to trust in the STQ can predict the students' trust significantly.

Multiple regression analysis was conducted on survey data analysis, which was to see whether the antecedents to trust predicted the students' trust in the trust dilemma where information about trustworthiness was ambiguous.

Description			**Abbreviation**
The students' trust (Dependent Variable)			T_{STU}
Predictor Variables			
Antecedents to trust	the students' perceived trustworthiness properties of the learning activity	The students' perceived integrity	PI_{STU}
		The students' perceived benevolence	PB_{STU}
		The students' perceived competence	PC_{STU}
	the students' assumption to trust	The students' propensity to trust	PT_{STU}
		The students' prior knowledge	KW_{STU}

Table 9-1: Variables in the multiple regression analysis for studying the relationship between the antecedents to trust of STQ and the students' trust in Trust Dilemma I.

Table 9-1 shows a multiple regression model with five predictor variables from two antecedents to trust.

The null and alternative hypotheses are:

H_0: There is no relationship between the antecedents to trust via the five predictors (PT_{STU}, KW_{STU}, PC_{STU}, PB_{STU}, PI_{STU}) and the students' trust

$$H0: \beta_{\mathrm{PT}_{STU}} = \beta_{\mathrm{KW}_{STU}} = \beta_{\mathrm{PC}_{STU}} = \beta_{\mathrm{PB}_{STU}} = \beta_{\mathrm{PI}_{STU}} = 0$$

H_1: There is a relationship between the antecedents to trust via the five predictors (PT_{STU}, KW_{STU}, PC_{STU}, PB_{STU}, PI_{STU}) and the students' trust

$$H1: not\ all\ \beta\ are\ 0$$

Descriptive Statistics

	Mean	Std. Deviation	N
T_{STU}	.62	.14	35
PI_{STU}	.82	.11	35
PB_{STU}	.80	.13	35
PC_{STU}	.82	.11	35
PT_{STU}	.52	.12	35
KW_{STU}	.56	.22	35

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.66	.43	.11

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.29	5	.06	4.45	.004
	Residual	.38	29	.01		
	Total	.67	34			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	.11	.18		.60	.551
	PI_{STU}	-.40	.39	-.32	-1.05	.304
	PB_{STU}	.01	.31	.00	.013	.990
	PC_{STU}	.53	.35	.43	1.51	.141
	PT_{STU}	.51	.17	.44	3.07	.005
	KW_{STU}	.24	.09	.38	2.71	.011

Figure 9-2: The results of multiple regression analysis for studying the relationship between the antecedents to trust and the students' trust in Trust Dilemma I

Figure 9-2 shows the results of the multiple regression analysis. It was found that a regression model of the antecedents to trust statistically and significantly predict the students' trust, F (5, 29) = 4.45, p = .004, R^2 = .43. In other words, the relationship between the antecedents to trust and the students' trust (R^2 = .43) was found to exceed

Cohen's (1988) convention for a large effect size (R^2 = .26). The hypothesis H_0 was rejected.

According to Figure 9-2, the analysis shows that three predictor variables of the students' perception of trustworthiness, PC_{STU}, PB_{STU}, PI_{STU}, did not significantly (p-value > 0.05) predict the students' trust. However, two predictor variables of students' assumption to trust: PT_{STU}, KW_{STU} did significantly predict the students' trust.

9.4 Results for LOT models in the Trust Dilemma where the information about trustworthiness was ambiguous

Chapter 5 proposed a LOT model with five predictors variables proposed in order to predict the degree of students' trust. Chapter 6 show how to use LOT models to calculate the degree of trust in a learning activity. According Chapter 6, two methods for calculating the degree of trustworthiness for applying in a LOT model are proposed: Method A is the calculation of the degree of trustworthiness using the expert's whole learning path or the given learning path, and Method B is the calculation of the degree of trustworthiness using the trustors' learning path. Therefore, this section contains two parts: (1) the data analysis aims to validate the LOT model applying Method A and (2) the data analysis aims to validate the LOT model applying Method B. Therefore, a conjecture is stated as follows:

> If the LOT models are valid in Trust Dilemma I, at least one of the predictor variables in a LOT model can predict the students' trust significantly.

Further, how the students' trust can be explained by variations in the predictor variables was investigated.

9.4.1. Result for the LOT model applying Method A

To validate the LOT model applying Method A, the regression model for predicting a degree of students' trust was conducted based on the LOT model applying Method A. A multiple regression model was conducted by five predictor variables from two antecedents to trust. Firstly, the students' assumption to trust consists of: students' propensity to trust (PT_{STU}) and students' prior knowledge (KW_{STU}). Secondly, the trustworthiness properties of a learning activity consist of: competence (C_{LOTA}), benevolence (B_{LOTA}) and integrity (I_{LOTA}). Multiple regression analysis was conducted on two sources of data: the survey data was used in the predictor variables of the students' assumption to trust, the data from the calculation of Method A was used in the trustworthiness properties of the learning activity.

Descriptive Statistics

	Mean	Std. Deviation	N
T_{STU}	.63	.15	37
I_{LOTA}	.87	.12	37
B_{LOTA}	.69	.23	37
C_{LOTA}	.47	.24	37
PT_{STU}	.52	.12	37
KW_{STU}	.57	.23	37

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.59	.35	.13

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.28	5	.06	3.32	.016
	Residual	.53	31	.02		
	Total	.81	36			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	.35	.32		1.13	.269
	I_{LOTA}	-.30	.53	-.24	-.56	.577
	B_{LOTA}	.18	.23	.26	.77	.448
	C_{LOTA}	.01	.17	.02	.09	.931
	PT_{STU}	.61	.19	.48	3.27	.003
	KW_{STU}	.15	.10	.23	1.48	.148

Figure 9-3: The results of multiple regression analysis for studying the relationship between the predictor variables of the LOT model applying Method A and the students' trust in Trust Dilemma I

The null and alternative hypotheses are:

H_0: There is no relationship between the LOT model applying Method A via the five predictors (PT_{STU}, KW_{STU}, C_{LOTA}, PB_{LOTA}, I_{LOTA}) and the degree of students' trust.

$$H0: \beta_{PT_{STU}} = \beta_{KW_{STU}} = \beta_{C_{LOTA}} = \beta_{B_{LOTA}} = \beta_{I_{LOTA}} = 0$$

H_1: There is a relationship between the LOT model applying Method A via the five predictors (PT_{STU}, KW_{STU}, C_{LOTA}, PB_{LOTA}, I_{LOTA}) and the degree of students' trust.

$$H1: not\ all\ \beta\ are\ 0$$

The prediction model was reached in four assumptions on which multiple regression analysis is based. It was found that a regression model of the LOT model applying Method A statistically significantly predicts the students' trust, $F(5,31)= 3.32$, $p = .016$, $R^2 = .35$. In other words, the relationship between the LOT model applying Method A and the student's trust ($R^2 = .35$) was found to exceed Cohen's (1988) convention for a large effect size ($R^2 = .26$). The hypothesis H_0 was rejected.

According to Figure 9-3, the analysis shows that three predictor variables of the student's perception of trustworthiness, C_{LOTA}, B_{LOTA}, I_{LOTA}, and KW_{STU}, did not significantly (p-value > 0.05) predict the students' trust. However, PT_{STU}, which is the predictor variable of students' assumption to trust, did significantly predict the students' trust.

9.4.2. Result for the LOT model applying Method B

To validate the LOT model applying Method B, the regression model for predicting a degree of students' trust was conducted. The multiple regression model was conducted by five predictor variables from two antecedents to trust. Firstly, the students' assumption to trust consists of: students' propensity to trust (PT_{STU}) and students' prior knowledge (KW_{STU}). Secondly, the trustworthiness properties of the learning activity consist of: competence (C_{LOTB}), benevolence (B_{LOTB}) and integrity (I_{LOTB}). Multiple regression analysis was conducted on two sources of data: the survey data was used in the predictor variables of the students' assumption to trust, and the data from the calculation of Method B was used in the trustworthiness properties of the learning activity.

Descriptive Statistics

	Mean	Std. Deviation	N
T_{STU}	.62	.14	36
I_{LOTB}	.89	.02	36
B_{LOTB}	.58	.10	36
C_{LOTB}	.62	.13	36
PT_{STU}	.52	.12	36
KW_{STU}	.57	.23	36

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.66[a]	.44	.11

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.29	5	.06	4.66	.003
	Residual	.38	30	.01		
	Total	.67	35			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	-1.33	1.06		-1.24	.219
	I_{LOTB}	1.50	1.22	.19	1.23	.228
	B_{LOTB}	.29	.21	.20	1.38	.177
	C_{LOTB}	.09	.17	.08	.49	.625
	PT_{STU}	.56	.17	.48	3.28	.003
	KW_{STU}	.17	.09	.29	2.00	.055

Figure 9-4: the results of multiple regression analysis for studying the relationship between the predictor variables of LOT model applying Method A and the students' trust in Trust Dilemma I

The null and alternative hypotheses are:

H_0: There is no relationship between the LOT model applying Method B via the five predictors (PT_{STU}, KW_{STU}, C_{LOTB}, PB_{LOTB}, I_{LOTB}) and the degree of students' trust.

$$H0: \beta_{\mathrm{PT}_{STU}} = \beta_{\mathrm{KW}_{STU}} = \beta_{\mathrm{C}_{LOTB}} = \beta_{\mathrm{B}_{LOTB}} = \beta_{\mathrm{I}_{LOTB}} = 0$$

H_1: There is relationship between the LOT model applying Method B via the five predictors (PT_{STU}, KW_{STU}, C_{LOTB}, PB_{LOTB}, I_{LOTB}) and the degree of students' trust.

$$H1: not\ all\ \beta\ are\ 0$$

The prediction model was reached in four assumptions on which multiple regression analysis is based. It was found that a regression model of the LOT model applying Method B statistically significantly predicts the students' trust, $F(5,30)= 4.67$, $p = .003$, $R^2 = .44$. In other words, the relationship between the LOT model applying Method B and the students' trust ($R^2 = .44$) was found to exceed Cohen's (1988) convention for a large effect size ($R^2 = .26$). The hypothesis H_0 was rejected.

According Figure 9-4, the analysis shows that three predictor variables of the students' perception of trustworthiness, C_{LOTB}, B_{LOTB}, I_{LOTB}, and KW_{STU}, did not significantly (p-value > 0.05) predict the student's trust. However, PT_{STU}, which is the predictor variable of students' assumption to trust, did significantly predict the student's trust.

9.5 Results for performances of LOT models in comparison with the students' trust theories in Trust Dilemma I

This section reports comparison result of all models' performance for predicting the degree of students' trust in Table 9-2. F-ratio (Field A, 2013) was conducted to compare R^2 from three models: the prediction model from the questionnaire (STQ), the LOT model applying Method A (LOTA), and the LOT model applying Method B (LOTA).

Models ID	Regression function of Models	Description of Models' function
STQ	$T_{STU} = f(PT_{STU}, KW_{STU}, B_{STU}, I_{STU}, C_{STU})$	The prediction model from questionnaire
LOTA	$T_{LOTA} = f(PT_{STU}, KW_{STU}, B_{LOTA}, I_{LOTA}, C_{LOTA})$	The LOT model applying Method A
LOTB	$T_{LOTB} = f(PT_{STU}, KW_{STU}, B_{LOTB}, I_{LOTB}, C_{LOTB})$	The LOT model applying Method B

Table 9-2: All models for predicting the degree of students' trust

The null and alternative hypotheses were stated:

H_0: There is no performance difference between all models: STQ, LOTA, and LOTB

H_1: There is performance difference between some models

	R Square	Number of Predictors, df(regression)	df(residual)	Number of Subject	K change
STQ (baseline)	0.434	5	29	35	3
LOTA	0.349	5	31	37	3
LOTB	0.437	5	30	36	3

H0:	R Square Change	F-radio	df1 (numerator)	df2 (denominator)	Critical F (α = 0.05)
STQ = LOTA	0.085	1.452	5	29	2.545
LOTB = STQ	0.003	0.053	5	30	2.534
LOTB = LOTA	0.088	1.563	5	30	2.534

Figure 9-5: The F-test result of STQ, LOTA, and LOTB models

The performance of all models is not different, when F-ratio is lower than the Critical F. According to Figure 9-5 if the results show that all F-ratio are lower than Critical F then we accept the null hypothesis at the 5% level of significance. There is no significant different in the predictor models: STQ, LOTA, and LOTB.

9.6 Summary

Data Interpretation and Reporting about the students' trust theories and LOT models that appeared in Trust Dilemma I, where the information about trustworthiness was ambiguous, were shown in this Chapter. All models were statistically significant predictors of students' trust. The students' propensity to trust was the main predictor variable in all models in Trust Dilemma I. The F-ratio for comparing all models was significant.

Chapter 10 Discussion: When Information About Trustworthiness Was Ambiguous

10.1 Introduction

This chapter discusses the results on students' trust theories, LOT models, their relationship in Trust Dilemma I, all related back to the literature and theories presented in this research.

10.2 Reliability of Measuring Perceived Trustworthiness

This research proposed a learning path as the source of information about trustworthiness. The question of whether the information, which is gathered from the learning path is reliable for measuring perceived trustworthiness, was raised. To answer this question, Cronbach's Alpha Test was performed from collected data. The data was collected by the 9-items scale in Table 10-1 for measuring the perceived trustworthiness, which was developed based on the learning path concept. Figure 8-2 shows the Cronbach alpha coefficient of subcategories of perceived trustworthiness (integrity, benevolence, and competence) higher or equal to than .70, which indicates an acceptable level of internal consistency for the 9-items scale. This means that all of the items (variables) vary in the same direction. For example, the students showed that they understood that the two statements "It identifies what I need to learn to achieve my desired learning outcome (dLO)" and "It involves the capability verb that relates with what I need to do to achieve my desired learning outcome (dLO)" are related with the competence variable. Therefore, the 9-items scale of information about trustworthiness has high reliability for measuring students' perceived trustworthiness of a learning activity.

10.3 Perceived trustworthiness of a learning activity and trust decisions when the information about trustworthiness was ambiguous

Section 9.2 reports to verify whether the students' decision to trust was influenced by the properties of trustworthiness of a learning activity. Table 10-1 summarises this result, where the findings show three property categories: integrity, benevolence and competence. The students agree that these properties significantly influence the decision to trust. Thus, these findings verified that the students' trust was influenced by properties of trustworthiness of a learning activity when the information about trustworthiness was ambiguous. This finding is supported by Kramer & Tyler (1996), in that the perceived trustworthiness was the factor in causing an individual to trust in ambiguous situations. For example, Deutsch (1962) stated when the individual is dealing with an ambiguous path, the path that can lead to an event perceived to be beneficial or to an event perceived to be harmful.

Types of students' perceived trustworthiness of a learning activity	***Mean***
Students' perceived integrity	5.73*
Students' perceived benevolence	5.61*
Students' perceived competence	5.77*

*p<0.001

Table 10-1: Summary of means of students, who perceived trustworthiness, and agree that trustworthiness properties influence their decision to trust with scores > 4 in Trust Dilemma I ((1) Strongly disagree, (2) Disagree, (3) Slightly disagree, (4) Neutral, (5) Slightly agree, (6) Agree, (7) Strongly agree)

10.4 Predictors in the Trust Dilemma where the information about trustworthiness was ambiguous

To validate the models for predicting students' trust, Sections 9.3 and 9.4 show the multiple regression model was conducted by using the data from the questionnaire based on students' trust theories (STQ) and the Learning Outcome-based Trust (LOT) model. As maintained in Chapter 7, two methods were proposed for calculating the degree of trustworthiness of a learning activity in the LOT model: (1) Method A is the calculation of the degree of trustworthiness using the expert whole learning path or the given learning path (LOTA), and (2) Method B is the calculation of the degree of trustworthiness using the trustor learning path (LOTB). Table 10-2 shows a summary of three multiple regression results for predicting the degree of students' trust: STQ, LOTA and LOTB.

Predictor Models	***R Square***	***P***
STQ	0.43	0.004
LOTA	0.35	0.016
LOTB	0.44	0.003

Table 10-2 Model summary results of STQ, LOTA and LOT B for predicting the degree of students' trust

As shown in Table 10-2, there is significant positive correlation between the degree of students' trust and the degree of trust from all predictor models. According to Cohen (1988), all R-squared results suggest a large effect size that means a performance of STQ and the LOT model applying Method A and Method B are consistent enough to keep it in line with the actual students' trust. Thus, all predictor models STQ, LOTA and LOTB can predict the student's trust degree, and they are valid where the information about trustworthiness was ambiguous. Therefore, LOTA can predict trust as well as STQ can, and also LOTB. This means we can explain how the students' trust occurs via the two proposed antecedents to trust: the students' assumption to trust and the trustworthiness of the learning activity. The finding is consistent with the Mayer et al. (1995) model, which discusses that trust is construed from the trustor's propensity to trust and the trustor's perception of the trustworthiness of the entity to be trusted. Mayer et al. states three dimensions of perceived trustworthiness: benevolence, ability, and integrity.

10.5 Evaluation of the LOT models by comparing the prediction performance with the STQ model

Section 9.5 compares R^2 from three regression models: the prediction model from the questionnaire (STQ), the LOT model applying Method A (LOTA) and the LOT model applying Method B (LOTB). The results of Section 9.5 are summarised in Table 10-3 that shows there are no differences in prediction performance between three models.

The comparison between the predictor models	**R Square Change**	**F-radio**	**Critical F (0.05)**	**Decision**
STQ vs. LOTA	0.085	1.452	2.545	No different
LOTB vs. STQ	0.003	0.053	2.534	No different
LOTB vs. LOTA	0.088	1.563	2.534	No different

Table 10-3: Summary of the F-ratio results for comparing the prediction performance between three predictor models: STQ, LOTA, and LOTB

The LOT model applying Method B did not perform better than the LOT model applying Method A, and was not better than STQ. The students' assumption to trust was gathered by using the same method (the same collected data) in all models. In contrast, the gathering method of the trustworthiness of a learning activity is the difference in all models. However, there are no differences in performance according to Table 10-3. Therefore, the trustworthiness of a learning activity is the antecedent to trust that tends to not affect the students' trust in the situation where the information about trustworthiness was ambiguous.

In other words, in the Trust Dilemma where trustworthiness was ambiguous, all predictor models were no different because all model have the same main predictor variables, which in the students' assumption to trust. This finding is supported by Gill et al. (2005), which studied intentions to trust when information about trustworthiness was ambiguous, correlated with the students' propensity to trust. When little information about the trustee is recognised, trustors will use their propensity to trust for their decision (Colquitt et al., 2014).

10.6 Investigation of main predictor variables in a Trust Dilemma where the information about trustworthiness was ambiguous

Section 9.3 shows the result of a multiple regression model that was conducted by using the data from STQ. Section 9.4 reports two multiple regression results of the LOT model applying Method A and Method B. Table 10-4 shows a summary of the table of coefficients of all predictor models: STQ, LOTA and LOTB.

As shown in Table 10-4, the students' propensity to trust (PT_{STU}) and levels of students' prior knowledge (KW_{STU}) are two predictor variables that were significant in the STQ model. This finding is supported by Mayer et al., (1995), that knowledge, capabilities and the propensity to trust a manager will influence an employee's trust. However, only the students' propensity to trust (PT_{STU}) was a significant predictor variable in LOTA and LOTB. Goldberg (1990) suggested the propensity to trust is a means for computing trust, and the propensity to trust should be studied within the wider framework of present personality taxonomies.

Predictor Models		***Predictor Variables***	***Code***	***P***
STQ	Students' assumption to trust	students' propensity to trust	PT_{STU}	.005*
		students' prior knowledge	KW_{STU}	.011*
	Students' perceived trustworthiness	students' perceived integrity	PI_{STU}	.304
		students' perceived benevolence	PB_{STU}	.990
		students' perceived competence	PC_{STU}	.141
LOTA	Students' assumption to trust	students' propensity to trust	PT_{STU}	.003*
		students' prior knowledge	KW_{STU}	.148
	Calculating trustworthiness by Method A	Degree of Integrity of learning activity	I_{LOTA}	.577
		Degree of benevolence of learning activity	B_{LOTA}	.448
		Degree of competence of learning activity	C_{LOTA}	.931
LOTB	Students' assumption to trust	students' propensity to trust	PT_{STU}	.003*
		students' prior knowledge	KW_{STU}	.055
	Calculating trustworthiness by Method B	Degree of Integrity of learning activity	I_{LOTB}	.228
		Degree of benevolence of learning activity	B_{LOTB}	.177
		Degree of competence of learning activity	C_{LOTB}	.625

*$p \leq 0.05$

Table 10-4: Summary of coefficients of all predictor models: STQ, LOTA, and LOTB

Therefore, there is only one antecedent that affects the students' trust, and that is the students' assumption to trust, in the Trust Dilemma where trustworthiness was ambiguous. These findings are sympathetic to the idea that a propensity to trust would only emerge when there was ambiguity or lack of information about trustworthiness (Mayer et al., 1995; Dirks and Ferrin, 2001). The development of differences of trust in each entity was led by individual differences in the propensity to trust (Gill et al., 2005; Mayer et al., 1995).

10.7 Summary

This chapter discusses an experiment of student's trust when the information about trustworthiness was ambiguous. In this case, the students decide to trust mainly based on their propensity to trust; even though they accept that three trustworthiness properties of a learning activity are influential on their decision to trust. The result of the LOT model applying Method A (LOTA), Method B (LOTB) and the prediction model from the questionnaire (STQ) correspond with the actual students' trust. Therefore, the LOT model can predict the degree of students' trust in a learning activity when trustworthiness was ambiguous.

The three validity trust models – STQ, LOTA and LOTB – developed in this research will help us understand how the students make decisions to trust or not to trust in a learning activity, and provide the students with approaches to help their learning where the information about trustworthiness is ambiguous. The models may help in the construction of good cooperation, especially in learning resource sharing.

The finding also showed that when trustworthiness was ambiguous the main predictor is the students' propensity to trust. Thus, the role of propensity to trust is important in the prediction of a students' trust, and could also be investigated as part of future research.

Chapter 11 Experiment Results: When Information About Trustworthiness Was Clear

11.1 Introduction

This chapter reports on experimental validation of students' trust theories and the LOT models in Trust Dilemma II were shown. The relationship between the students' trust theories or LOT models and the students' trust was investigated.

11.2 Result for verifying three types of trustworthiness properties of a learning activity when the information about trustworthiness was clear

Section 6.3.2 discussed the perceived trustworthiness of a learning activity, being one of the antecedents of students' trust, and there are three types of trustworthiness properties suggested in the conjecture, stated as follows:

> If three types of trustworthiness properties – integrity (PI_{STU}), benevolence (PB_{STU}), and competence (PC_{STU}) – influence the students' decision to trust, then the average rating of the students, who perceive these trustworthiness properties' influence on their decision to trust, is greater than 4 (Neutral).

One-sample t-tests were conducted to verify the influence of three types of trustworthiness on students' decision to trust.

The null and alternative hypotheses are:

H_0: $\mu = \mu_0$: The average rating of students' perceived trustworthiness = 4

H_1: $\mu > \mu_0$: The average rating of students' perceived trustworthiness > 4

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
PI_{STU}	51	4.75	1.21	.17
PB_{STU}	51	5.01	1.19	.17
PC_{STU}	51	5.09	1.22	.17

One-Sample Test

	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	p-value	Mean Difference	Lower	Upper
PI_{STU}	4.38	50	< .001	.75	.40	1.09
PB_{STU}	6.1	50	< .001	1.01	.68	1.35
PC_{STU}	6.33	50	< .001	1.08	.74	1.43

Figure 11-1: The results of one-sample t-test for comparing a students' agreement rating mean to 4 (Neutral) in Trust Dilemma II

Figure 11-1 shows results of one-sample t-test analysis. They were was conducted on the agreement scores to assess whether their mean was significantly different from 4, which is the neutral agreement that three types of trustworthiness influence on their decision to trust. The mean of students who perceived PI_{STU} (M = 4.75, s = 1.21), PB_{STU} (M = 5.01, s = 1.19), and PC_{STU} (M = 5.09, s = 1.22) was significantly different from 4, p < .0001. Therefore, H_0 was rejected. There is sufficient evidence to conclude that the average of students who agree that perceived integrity (PI_{STU}), benevolence (PB_{STU}) and competence (PC_{STU}) influence their decision to trust, was significantly higher than 4 (Neutral).

11.3 Results for students' trust theories where the information about trustworthiness was clear

The questionnaire and survey based on students' trust (STQ) were completed to formulate the students' trust theories. Survey data was collected from participants and analysed. The data analysis aims to (1) validate students' trust theories, (2) investigate the relationship between antecedents to trust and the students' trust in a trust dilemma where the information about trustworthiness was ambiguous. Therefore, the conjecture is stated as follows:

> If the students' trust theories are valid in Trust Dilemma I, at least one of the predictor variables of the antecedents to trust in the STQ can predict the students' trust significantly.

Multiple regression analysis was conducted on survey data analysis, which was to see whether the antecedents to trust predicted the students' trust in a trust dilemma where information about trustworthiness was clear.

Description			**Abbreviation**
The students' trust (Dependent Variable)			T_{STU}
Predictor Variables			
Antecedents to trust	the students' perceived trustworthiness properties of the learning activity	The students' perceived integrity	PI_{STU}
		The students' perceived benevolence	PB_{STU}
		The students' perceived competence	PC_{STU}
	the students' assumption to trust	The students' propensity to trust	PT_{STU}
		The students' prior knowledge	KW_{STU}

Table 11-1: Variables in the multiple regression analysis for studying the relationship between the antecedents to trust of the STQ and the students' trust in Trust Dilemma II

Table 11-1 shows multiple regression models with five predictor variables from two antecedents to trust.

The null and alternative hypotheses are:

H_0: There is no relationship between the antecedents to trust via the five predictors (PT_{STU}, KW_{STU}, PC_{STU}, PB_{STU}, PI_{STU}) and the students' trust

$$H0: \beta_{\mathrm{PT}_{STU}} = \beta_{\mathrm{KW}_{STU}} = \beta_{\mathrm{PC}_{STU}} = \beta_{\mathrm{PB}_{STU}} = \beta_{\mathrm{PI}_{STU}} = 0$$

H_1: There is a relationship between the antecedents to trust via the five predictors (PT_{STU}, KW_{STU}, PC_{STU}, PB_{STU}, PI_{STU}) and the students' trust

$$H1: not\ all\ \beta\ are\ 0$$

Descriptive Statistics

	Mean	Std. Deviation	N
T_{STU}	.78	.14	50
PI_{STU}	.69	.16	50
PB_{STU}	.72	.16	50
PC_{STU}	.73	.16	50
PT_{STU}	.56	.13	50
KW_{STU}	.60	.23	50

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.64	.40	.11

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.38	5	.08	5.96	<.001
	Residual	.57	44	.01		
	Total	.95	49			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	p-value
1	(Constant)	.38	.10		3.65	.001
	PI_{STU}	-.40	.20	-.46	-2.01	.051
	PB_{STU}	.46	.22	.53	2.04	.048
	PC_{STU}	.37	.13	.43	2.97	.005
	PT_{STU}	.04	.14	.04	.31	.757
	KW_{STU}	.08	.08	.12	1.07	.290

Figure 11-2: The results of multiple regression analysis for studying the relationship between the antecedents to trust and the students' trust in Trust Dilemma II

Figure 11-2 shows the results of the multiple regression analysis. It was found that a regression model of the antecedents to trust statistically significantly predict the students' trust, F (5, 44) = 5.96, $p < .001$, $R^2 = .40$. In other words, the relationship between the antecedents to trust and the students' trust ($R^2 = .40$) was found to exceed Cohen's (1988) convention for a large effect size ($R^2 = .26$). The hypothesis H_0 was rejected.

According to Figure 11-2, the analysis shows that three predictor variables of the students' perception of trustworthiness, PC_{STU}, PB_{STU}, PI_{STU}, did significantly predict the students' trust. In contrast, two predictor variables of the students' assumption to trust: PT_{STU}, KW_{STU} did not significantly predict the students' trust (p-value > 0.05).

11.4 Results for LOT models in a Trust Dilemma where the information about trustworthiness was clear

Chapter 5 described a LOT model with five predictors variables proposed to predict the degree of students' trust. Chapter 6 show how to uses a LOT model to calculate the degree of trust in a learning activity. According to Chapter 6, two methods for calculating the degree of trustworthiness for applying in a LOT model are proposed: Method A is the calculation of degree of trustworthiness using the expert whole learning path or the given learning path, and Method B is the calculation of the degree of trustworthiness using the trustor's learning path. Therefore, this section contains two parts: (1) the data analysis aims to validate the LOT model applying Method A and (2) the data analysis aims to validate the LOT model applying Method B. Therefore, a conjecture is stated as follows:

> If the LOT models valid in Trust Dilemma II, at least one of the predictor variables in a LOT model can predict the students' trust significantly.

Further, how the students' trust can be explained by variations in the predictor variables were investigated.

11.4.1. Result for LOT model applying Method A

To validate the LOT model applying Method A, the regression model for predicting a degree of students' trust was conducted based on the LOT model applying Method A. A multiple regression model was conducted by five predictor variables from two antecedents to trust. Firstly, the students' assumption to trust consists of: the students' propensity to trust (PT_{STU}) and the students' prior knowledge (KW_{STU}). Secondly, the trustworthiness properties of a learning activity consists of: competence (C_{LOTA}), benevolence (B_{LOTA}) and integrity (I_{LOTA}). Multiple regression analysis was conducted on two sources of data: the survey data was used in the predictor variables of the students' assumption to trust, the data from the calculation of Method A was used in the trustworthiness properties of the learning activity.

The null and alternative hypotheses are:

H_0: There is no relationship between the LOT model applying Method A via the five predictors (PT_{STU}, KW_{STU}, C_{LOTA}, PB_{LOTA}, I_{LOTA}) and the degree of students' trust.

$$H0: \beta_{\mathrm{PT}_{STU}} = \beta_{\mathrm{KW}_{STU}} = \beta_{\mathrm{C}_{LOTA}} = \beta_{\mathrm{B}_{LOTA}} = \beta_{\mathrm{I}_{LOTA}} = 0$$

H_1: There is relationship between the LOT model applying Method A via the five predictors (PT_{STU}, KW_{STU}, C_{LOTA}, PB_{LOTA}, I_{LOTA}) and the degree of students' trust.

$$H1: not\ all\ \beta\ are\ 0$$

The prediction model was reached in four assumptions on which multiple regression analysis is based. Figure 11-3 shows the results of the multiple regression analysis using the enter method. It was found that a regression model of the LOT model applying Method A significantly predicts students' trust, $F(5, 44) = 2.56$, $p<.05$, $R = .48$. In other words, the relationship between the LOT model applying Method A and the students' trust ($R^2 = .23$) was found to exceed Cohen's (1988) convention for a medium effect size ($R^2 = .13$). The hypothesis H_0 was rejected.

According Figure 11-3, the analysis shows that three predictor variables of the students' perception of trustworthiness, C_{LOTA}, B_{LOTA}, I_{LOTA}, and one predictor in assumption to trust, KW_{STU}, were significant predictors of students' trust. In contrast, PT_{STU}, which is the predictor variable of students' assumption to trust, did not significantly predict the students' trust (p-value > 0.05).

Descriptive Statistics

	Mean	Std. Deviation	N
T_{STU}	.78	.15	50
I_{LOTA}	.88	.11	50
B_{LOTA}	.56	.16	50
C_{LOTA}	.53	.10	50
PT_{STU}	.56	.13	50
KW_{STU}	.60	.23	50

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.475	.225	.137

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.24	5	.05	2.56	.041
	Residual	.82	44	.02		
	Total	1.06	49			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	-.01	.34		-.03	.978
	I_{LOTA}	.92	.43	.70	2.15	.037
	B_{LOTA}	-.43	.29	-.46	-1.51	.139
	C_{LOTA}	.07	.22	.05	.30	.770
	PT_{STU}	.25	.16	.22	1.58	.121
	KW_{STU}	.09	.09	.14	.95	.346

Figure 11-3: The results of multiple regression analysis for studying the relationship between the predictor variables of the LOT model applying Method A and the students' trust in Trust Dilemma II

11.4.2. Result for the LOT model applying Method B

To validate the LOT model applying Method B, the regression model for predicting a degree of students' trust was conducted. The multiple regression model was conducted by five predictor variables from two antecedents to trust. Firstly, the students' assumption to trust consists of: students' propensity to trust (PT_{STU}) and students' prior knowledge (KW_{STU}). Secondly, the trustworthiness properties of the learning activity consist of: competence (C_{LOTB}), benevolence (B_{LOTB}) and integrity (I_{LOTB}). Multiple regression analysis was conducted on two sources of data: the survey data was used in the predictor variables of the students' assumption to trust, and the data from the calculation of Method B was used in the trustworthiness properties of the learning activity.

The null and alternative hypotheses are:

H_0: There is no relationship between the LOT model applying Method B via the five predictors (PT_{STU}, KW_{STU}, C_{LOTB}, PB_{LOTB}, I_{LOTB}) and the degree of students' trust.

$$H0: \beta_{\mathrm{PT}_{STU}} = \beta_{\mathrm{KW}_{STU}} = \beta_{\mathrm{C}_{LOTB}} = \beta_{\mathrm{B}_{LOTB}} = \beta_{\mathrm{I}_{LOTB}} = 0$$

H_1: There is a relationship between the LOT model applying Method B via the five predictors (PT_{STU}, KW_{STU}, C_{LOTB}, PB_{LOTB}, I_{LOTB}) and the degree of students' trust.

$$H1: not\ all\ \beta\ are\ 0$$

The prediction model was reached in four assumptions on which multiple regression analysis is based. Figure 11-6 shows the results of the multiple regression analysis using the enter method. It was found that a regression model of the LOT model applying Method B statistically significantly predict the students' trust, $F(5, 43) = 5.66$, $p < .001$, $R^2 = .40$. In other words, the relationship between the LOT model applying Method B and the students' trust ($R^2 = .40$) was found to exceed Cohen's (1988) convention for a large effect size ($R^2 = .26$). The hypothesis H_0 was rejected.

According Figure 11-4, the analysis shows that two predictor variables of the students' perception of trustworthiness, C_{LOTB} and I_{LOTB}, did significantly predict the students' trust. PT_{STU} and KW_{STU} which is the predictor variable of students' assumption to trust, did not significantly predict the students' trust (p-value > 0.05).

Descriptive Statistics

	Mean	Std. Deviation	N
TSTU	.78	.15	49
ILOTB	.90	.09	49
BLOTB	.73	.19	49
CLOTB	.42	.21	49
PTSTU	.56	.13	49
KWSTU	.60	.23	49

Model Summary

Model	R	R Square	Std. Error of the Estimate
1	.630	.397	.120

ANOVA

Model		Sum of Squares	df	Mean Square	F	p-value
1	Regression	.41	5	.08	5.66	<.001
	Residual	.62	43	.01		
	Total	1.03	48			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	p-value
		B	Std. Error	Beta		
1	(Constant)	-.15	.34		-.43	.668
	ILOTB	1.27	.63	.79	2.03	.049
	BLOTB	-.52	.30	-.66	-1.76	.086
	CLOTB	.23	.11	.33	2.09	.043
	PTSTU	.06	.14	.05	.39	.698
	KWSTU	.06	.08	.09	.73	.470

Figure 11-4: The results of multiple regression analysis for studying the relationship between the predictor variables of LOT model applying Method B and the students' trust in Trust Dilemma II

11.5 Results for performances of LOT models in comparison with the students' trust theories when the information about trustworthiness was clear

This section reports comparison result of all models' performance for predicting the degree of students' trust in Table 11-2. F-ratio (Field A., 2013) was conducted to compare R^2 from three models: the prediction model from the questionnaire (STQ), the LOT model applying Method A (LOTA), and the LOT model applying Method B (LOTB).

Models ID	Regression function of Models	Description of Models' function
STQ	$T_{STU} = f(PT_{STU}, KW_{STU}, B_{STU}, I_{STU}, C_{STU})$	The prediction model from questionnaire
LOTA	$T_{LOTA} = f(PT_{STU}, KW_{STU}, B_{LOTA}, I_{LOTA}, C_{LOTA})$	The LOT model applying Method A
LOTB	$T_{LOTB} = f(PT_{STU}, KW_{STU}, B_{LOTB}, I_{LOTB}, C_{LOTB})$	The LOT model applying Method B

Table 11-2: All model for predicting the degree of students' trust

The null and alternative hypotheses were stated:

H_0: There is no performance difference between all models: STQ, LOTA, and LOTB

H_1: There is performance difference between some models

	R Square	Number of Predictors, df(regression)	df(residual)	Number of Subject	k_change
STQ (baseline)	0.404	5	44	50	3
LOTA	0.225	5	44	50	3
LOTB	0.397	5	43	49	3

H0:	R Square Change	F-radio	df1 (numerator)	df2 (denominator)	Critical F (0.05)	Answer
STQ = LOTB	0.007	0.17	5	44	2.43	Accept
STQ = LOTA	0.179	3.39	5	44	2.43	Reject
LOTB = LOTA	0.172	4.09	5	43	2.43	Reject

Figure 11-5: The F-test result of STQ, LOTA, and LOTB models

The performance of all models is not different, when the F-ratio is lower than the Critical F. According Figure 11-5, if the results show that only the first pair (STQ compared with LOTA) F-ratio are lower than Critical F (0.05) then we accept the null hypothesis at the 5% level of significance. Other pairs of the null hypothesis were rejected. There is significant different between STQ and LOTA, and between LOTA and LOTB. There is no significant different between STQ and LOTB.

11.6 Summary

Data Interpretation and Reporting about the student's trust theories and LOT models that appeared in Trust Dilemma II, where the information about trustworthiness was clear, were shown in this Chapter. All models were statistically significant predictors of students' trust. The set of trustworthiness properties of a learning activity tend to be the main predictor of all models in Trust Dilemma II. The F-ratio for comparing all models in Trust Dilemma II, only the pair of models STQ and LOTB, was significant. Other pairs of F-ratio were not significant.

Chapter 12 Discussion: When Information About Trustworthiness Was Clear

12.1 Introduction

This chapter discusses the results on students' trust theories, LOT models, their relationship in Trust Dilemma II, all related back to the literature and theories presented in this research.

12.2 Reliability of Measuring Perceived Trustworthiness

This experimental set-up was the same as in Section 10.2, to answer the question of whether the information, which is gathered from the learning path, is reliable for measuring perceived trustworthiness. According to Cavana et al. (2001), the reliability of a measure shows the stability and consistency with which the items scale measures the concept and helps to determine the 'goodness' of a measure. All the variables were verified for the consistency reliability of the items within the variables by using the Cronbach's Alpha reliability analysis. Cronbach's alpha of 0.50 or higher shows a satisfactory level of internal reliability (Nunally, 1978). If the actual score is not measuring the same thing at all, Cronbach's alpha equals zero. If all items measure the same thing (true score) and all items are entirely reliable, Cronbach's alpha equals one.

Cronbach's Alpha Test was performed from collected data. The data was collected by the 9-items scale in Figure 8-5 shows the Cronbach's alpha for the constructs with the perceived trustworthiness 0.74 (perceived integrity), 0.81 (perceived benevolence), and 0.92 (perceived competence). The results shown that the Cronbach's alpha for all variables was well above 0.7 as commended by Cavana et al. (2001). The Cronbach's alpha coefficient for all the variables used for measuring perceived trustworthiness exceeded the preferable coefficients of 0.7. Thus, the 9-items scale was highly consistent, stable and reliable for measuring students' perceived trustworthiness of a learning activity when information about trustworthiness was clear.

The findings from Section 10.2 and this section shows the 9-items scale was reliable for measuring perceived trustworthiness in both situations (when information about trustworthiness was either ambiguous or clear). The previous studies showed that perceived trustworthiness is related with trustworthy behaviour in relationships (Levin et al., 2006). For example, the relationship between a supplier and a buyer is better when the supplier is perceived as trustworthy; the buyers will understand this as an explanation of the suppliers' trustworthiness (Möllering, 2002). Thus, if the measurement of perceived trustworthiness is reliable, the information about the trustworthiness properties of a learning activity, which is gathered based on the learning path, tends to be reliable.

12.3 Perceived trustworthiness of learning activity and trust decisions when the information about trustworthiness was clear

Section 11.2 reports to verify whether the students' decision to trust was influenced by the properties of trustworthiness of a learning activity. Table 12-1 summarises this result, where the findings show three property categories: integrity, benevolence and competence. The students agree that these properties significantly influence the decision to trust. Thus, these findings verified that the students' trust was influenced by properties of trustworthiness of a learning activity when the information about trustworthiness was clear. The findings lend support to previous studies, in that perceptions of trustworthiness are influenced by trustee attributes: ability (competence), integrity, and benevolence (Butler, 1991; Mayer et al., 1995).

Types of students' perceived trustworthiness of learning activity	***Mean***
Students' perceived integrity	4.75*
Students' perceived benevolence	5.01*
Students' perceived competence	5.09*

*p<0.001

Table 12-1: Summary of means of students, who perceived trustworthiness, and agree that trustworthiness properties influence their decision to trust with scores > 4 in Trust Dilemma II ((1) Strongly disagree, (2) Disagree, (3) Slightly disagree, (4) Neutral, (5) Slightly agree, (6) Agree, (7) Strongly agree)

Section 10.3 and this section support the findings that perceived trustworthiness is verified as influencing students' trust in both situations (when information about trustworthiness was either ambiguous or clear). This finding supported Gill et al. (2005), that found individual perceptions of trustworthiness are valid in a trust dilemma concerning the clarity or ambiguity of information. The previous studies probably explain why the students' trust was influenced by the trustworthiness of a learning activity. The findings of Levin & Cross (2004) support that a trustworthy knowledge source increases the chance that the students, who have perceived trustworthiness, will pay attention to learn from and engage with the transferred knowledge. Trustworthiness supports the enhancement of knowledge across entities, and the trustworthy entities may be motivated by the recipients to share their knowledge (Szulanski et al., 2004). Giffin (1967) suggested that individuals choose information because of the trustworthiness of the source rather than its expertise.

12.4 Predictors in Trust Dilemma where the information about trustworthiness was ambiguous

To validate the models for predicting students' trust, Sections 11.3 and 11.4 show the multiple regression model was conducted by using the data from the questionnaire based on students' trust theories (STQ) and the Learning Outcome-based Trust (LOT) model. As Maintained in Chapter 7, two methods were proposed for calculating the degree of trustworthiness of a learning activity in the LOT model (1) Method A is the calculation of the degree of trustworthiness using the expert whole learning path (LOTA) or the given learning path, and (2) Method B is the calculation of the degree of trustworthiness using the trustor learning path (LOTB). Table 12-2 shows summary of three multiple regression results for the predicting the degree of students' trust: STQ, LOTA and LOTB.

Predictor Models	***R Square***	***P***
STQ	0.40	< 0.001
LOTA	0.23	0.041
LOTB	0.40	< 0.001

Table 12-2: Model summary results of STQ, LOTA and LOT B for predicting the degree of students' trust

As shown in Table 12-2, there is significant positive correlation between the degree of students' trust and the degree of trust from all predictor models. According to Cohen (1988), R-squared results of STQ and Method B suggest a large effect size. The results of Method A suggest a medium effect size. This means that the performance of STQ and the LOT model applying Method A and Method B are consistent with the students' actual trust. Thus, all predictor models STQ, LOTA and LOTB can predict the student's trust degree, and they are valid where the information about trustworthiness was clear. This finding is consistent with the conceptualisation of trust from Lewis & Weigert (1985), Mayer et al. (1995) and McKnight et al. (2002) that includes three trustworthiness properties: integrity, competence and benevolence. Also, the propensity to trust may influence the decision to trust (Mayer et al., 1995; McKnight et al., 1998; Rosenberg, 1956; Rotter, 1967; Stack, 1978).

The finding from Section 10.4 and this section support that all predictor models STQ, LOTA and LOTB are valid to predict students' trust in both clear and ambiguous situations. All STQ, LOTA and LOTB shown the students' trust could be predicted by using the set of the students' propensity to trust, students' prior knowledge, and information about trustworthiness of learning activity: integrity, benevolence and competence. This is supported by existing trust models. For example, the model of Mayer et al. (1995) and Rotter (1967) that also suggested propensity to trust and trustworthiness are antecedents to trust. However, our LOT model deployed the learning path as the source of information about the trustworthiness of a learning activity, which is different from other models. For example, Mayer et al. (1995) and Rotter (1967) suggested a person’s character is a source of trustworthiness, and Aqueveque (2005) and Davies & Prince (2005) all suggested reputation as a source of trustworthiness. Kennedy et al. (2008), Rotenberg et al. (2004), Schilke & Cook (2015) all suggested inter-institutional relationships as a source of trustworthiness.

12.5 Evaluation of the LOT models by comparing the prediction performance with the STQ model

Section 11.5 compare R^2 from three regression models: the prediction model from the questionnaire (STQ), the LOT model applying Method A (LOTA) and the LOT model applying Method B (LOTB). The results of Section 11.5 were summarised in Table 10-4 that shows there are no differences in prediction performance between three models.

The comparison between the predictor models	R Square Change	F-ratio	Critical F (0.05)	Decision
STQ vs. LOTB	0.007	0.17	2.43	no different
LOTA vs. STQ	0.179	3.39	2.43	different
LOTB vs. LOTA	0.172	4.09	2.43	different

Table 12-3: Summary of the F-ratio results for comparing the prediction performance between three predictor models: STQ, LOTA, and LOTB

LOTB and STO performed no different but LOTB and STQ performed better than LOTA. The students’ assumption to trust was gathered by using same method (the same collected data) in all models. In contrast, the gathering method of the trustworthiness of a learning activity is the difference in all models. For these reasons, LOTB performed better than LOTA because the result of Method B for calculating the degree of trustworthiness performs better than Method A. At the same time, the performances of LOTB and STQ are no different because Method B tends to calculate the degree of trust as well as the students’ perceived trustworthiness that was collected from the questionnaire. From this analysis, we found that using the trustors’ learning path was better than using the given learning path in order to calculate the degree of trustworthiness. Zucker (1986) suggests trust is based on rules of accountability and cooperation embedded in similarity among entities. This similarity is based on their characteristics or properties. In the predictor model, the students' characteristics and their learning activities' properties were compared via a learning path for calculating trust. Cash et al. (1975) says trust has been measured as the trustors' willingness to reveal their information to a stranger. The strangers take part to understand the trustors' information for trust-building exercises (Scott, 1980). In understanding the students as trustors, the trustor learning path identifies a trustor's information more precisely than a given learning path.

12.6 Investigation of main predictor variables in a Trust Dilemma where the information about trustworthiness was clear

Section 11.3 shows the result of a multiple regression model that was conducted by using the data from STQ. Section 11.4 reports two multiple regression results of the LOT model applying Method A and Method B. Table 12-4 shows a summary of the table of coefficients of all predictor models: STQ, LOTA and LOTB.

As shown in Table 12-4, all significant predictor variables in all models are only in the 'trustworthiness' antecedent. Therefore, the trustworthiness of learning activity is the main antecedent that tends to affect the students' trust in the situation where the information about trustworthiness was clear. This finding is supported by Covey (2004 p. 147), which stated that "Trust, the verb, comes from the potential trustworthiness of the one receiving the trust and the clear trustworthiness of the one giving the trust."
All predictor variables in students' perceived trustworthiness were significant in the STQ model. This supports the finding that perceived trustworthiness is a multifaceted concept (Barber, 1983, Mishra, 1996, and Rempel et al, 1985). The degree of integrity of a learning activity (I_{LOTA}, I_{LOTB}) was a significant predictor variable in both LOTA and LOTB. However, the degree of competence of a learning activity (C_{LOTA}) was also a significantly predictor of students' trust in LOTB. This shown LOTB could gather the information about trust more than LOTA, and for this reason supports the finding that LOTB performs better than LOTA.

Predictor Models		***Predictor Variables***	***Code***	***P***
STQ	Students' assumption to trust	Students' propensity to trust	PT_{STU}	.76
		Students' prior knowledge	KW_{STU}	.29
	Students' perceived trustworthiness	Students' perceived integrity	PI_{STU}	.05*
		Students' perceived benevolence	PB_{STU}	.05*
		Students' perceived competence	PC_{STU}	≤ 0.05*
LOTA	Students' assumption to trust	Students' propensity to trust	PT_{STU}	.12
		Students' prior knowledge	KW_{STU}	.35
	Calculating trustworthiness by Method A	Degree of Integrity of learning activity	I_{LOTA}	.04*
		Degree of benevolence of learning activity	B_{LOTA}	.14
		Degree of competence of learning activity	C_{LOTA}	.77
LOTB	Students' assumption to trust	Students' propensity to trust	PT_{STU}	.70
		Students' prior knowledge	KW_{STU}	.47
	Calculating trustworthiness by Method B	Degree of Integrity of learning activity	I_{LOTB}	.05*
		Degree of benevolence of learning activity	B_{LOTB}	.09
		Degree of competence of learning activity	C_{LOTB}	.04*

*$p \leq 0.05$

Table 12-4: Summary of coefficients of all predictor models: STQ, LOTA, and LOTB

As shown in the results, the trustworthiness of a learning activity is the main antecedent for predicting trust in Trust Dilemmas where trustworthiness was clear. In contrast, the trustworthiness of a learning activity is the main antecedent for predicting trust in Trust Dilemmas where the trustworthiness was clear (Section 10.4). When comparing between two Trust Dilemmas, the main antecedents to predict students' trust are different. This finding was supported by Gill et al. (2005), which stated an individual's propensity to trust correlates with trust when information about trustworthiness was ambiguous, but did not correlate with trust when information about trustworthiness was clear.

12.7 Summary

This chapter discusses an experiment of student's trust when the information about trustworthiness was clear. In this case, the students decide to trust mainly based on the trustworthiness of learning activity. The result of LOT Model applying Method B (LOTB) performed as good as the prediction model from the questionnaire (STQ), but performed better than Method A (LOTB). However, all predictor models – STQ, LOTA and LOTB – correspond with the actual students' trust. Therefore, The LOT model can predict and help us understand the students' trust in a learning activity when trustworthiness is clear. The finding also shows that when trustworthiness is clear, the main antecedent to predict students' trust is the trustworthiness of the learning activity. Thus, the role of trustworthiness in a learning activity is important in the prediction of a student's trust. The role of trustworthiness and how it relates with perceived trustworthiness will be investigated more in the next chapter.

Chapter 13 Experiment Results: Investigation on Students' Perceived Trustworthiness

13.1 Introduction

This chapter reports on the experimental investigation on students' perceived trustworthiness, and the relationship between the students' perceived trustworthiness and the antecedents to trust is investigated.

13.2 Results for relationships among the students' perceived trustworthiness and the antecedents to trust in the trust dilemma where information about trustworthiness was ambiguous

This section reports the results where the information about trustworthiness was ambiguous (Trust Dilemma I). It is separated into two parts: firstly, the result of the canonical correlation analysis between the students' perceived trustworthiness, and antecedents to trust based on the LOT model applied to the given learning path or the given learning path (Method A); secondly, the result of the canonical correlation analysis between the students' perceived trustworthiness, and antecedents to trust based on the LOT model applied to the trustor learning path (Method B).

13.2.1. The canonical correlation analysis between the students' perceived trustworthiness, and antecedents to trust from the LOT model applying the given learning path in the trust dilemma, where information about trustworthiness was ambiguous

There are two sets of variables: the set of predictor variables, which come from antecedents to trust of the LOT model applying the given learning path (Method A), and the set of dependent variables, which come from the student's perceived trustworthiness. Canonical correlation analysis was performed to assess the pattern of relationships between the set of predictor variables and the set of dependent variables. The null hypothesis is that the canonical correlations associated with the canonical functions are all equal to zero, which means that the set of predictor variables of the antecedents to trust is independent from the set of dependent variables of the students' perceived trustworthiness. Wilks's lambda and the chi-square test are used to test the null hypothesis. If the chi-square statistic corresponding to Wilks's lambda is statistically significant we conclude that there is a relationship between the dependent groups and the independent variables.

Test Name	Value	Approx. F	Hypoth. DF	Error DF	p-value of F
Pillai's	0.28	.63	15	93	.844
Hotelling's	0.32	.6	15	83	.868
Wilks's λ	0.74	.61	15	80.5	.856

Table 13-1: Summary of multivariate tests of significance of the canonical correlation between the set of predictor variables of antecedents to trust from the LOT model applying the given learning path, and the set of dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was ambiguous

In Table 13-1, three statistical measures were used to test the significance of the canonical correlations: Wilks's lambda λ = .856, Pillai's Trace = .844 and Hotelling's Trace = .868, all not statistically significant at a confidence level of .05. Therefore, there is no canonical correlation between the two sets: the set of predictor variables of antecedents to trust, and the set of dependent variables of students' perceived trustworthiness.

13.2.2. The canonical correlation analysis between the students' perceived trustworthiness, and antecedents to trust from the LOT model applying the trustor learning path in the trust dilemma, where information about trustworthiness was ambiguous

There are two sets of data: the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path (Method B), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma, where information about trustworthiness was ambiguous. Canonical correlation analysis was performed to assess the pattern of relationships between the set of predictor variables and the set of dependent variables.

Test Name	**Value**	**Approx. F**	**Hypoth. DF**	**Error DF**	**p-value of F**
Pillai's	0.26	.58	15	93	.880
Hotelling's	0.29	.53	15	83	.917
Wilks's λ	0.76	.56	15	80.5	.900

Table 13-2: Summary of multivariate tests of significance of canonical correlation between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path, and the set of dependent variables of students' perceived trustworthiness in the trust dilemma, where information about trustworthiness was ambiguous

In Table 13-2, three statistic measures were used to test the significance of the canonical correlations: Wilks's lambda λ = .900, Pillai's Trace = .880 and Hotelling's Trace = .917, all not statistically significant at a confidence level of .05. Therefore, there is no canonical correlation between the two sets: the set of predictor variables of antecedents to trust, and the set of dependent variables of students' perceived trustworthiness.

13.3 Results for relationships among the antecedents to trust and the students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear

This section reports the results where the information about trustworthiness was clear (Trust Dilemma II). There are separated into two parts. Firstly, the result of the canonical correlation analysis between the set of predictor variables of antecedents to trust from the LOT model applying the expert whole learning path or the given learning path (Method A), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma, where information about trustworthiness was clear. Secondly, the result of canonical correlation analysis between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path (Method B), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear.

13.3.1. The canonical correlation analysis between the students' perceived trustworthiness, and antecedents to trust from the LOT model applying the given learning path in the trust dilemma, where information about trustworthiness was clear

There are two sets of variables: the set of predictor variables of antecedents to trust from the LOT model applying the given learning path (Method A), and the set of dependent variables of students' perceived trustworthiness as shown in Table 13-3.

To investigate the effect of the set of predictor variables on the set of dependent variables, the canonical correlation analysis will find canonical functions of the set of predictor variables on the set of dependent variables that have maximum correlation with each other. The null hypothesis is that the canonical correlations value associated with the canonical functions are all equal to zero, which means that the set of predictor variables is independent from the set of dependent variables.

The canonical functions were constructed for performing canonical correlation analysis between the predictor variables and the dependent variables in Table 13-3. Canonical correlation analysis was performed for calculating the canonical correlation value to assess the pattern of relationships between the predictor variables and the dependent variables.

	Abbreviations	Descriptions
Predictor Variables		
The set of antecedents to trust from LOT model applying Method A in Trust Dilemma II	I_{LOTA}	The trustworthiness property of integrity
	B_{LOTA}	The trustworthiness property of benevolence
	C_{LOTA}	The trustworthiness property of competence
	PT_{STU}	The students' propensity to trust
	KW_{STU}	The students' prior knowledge
Dependent Variables		
The set of student's perceived trustworthiness in Trust Dilemma II	PI_{STU}	the students' perceived integrity
	PB_{STU}	the students' perceived benevolence
	PC_{STU}	the students' perceived competence

Table 13-3: All variables in the canonical correlation analysis between the set of predictor variables of antecedents to trust from LOT model applying the given learning path (Method A) and the set of dependent variables of student's perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

Canonical Functions	Eigenvalue	Percent	Cumulative Percent	Canonical Correlation	Squared Correlation
1	0.64	73.7	73.7	0.62	0.39
2	0.17	2.	93.7	0.38	0.14
3	0.05	6.3	100	0.22	0.05

Canonical Functions	Wilks's	F	Hypothesis DF	Error DF	p-value
1	0.5	2.31	15	119	.006
2	0.81	1.23	8	88	0.29
3	0.95	0.81	3	45	0.49

Canonical Functions	% Variance Dependent Variables	Cumulative % Dependent Variables	% Variance Predictor Variables	Cumulative % Predictor Variables
1	75	75	28.5	28.5
2	15.1	90.2	18.5	47
3	9.79	100	25.3	72.2

Figure 13-1: All Canonical Functions between the set of predictor variables of antecedents to trust from the LOT model applying the given learning path (Method A), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

The three canonical correlation values and the multivariate tests of each of the canonical functions are illustrated in Figure 13-1. This shows that Canonical Function 1 was statistically significant at the .05 level (Wilks's = .50, F(15,119) = 2.31, p = 0.006). Therefore, there was at least one statistically significant relationship between the predictor variables and the dependent variables. The 39% of shared variants between the predictor variables and the dependent variables can be explained by Canonical Function 1. Canonical Function 1 explained 28.5% of variants in the set of predictor variables. At the same time, 75% of variants in the set of dependent variables were explained by Canonical Function 1. The correlations loading are included in Table 13-4, which examination of the loadings suggests only first canonical.

The canonical loading values in Table 13-4 were used to examine the relationship between the antecedent of trust in the LOT model using Method A and the student's perceived trustworthiness. The positive values mean that high degrees of integrity, benevolence, propensity to trust, and prior knowledge are related to high degrees of student's perceived trustworthiness. However, the minus value shows the opposite trend, that high degrees of competence are related to low degrees of student's perceived trustworthiness

	Variables	**Canonical Function 1**
		Canonical Loadings
	Predictor Set	
The set of antecedents to trust from the LOT model applying Method A in Trust Dilemma II	I_{LOTA}	0.76
	B_{LOTA}	0.44
	C_{LOTA}	-0.42
	PT_{STU}	0.25
	KW_{STU}	0.64
	Dependent Set	
The set of students' perceived trustworthiness in Trust Dilemma II	PI_{STU}	0.90
	PB_{STU}	0.98
	PC_{STU}	0.69

Table 13-4: A completed canonical loading between the set of predictor variables of antecedents to trust from the LOT model applying the given learning path (Method A) and the set of dependent variables of student's perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

13.3.2. The canonical correlation analysis between the predictor variables of antecedents to trust of the LOT model applying the trustor learning path, and the dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear

There are two sets of variables: the predictor variables of antecedents to trust of the LOT model applying the trustor learning path (Method B), and the set of dependent variables of students' perceived trustworthiness (Trust Dilemma II), as shown in Table 13-5.

To investigate the effect of the set of predictor variables on the set of dependent variables in Table 13-5, the canonical correlation analysis will find canonical functions of the set of predictor variables on the set of dependent variables that have maximum correlation with each other. The null hypothesis is that the canonical correlation value associated with the canonical functions are all equal to zero, which means that the set of predictor variables is independent from the set of dependent variables.

	Abbreviation	**Description**
Predictor Variables		
The set of antecedents to trust from LOT model applying Method B in Trust Dilemma II	I_{LOTB}	The trustworthiness property in integrity
	B_{LOTB}	The trustworthiness property in benevolence
	C_{LOTB}	The trustworthiness property in competence
	PT_{STU}	The students' propensity to trust
	KW_{STU}	The student's prior knowledge
Dependent Variables		
The set of student's perceived trustworthiness in Trust Dilemma II	PI_{STU}	the student's perceived integrity
	PB_{STU}	the student's perceived benevolence
	PC_{STU}	the student's perceived competence

Table 13-5: All variables in the canonical correlation analysis between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning activity (Method B), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

In Table 13-5, all variables are shown in the canonical correlation analysis between the set of predictor variables of antecedents to trust from the LOT model applying the trustors' learning path (Method B), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma, where information about trustworthiness was clear (Trust Dilemma II).

The canonical functions were constructed for performing canonical correlation analysis between the predictor variables and the dependent variables in Table 13-5. Canonical correlation analysis was performed for calculating the canonical correlation value to assess the pattern of relationships between the predictor variables and the dependent variables.

Canonical Functions	Eigenvalue	Percent	Cumulative Percent	Canonical Correlation	Squared Correlation
1	0.69	66.3	66.3	0.64	0.41
2	0.29	28	94.3	0.47	0.23
3	0.06	5.72	100	0.24	0.06

Canonical Functions	Wilks's	F	Hypothesis DF	Error DF	p-value
1	0.43	2.82	15	119	0.001
2	0.73	1.87	8	88	0.075
3	0.94	0.9	3	45	0.452

Canonical Functions	% Variance Dependent Variables	Cumulative % Dependent Variables	% Variance Predictor Variables	Cumulative % Predictor Variables
1	75.6	75.6	26.2	26.2
2	18.6	94.1	21.1	47.3
3	5.86	100	19.8	67.0

Figure 13-2: All Canonical Functions between the set of predictor variables of antecedents to trust from the LOT model applying the trustors' learning path (Method B), and the set of dependent variables of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

The three canonical correlation value and the multivariate tests of each of the canonical function was illustrated in Figure 13-2. The results in Figure 13-2 show Canonical Function 1 was statistically significant at the .05 level (Wilks's = .0.5, F(15,119) = 2.82, p = 0.001). Therefore, there was at least one statistically significant relationship between the predictor variables and the dependent variables. The 41% of shared variants between the predictor variables and the dependent variables can be explained by Canonical Function 1. Canonical Function 1 explained 26.2% of variants in the set of predictor variables. At the same time, 75.6% of variants in the set of dependent variables were explained by the Canonical Function 1. The correlations loading are included in Table 13-6, which examination of the loadings suggests only first canonical.

	Variable	Function 1
		Canonical Loadings
	Predictor Set	
The set of antecedents to trust from LOT model applying Method B in Trust Dilemma II	I_{LOTB}	0.77
	B_{LOTB}	0.56
	C_{LOTB}	0.05
	PT_{STU}	0.32
	KW_{STU}	0.54
	Dependent Set	
The set of student's perceived trustworthiness in Trust Dilemma II	PI_{STU}	0.92
	PB_{STU}	0.91
	PC_{STU}	0.77

Table 13-6: A completed canonical analysis between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path (Method B), and the set of dependent variables of student's perceived trustworthiness in the trust dilemma where information about trustworthiness was clear (Trust Dilemma II)

13.4 Result for investigating whether the trust dilemma where information about trustworthiness was clear had the higher average of students' trust than where information about trustworthiness was ambiguous

This section reported the results for investigating whether trust dilemma where information about trustworthiness was clear (Trust Dilemma II) had the higher average of students' trust than where information about trustworthiness was ambiguous (Trust Dilemma I). A one-way analysis of covariance (ANCOVA) was conducted to compare the mean students' trust between Trust Dilemma I and Trust Dilemma II, by calculating mean students' trust per group adjusted for all antecedents to trust (PT_{STU}, KW_{STU}, PI_{STU}, PB_{STU}, and PC_{STU}).

Prior to the ANCOVA test, Levene's test for equality of variances was done. Figure 13-3 shows the Levene's test is higher than the conventional 0.05 ($p = .753$) and the variances between Trust Dilemma I and Trust Dilemma II are not different (they are homogeneous). Therefore, the assumptions for ANCOVA are met. The Descriptive Statistics table gave the unadjusted mean students' trust for Trust Dilemma I and Trust Dilemma II.

Descriptive Statistics

Dependent Variable: students' trust

Trust Dilemma	Mean	Std. Deviation	N
Trust Dilemma I	.63	.15	37
Trust Dilemma II	.78	.15	51
Total	.71	.17	88

Levene's Test of Equality of Error Variances[a]

Dependent Variable: students' trust

F	df1	df2	p
.100	1	86	.753

a. Design: Intercept + PT_{STU} + KW_{STU} + PI_{STU} + PB_{STU} + PC_{STU} + Trust Dilemma, Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Tests of Between-Subjects Effects

Dependent Variable: students' trust

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	1	6	.166	9.67	< .001
Intercept	.21	1	.212	12.37	.001
PT_{STU}	.11	1	.117	6.82	.011
KW_{STU}	.11	1	.114	6.65	.012
PI_{STU}	.07	1	.073	4.25	.043
PB_{STU}	.04	1	.039	2.26	.137
PC_{STU}	.06	1	.062	3.64	.060
Trust Dilemma	.27	1	.267	15.56	< .001
Error	1.39	81	.017		
Total	47.2	88			
Corrected Total	2.38	87			

Figure 13-3: Summary of ANCOVA result for comparing the adjusted means of students' trust in trust dilemma where information about trustworthiness was clear and where information about trustworthiness was ambiguous

In tests of the Between-Subjects Effects table, the p-values for the Trust Dilemma factor are less than the conventional 0.05 ($F(1, 81) = 15.56$, $p < .001$). The Trust Dilemma factor has significant effect on the dependent variable (students' trust) when the covariates (PT_{STU}, KW_{STU}, PI_{STU}, PB_{STU}, and PC_{STU}) were equalled. Therefore, there was a difference between Trust Dilemma I and Trust Dilemma II on the students' trust after adjusting for the effect of PT_{STU}, KW_{STU}, PI_{STU}, PB_{STU}, and PC_{STU}. PT_{STU}, KW_{STU}, and PI_{STU} were significant and they had an effect on students' trust, which had been taken out by ANCOVA. On the other hand, PB_{STU} and PC_{STU} were not significant and there was no effect between either PB_{STU} or PC_{STU} on students' trust.

Univariate Tests

Dependent Variable: Students' trust

	Sum of Squares	df	Mean Square	F	p
Contrast	.28	1	.28	15.6	< .001
Error	1.4	81	.02		

The F tests the effect of Trust Dilemma. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Pairwise Comparisons

Dependent Variable: Students' trust

(I) Trust Dilemma	(J) Trust Dilemma	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
1.00	2.00	-.13*	.03	<.001	-.19	-.06
2.00	1.00	.13*	.03	<.001	.06	.19

Estimates

Dependent Variable: Students' trust

Trust Dilemma	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Trust Dilemma I	.64[a]	.02	.60	.69
Trust Dilemma II	.77[a]	.02	.73	.80

a. Covariates appearing in the model are evaluated at the following values: $PT_{STU} = .54$, $KW_{STU} = .58$, $PI_{STU} = .73$, $PB_{STU} = .74$, $PC_{STU} = .76$.

Figure 13-4: Result of simple group main effects

A simple main effect test was conducted with Trust Dilemma I and Trust Dilemma II. Hence the significant value for any one simple main effect required a p-value of .025 (.05/2). Figures 13-4 and 13-5 shown the adjusted mean for students' trust are estimated to be .641 and .766 for Trust Dilemma I and Trust Dilemma II respectively. As indicated in the Univariate Tests table, the corresponding population mean differs, $F(1, 81) = 15.6$, $p < .001$. Given a statistical significant among means then the pairwise difference among Trust Dilemma I and Trust Dilemma II was examined. Therefore, the mean students' trust in Trust Dilemma II was higher than Trust Dilemma I.

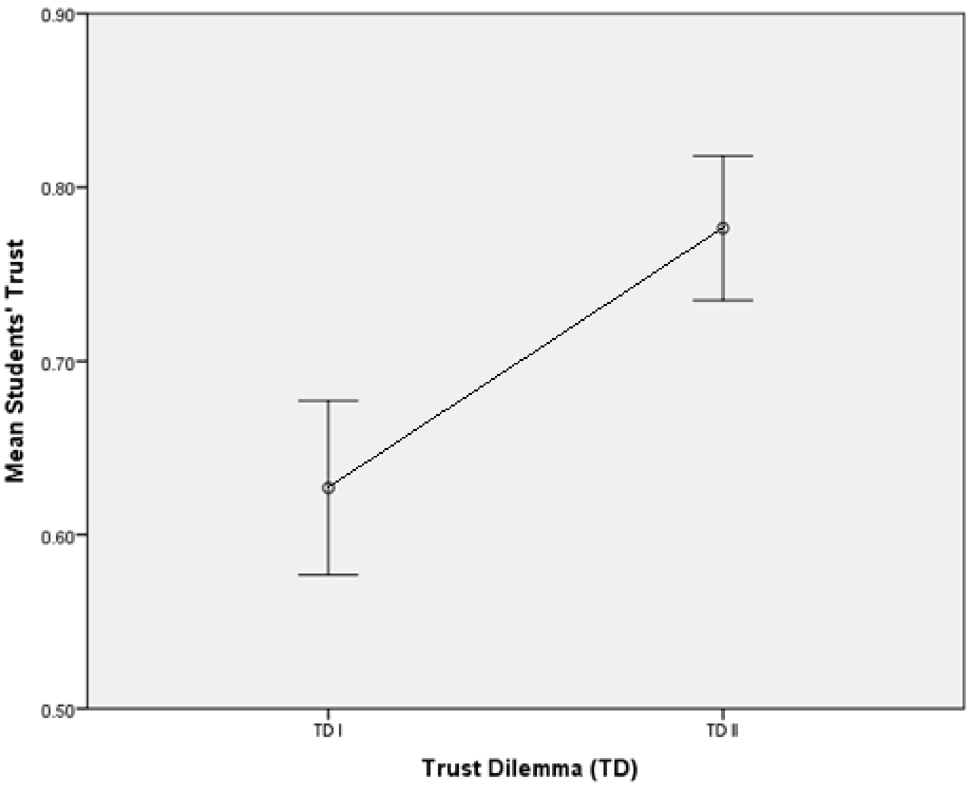


Figure 13-5: Graph for the result of simple group main effects

13.5 Summary

Data Interpretation and Reporting about the relationship between the students' perceived trustworthiness and the antecedents to trust were shown in this Chapter. In the trust dilemma where information about trustworthiness was ambiguous, there is no canonical relationship between the set of predictor variables of antecedents to trust and the set of dependent variables of students' perceived trustworthiness. In contrast, there is a canonical relationship between these two sets where information about trustworthiness was clear.

Chapter 14 Discussion on Students' Perceived Trustworthiness

14.1 Introduction

This chapter discusses the results on student's perceived trustworthiness in a trust dilemma where the information about trustworthiness was ambiguous (Trust Dilemma I) and where the information about trustworthiness was clear (Trust Dilemma II), related back to the literature and theories presented in this research.

14.2 Relationship between the antecedents to trust and the students' perceived trustworthiness, where information about trustworthiness was ambiguous

In Section 13.2, there were two canonical correlation analysis results. First, Table 13-1 shows the multivariate tests of significance of canonical correlation between the set of predictor variables of antecedents to trust from the LOT model applying the expert whole learning path (Method A), and the set of dependent variables of students' perceived trustworthiness. Second, Table 13-2 shown the multivariate tests of significance of the canonical correlation between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path (Method B), and the set of dependent variables of students' perceived trustworthiness.

Wilks's lambda is used to test the significance of a canonical correlation. Wilks's lambda varies from 0 to 1 and represents the variance not explained by the predictor variables. Thus, it is interpreted in an opposite way to the R-square. A lambda of 1 means that the predictor variables are not explaining any of the variance in the dependent variables. Lambdas of 0 show that predictor variables are explaining all of the variance. The smaller the lambda, the greater the variance explained. The null hypothesis is that there is no significant prediction of the dependent variate available from the predictor variate. In the other words, the null hypothesis states that the set of canonical functions are predicting no better than chance. Given that alpha level equals to 0.05, if the p-value of F value is less than alpha, the null hypothesis is rejected. If not, the null hypothesis is accepted. In Table 13-1, the Wilks's λ of 0.74 had no significant value (p-value of F = 0.86); thus, the null hypothesis was accepted; in Table 13-2, the Wilks's λ of 0.76 had no significant value (p-value = 0.9); thus, the null hypothesis was accepted.

Therefore, in the trust dilemma where information about trustworthiness was ambiguous, the set of predictor variables of antecedents to trust from the LOT model tended to not predict the set of dependent variables of the students' perceived trustworthiness. This experiment, the trust dilemma where trustworthiness was ambiguous, was constructed by referring to the learning situation that had not shown the learning path to the student. For these reasons, in the learning situation where the learning path was not shown, the students' perception of trustworthiness tended to not influence the students' decision to trust in the learning activity, due to the fact that there was not enough information for the students perceive. Thus, they will be unable to decide with a reasonable degree of trustworthiness whether the learning activity has performed reliably. This supports Zeithaml (1981), who shows that with services that have not enough valid information or a lack of information about customers' expectation criteria, making a customer evaluation is difficult and uncertain. The ambiguous phrasing has led to misinterpretations concerning the actual trust level (Miller, 2003).

In this experiment, all learning activity was provided and trusted by experts. In this case, if a student cannot perceive the trustworthiness of the provided learning activity, the student tended to rely on their propensity to trust. The trusting behaviour of the student who relies on propensity to trust may be risky, because diversity in propensity to trust is risky. For example, Peterson (2014) stated that "Diversity in group members' propensity to trust, or individual differences among group members in their tendency to trust others, is sufficient to trigger a downward trust spiral in groups."

14.3 Relationship between the antecedents to trust, and the students' perceived trustworthiness, where information about trustworthiness was clear

Section 13.3, there were two canonical correlation analysis results. Firstly, Figure 13-1 shows all canonical functions between the set of predictor variables of antecedents to trust from the LOT model applying the expert whole learning path (LOT applying Method A), and the set of dependent variables of students' perceived trustworthiness. Secondly, Figure 13-2 shows all canonical functions between the set of predictor variables of antecedents to trust from the LOT model applying the trustor learning path (LOT applying Method B), and the set of dependent variables of students' perceived trustworthiness. The Wilks's lambda for both canonical correlation analysis was significant, indicating that the set antecedents to trust from the LOT model applying Method A and Method B can reliably predict the set of student's perceived trustworthiness in the trust dilemma where information about trustworthiness was clear.

As shown in Figure 13-1 and Figure 13-2, there are three canonical functions that were determined in both canonical correlation analyses, for the reason that the number of canonical functions possible is equal to the smaller of the number of variables in each set. Only the first canonical function in each Table was interpreted because they were significant. For this reason, the principle is that variables in each canonical variate that contribute heavily to shared variances for these significant canonical functions are considered to be related to each other. The first canonical correlation value is 0.62 with an explained variance of the correlation of 73.7% and an eigenvalue of 0.64. Thus, there are positively correlated between the set antecedents to trust from the LOT model and the set of students' perceived trustworthiness in the trust dilemma where information about trustworthiness was clear. This means students, who were in the Trust Dilemma where trustworthiness was clear, tended to have perceived the trustworthiness of the learning activity. Hence, the finding was supported by the discussion in Section 12.5 that shows that where trustworthiness is clear (Trust Dilemma II), the trustworthiness of the learning activity tends to affect the students' trust.

Compare the learning situation in Trust Dilemma I and Trust Dilemma II. In Trust Dilemma I, the learning path was not shown to them before their deciding to trust. In contrast with Trust Dilemma II, the learning path was shown to them before the students decided to trust. The results show that only students in Trust Dilemma II perceived the trustworthiness of the learning activity. Therefore, the learning path tended to be the satisfactory source of trustworthiness for the learning activity. According to Smith (1998), the trustor would expect to observe the behaviour or properties of the entity before desiring to trust (Mayer et al., 1995; Rousseau et al., 1998). In the other words the students, who are in the learning situation where the learning path is shown, desired to trust by observing the learning path and desiring to rely on the information of trustworthiness of the learning activity, based on the learning path. Hence, the learning path tended to influence the students' trust in the learning activity. Subsequently from the discussion in Section 12.2, the LOT models, which deployed the learning path as a source, can predict students' trust. Thus, the learning path could be the source for calculating the degree of trustworthiness of a learning activity.

14.4 Investigation of the relationship between the antecedents to trust, and the students' perceived trustworthiness

According Table 13-4 and Table 13-6, there are five facts of analysis:

(1) No predictor variables of the antecedent to trust of the LOT model applying Method B negatively correlated with the set of dependent variables of the student's perceived trustworthiness. In contrast, the C_{LOTA} of the antecedent to trust of the LOT model applying Method A negatively correlated with the set of dependent variables of the student's perceived trustworthiness. Thus, this was enough evidence to support that Method B, which applies the trustor learning path for calculating the degree of trustworthiness, tends to predict the degree of trustworthiness better than Method A, which applyies the expert whole learning path. According Lewicki and Bunker (1995), trust is context-specific, and should be examined based on specific contextual and situational parameters. Hence, Method B can predict better than Method A because Method B applies the trustor learning path which has more specific context than Method A. However, even though this study shows that using the trustor learning path was better than using the expert whole learning path, the trustor learning path may not be better if it is not related to the expert whole learning path. According to Deutsch (1962), "a trusting behaviour occurs when an individual is confronted with an ambiguous path, a path that can lead to an event perceived to be beneficial or to an event perceived to be harmful."

(2) The integrity of the learning activity and the students' prior knowledge tend to mainly associate positively with the students' perception of trustworthiness. It means that

the students tended to perceive more trustworthiness, if they understood how the learning activity connected their prior knowledge with their intended learning outcome.

(3) The students' propensity to trust tended to associate slightly positively with the students' perception of trustworthiness. It means that if the student were in the Trusting Dilemma where information about trustworthiness was clear, the integrity of the learning activity had influence more than the students' propensity to trust.

(4) The benevolence of the learning activity tends to associate moderately positively with the students' perception of trustworthiness. It means that the students tended to perceived more trustworthiness if they knew how they could apply the learning activity with their prior knowledge. This supports Portz et al. (2012) that shows when participants have prior knowledge of WebTrust they perceive a web site with WebTrust to be more trustworthy than a web site without.

(5) There was inclined to be no association between the competence of the learning activity and the students' perceived trustworthiness. This means that the competence of the learning activity tended not to influence the students' perceived trustworthiness, even if the learning activity was related to their intended learning outcome.

14.5 Given the learning path as information about trustworthiness of the learning activity, and whether the learning path influenced the students' perceived trustworthiness

The main difference between the trust dilemmas where the information about trustworthiness was ambiguous (Trust Dilemma I) and where the information about trustworthiness was clear (Trust Dilemma II) is in the showing of the learning path. The learning path was not shown in Trust Dilemma I but the learning path was shown in Trust Dilemma II. According to Section 13.4, there was enough evidence that the average of students' trust in Trust Dilemma II was higher than in Trust Dilemma I. In addition, the previous discussion supports that the trustworthiness properties of the learning activity had influenced the students' trust when the learning path was shown. These reasons support that the learning path can give enough information about trustworthiness of a learning activity. Studies have demonstrated that, in the situations that show a learning path, learning activities are perceived to be more trustworthy than those that show no learning path. According to previous studies, the influence of the perception of trustworthiness gives the impression of an ability to lead individuals to collaborate with and support a trustworthy entity, such as voting for a trustworthy politician (Sigal et al., 1988) or collaborating with a trustworthy negotiator (Schurr and Ozanne ,1985).

14.6 Summary

This chapter discusses more about perceived trustworthiness. There is a relationship between the antecedents to trust and the students' perceived trustworthiness. Method A and Method B are the methods for calculating the degree of trustworthiness in a learning activity. Method A uses the expert whole path, while Method B uses the trustor learning path to calculate the degree of trustworthiness. Method B performed better than Method A because it used a more specific context of source.

Chapter 15 Conclusion and Future Works

This chapter concludes the report that reflects the research objectives and research questions, and shows the significance of this research in understanding trust in E-learning.

15.1 Conclusions

According to Section 5.3.2, the integrity of a learning activity was measured by the strongest relationship between the learning path ILOs and the learning activity. The benevolence of a learning activity was measured by the relationship between students' prior knowledge and the learning activity. The competence of a learning activity was measured by the relationship between students' desired ILO and the activity. This thesis offers a number of conclusions.

First, when the learning path was shown in the learning situation, the students' ability to perceive the trustworthiness of the learning activity (integrity, competence, and benevolence) was increased. The implication is that instructors who want to increase students' trust in learning activities need to show learning paths in their courses.

Second, when the learning path was shown in the learning situation, the more the integrity and benevolence of learning activity, the more the students' perceived the trustworthiness of the learning activity. The implication is that instructors who want to create trustworthy learning activities need to ensure they have the strongest relationship with the learning path ILOs and the strongest relationship with students' prior knowledge.

Third, when the learning path was not shown in the learning situation, the effect of students’ propensity to trust and students’ prior knowledge was increased on students’ trust. The implication is that, where a learning path is not available for some reason, the instructor should take extra care to develop the students’ prior knowledge. Similarly, when the learning situation is ambiguous or does not have a learning path, then the instructor should also develop the students’ prior knowledge.

Fourth, when the student chose their own personal learning path, trust was better predicted through increased benevolence, integrity and also competence. The implication is that students should be able to choose their own learning paths because this is expected to increase the relevance of the learning activity, the learning path ILOs, their prior knowledge and their desired learning outcomes.

15.2 Limitations

The trust dilemmas and the knowledge domains in these experiments were not as broad as the real world and so generalisation is limited. In addition, the number of ILO nodes in the learning paths was limited in scale.

The experiments used students with prior knowledge of the given knowledge domains. The LOT model probably needs further development to accommodate students who have no prior knowledge.

The research did not investigate the students’ motivation to achieve the desired learning outcomes. According to Jaasma & Koper (1999), there is a relationship between students’ trust and students’ motivation, so students’ motivation for achieving the desired learning outcome could mediate the influence of trust in the learning activities.

15.3 Future Work

The LOT model may have application in recommendation systems. It could predict trustworthy learning activities based on their antecedents to trust. A recommendation system based on the LOT model could rate or review various learning paths, and recommend the most trustworthy to a student. The potential future work would involve answering questions such as, how does the system get the various learning path? How do students tell the system about their antecedents?

The LOT model may have application in intelligent tutoring systems. Such systems aim to provide immediate and customized instruction or feedback to students (Joseph at el, 1988). The LOT model would examine whether the system is directing the students along trustworthy learning paths or along untrustworthy learning paths.

Both applications may need to categorise the quality of trust that the students place in their learning paths. Future work would be to develop an explanation of the quality of students' trust. Quality is multi-dimensional and different definitions are appropriate based on different situations (Viswanadhan, 2006). The quality of trust may be categorised under the different trust dilemmas shown in Table 15-1.

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Trustworthiness of present learning activity</th></tr>
<tr><th>High
(LA is relevant to learning path)</th><th>Low
(LA is not relevant to learning path)</th></tr>
<tr><td rowspan="2">Learning path (has high/low trustworthiness or high/low potential to achieve the desired learning outcome (dLO)</td><td>Positive (high trustworthiness, high potential to achieve the dLO)</td><td>Bonding trust</td><td>Hopeful trust</td></tr>
<tr><td>Negative (low trustworthiness, low potential to achieve the dLO)</td><td>Unstable trust</td><td>Distrust</td></tr>
</table>

Table 15-1: Quality of students' trust in an E-learning path

Table 15-1 shows four trust dilemmas that give four possible qualities of trust in an E-learning path.

1) 'Bonding trust' indicates that the student has bonding expectations for both the highly trustworthy learning activity and the learning path. The students who place this type of trust are in the right direction to achieving the desired learning outcome. This type of trust is most useful for the students.

2) 'Unstable trust' indicates that the student has a high expectation of the trustworthiness of the learning activity, but has low trust in the learning path. This means the students may go in the wrong direction in the future, even though the learning activity

that they are selecting is high in trustworthiness. This type of trust is not useful for the students.

3) ‘Hopeful trust’ indicates that the student has a low expectation of the trustworthiness of the learning activity, but has high trust in the learning path. This means the student is now on the right learning path but they are selecting the wrong learning activity, which may lead them to further wrong learning paths in the future. This type of trust is not useful for the students.

4) ‘Distrust’ indicates that the student has low expectations of the trustworthiness of both the learning activity and the learning path. This means the student are now in the wrong learning path, and they are also selecting the wrong learning activity. This type of trust is not useful for the students.

Future research will need to deal with a limitation in such situations where we are not sure how the model applies when students have low prior knowledge or particularly high prior knowledge. Future work will need to check and develop the model for this.

Appendix A USE CASES

A.1 Introduction

The purpose of this appendix is to define the Use Case for LOT Model application. The LOT Model applications are a program for applying LOT model to predict the degrees of student's trust and collect the actual students' trust for validating LOT model. The LOT model was applied into two applications: (1) LOT model applying the expert whole learning part, and (2) Calculating the degree of trust by using LOT model applying the student (trustor)'s learning part. Each application was tested in two trust dilemmas: Trust Dilemma I and Trust Dilemma II as shown in Table A-1.

Name of Trust Dilemma	**Trust Dilemma I**	**Trust Dilemma II**
Description of Trust Dilemma	The learning situation that a student has to decide to trust in a learning activity where information about trustworthiness was ambiguous	The learning situation that a student has to decide to trust in a learning activity where information about trustworthiness was clear
Knowledge Domain	Entity Relationship Diagram	Basic First Aids in Burns
Showing Learning part to student	No	Yes
Testing LOT model applying the expert whole learning path. (LOT applying Method A)	Yes	Yes
Testing LOT model applying the student's learning path (LOT applying Method B)	Yes	Yes

Table A-1. Details of Trust Dilemmas for testing LOT model applications

A.2 Used-Case Diagram

Two used-case diagrams were designed: (1) used-case diagram of LOT model applying the expert whole learning path (LOTA) as shown in Figure A-1, and (2) used-case diagram of LOT model applying student's learning part (LOTB), as shown in Figure A-2. The difference between two used-case diagrams is that students are able to choose their own learning path in the LOTB. This student's learning part is used to calculate a degree of trustworthiness in LOTB. Actors in both applications are the participants who were asked to play as a student role.

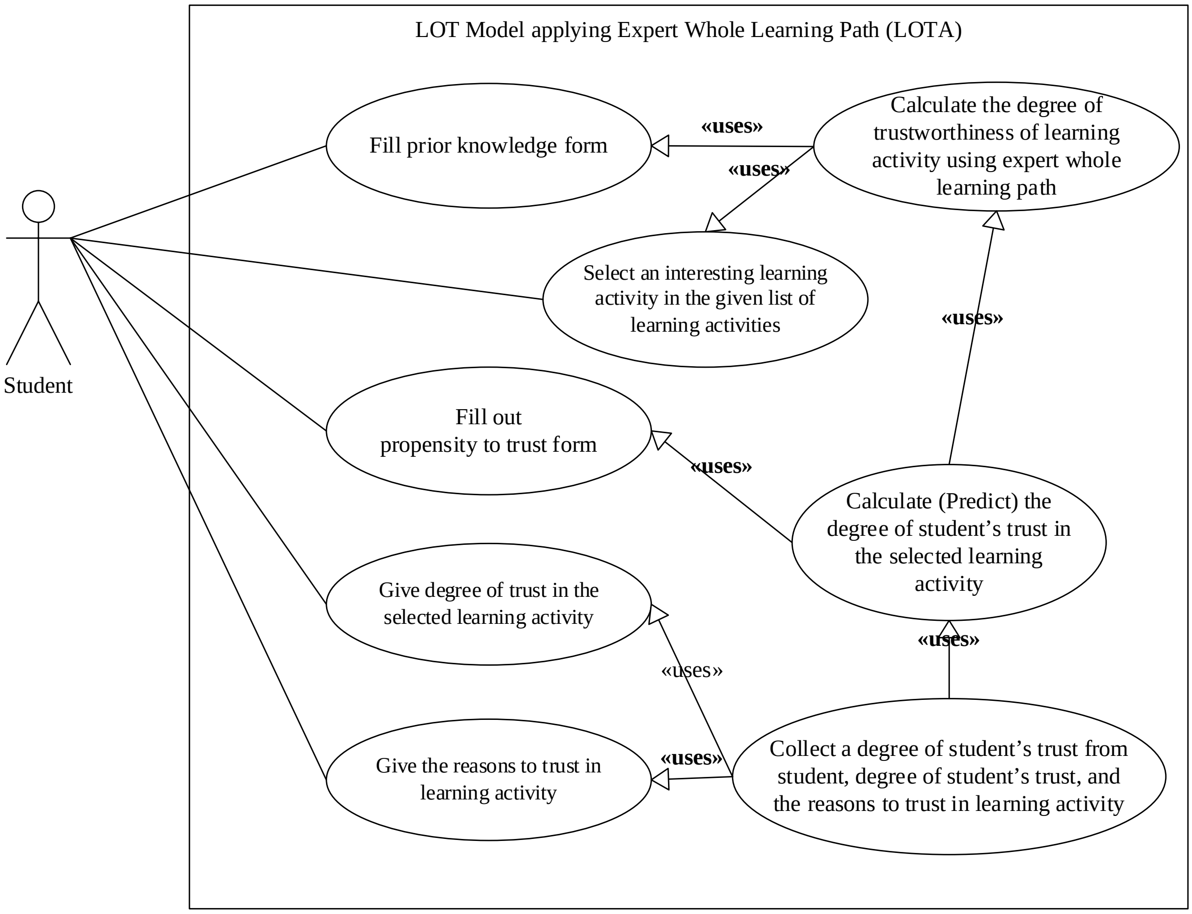


Figure A-1 Used-Case Diagram of
LOT model applying the expert whole learning path (LOTA)

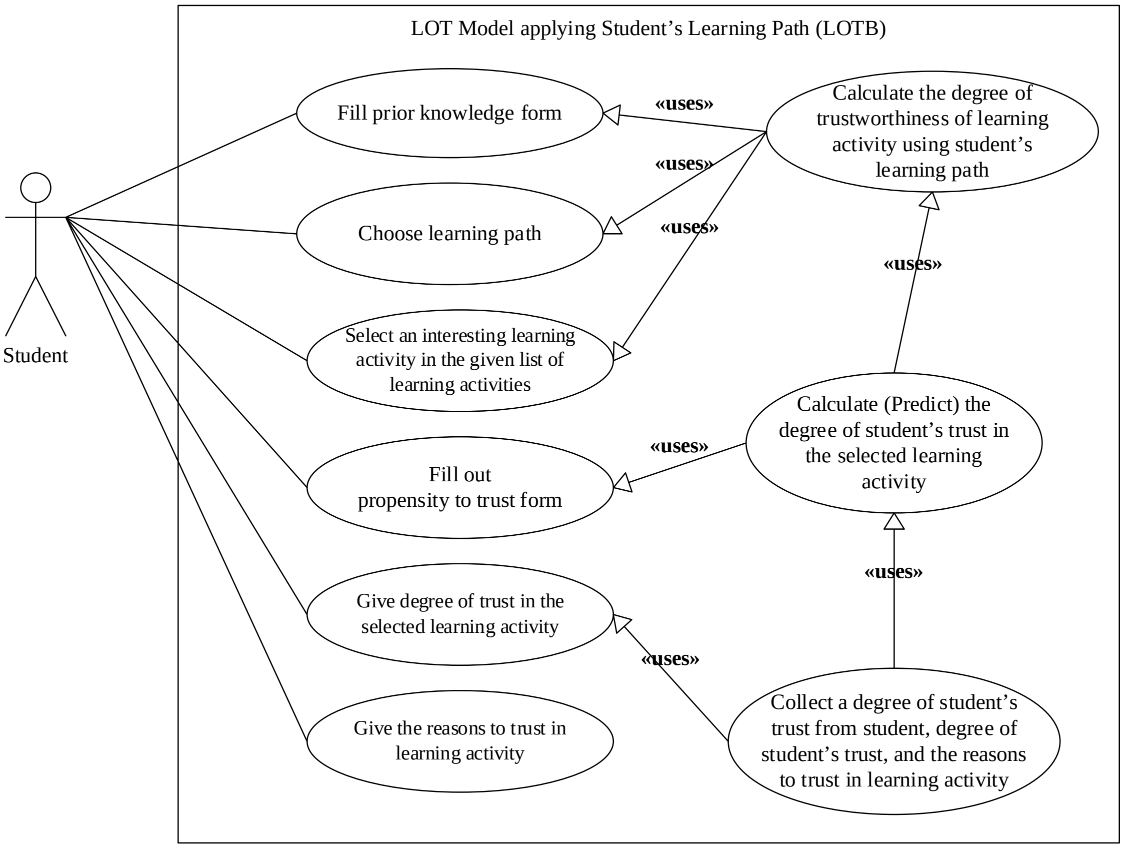


Figure A-2 Used-Case Diagram of

LOT model applying the student's learning path (LOTB)

Use Case	**Use Case ID**	**Trust Dilemma I**	**Trust Dilemma II**
Fill out prior knowledge form	UC-01	√	√
Fill out propensity to trust form	UC-02	√	√
Choose learning path	UC-03	-	√
Select an interesting learning activity in the given list of learning activities	UC-04	√	√
Give degree of trust in the selected learning activity	UC-05	√	√
Give the reasons to trust in learning activity	UC-06	√	√
Calculate the degree of trustworthiness of learning activity using expert whole learning path	UC-07	√	-
Calculate the degree of trustworthiness of learning activity using student's learning path	UC-08	-	√
Calculate (Predict) the degree of student's trust in the selected learning activity	UC-09	√	√
Collect a degree of student's Trust from student and Degree of student's Trust from Model in database	UC-10	√	√

Table A-2. List of Use Cases

UC-01: Fill out prior knowledge form

The participants were asked to act as a student to fill the prior knowledge form. Figure A-3 shows the interface to fill the prior knowledge form in LOTA. Figure A-4 shows the interface to fill the prior knowledge form in LOTBB.

Flows of Events are following:

1. The Use Case starts when the user signs the consent form, reads the instructions, and learns scenario.
2. The applications will display the screen as shown in Figure A-3 or Figure A-4.
3. The student fills out the prior knowledge form.
4. The student in LOT A will do the UC-02, UC-04, and UC-05. The student in LOT B will do the UC-02, UC-03, UC-04, and UC-05
5. The user selects submit.

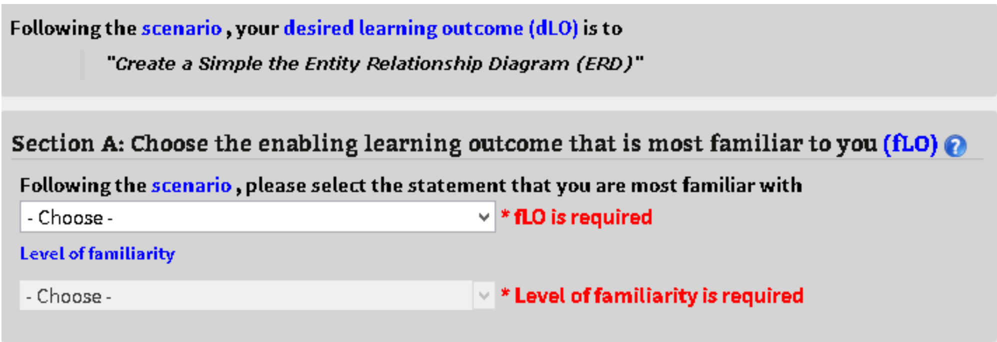


Figure A-3: The interface to fill the prior knowledge form in LOTA

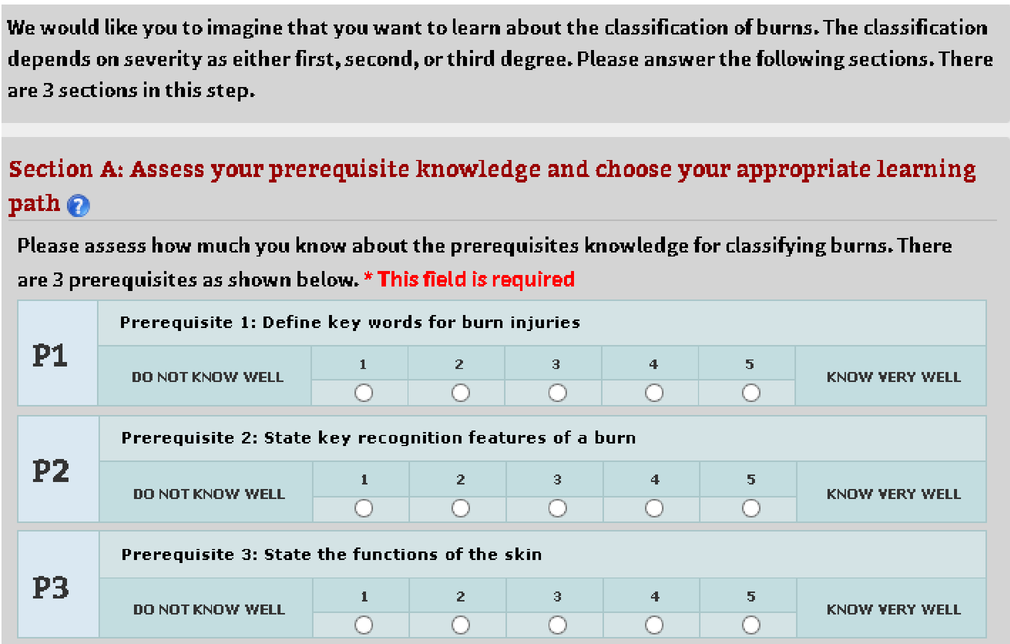


Figure A-4: The interface to fill the prior knowledge form in LOTB

UC-02: Fill out propensity to trust form

The participants were asked to act as a student to fill the propensity to trust form. Figure A-5 shows the interface to fill the propensity to trust form in both LOTA and LOTB.

Flows of Events are following:

1. The Use Case starts when the user signs the consent form, reads the instructions, and learns scenario.
2. The applications will display the screen as shown in Figure A-5.
3. The student fills the prior knowledge form.
4. The student in LOT A will do the UC-04, and UC-05. The student in LOT B will do the UC-03, UC-04, and UC-05
5. The user selects submit.

Figure A-5: The interface to fill the propensity to trust form in both LOTA and LOTB.

UC-03: Choose learning path

This use case will only occur in the LOT B. The participants were asked to act as a student to choose the most familiar learning path. Figure A-6 shows the interface to choose the familiar learning path in LOTB.

Flows of Events are following:

1. The Use Case starts when the user fills out prior knowledge form
2. The applications will display the screen as shown in Figure A-6.
3. The student in LOT B chooses the familiar learning path.
4. The student in LOT B will do the UC-04, and UC-05
5. The user selects submit.

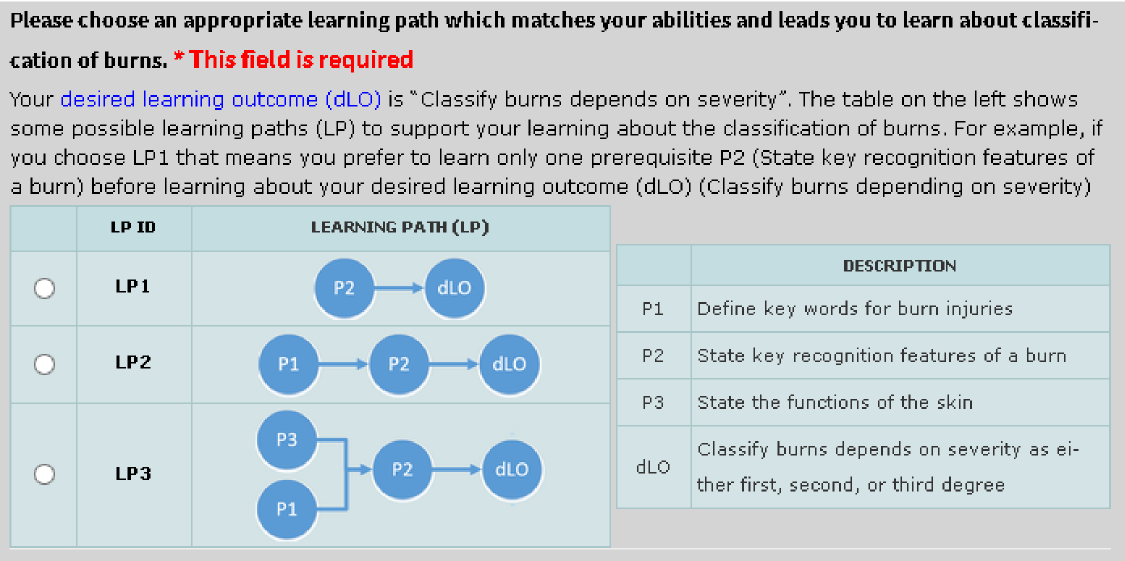


Figure A-6: The interface to choose learning path in LOTB

UC-04: Select an interesting learning activity in the given list of learning activities

The participants were asked to act as a student to an interesting learning activity in the given list of learning activities. Figure A-7 shows the interface to this use case in LOTA. Figure A-8 shows the interface to this use case in LOTB.

Flows of Events are following:

1. The Use Case in LOTA starts when the user completed UC-01 and UC02. The Use Case in LOTB starts when the user completed UC-01, UC02 and UC03.
2. The applications will display the screen as shown in Figure A-7 (for LOTA) and Figure A-8 (for LOTB).
3. The student selects an interesting learning activity in the given list of learning activities.
4. The student in LOT A and LOTB will do the UC-05.
5. The user selects submit.

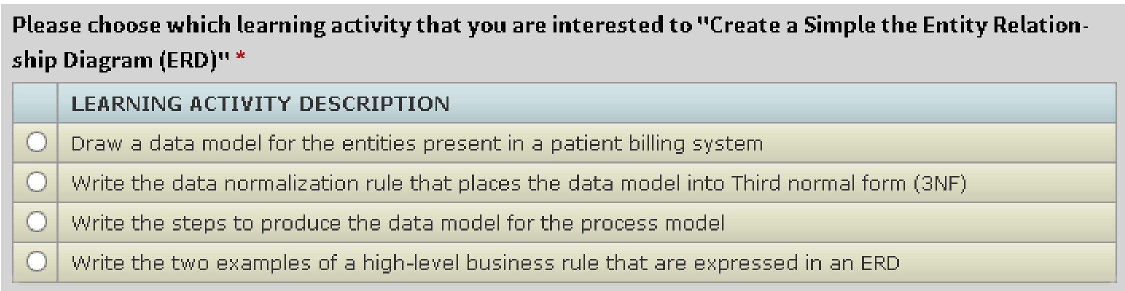


Figure A-7: The selecting an interesting learning activity in LOTA

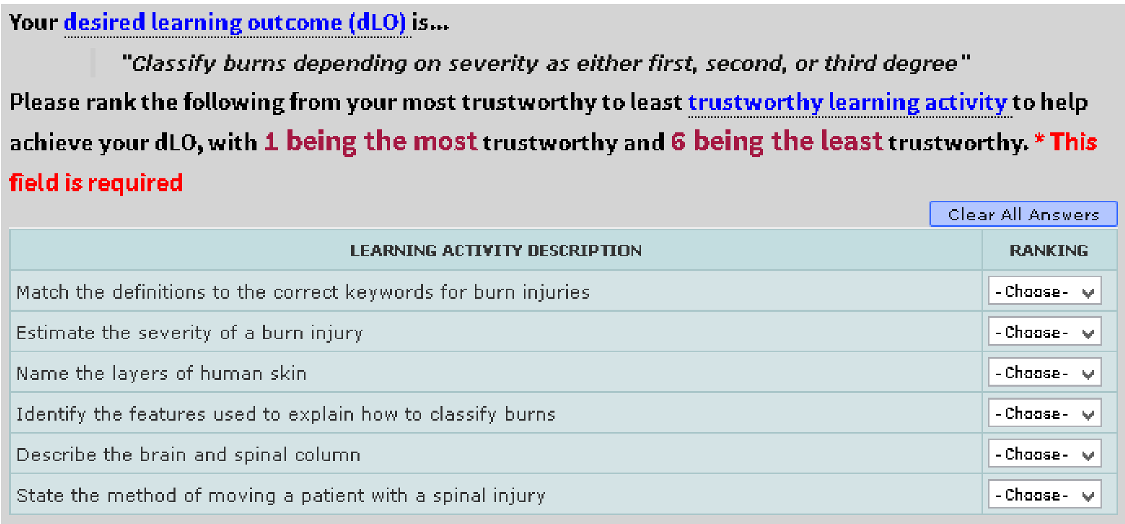


Figure A-8: The interface to select an interesting learning activity in LOTB

UC-05: Give degree of trust in the selected learning activity

The participants were asked to act as a student to give degree of trust in the learning activity that the student selected in UC-04. Figure A-9 shows the interface to this use case in LOTA. Figure A-10 shows the interface to this use case in LOTB.

Flows of Events are following:

1. The Use Case starts when the user selects an interesting learning activity.
2. The applications will display the screen as shown in Figure A-9 (for LOTA) and Figure A-10 (for LOTB).
3. The student gives degree of trust in the learning activity that the student selected in UC-04
4. The user selects submit.

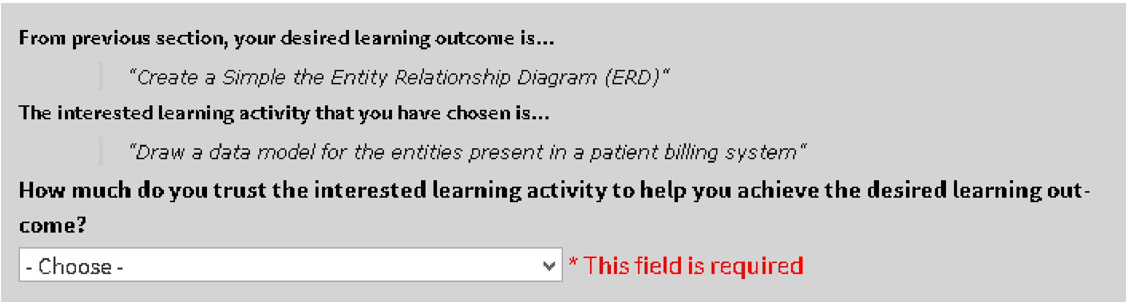


Figure A-9: The interface to give degree of trust in the learning activity in LOTA

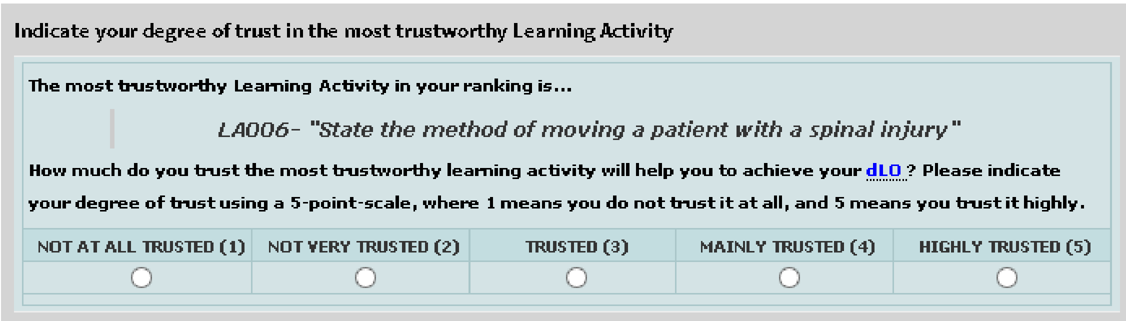


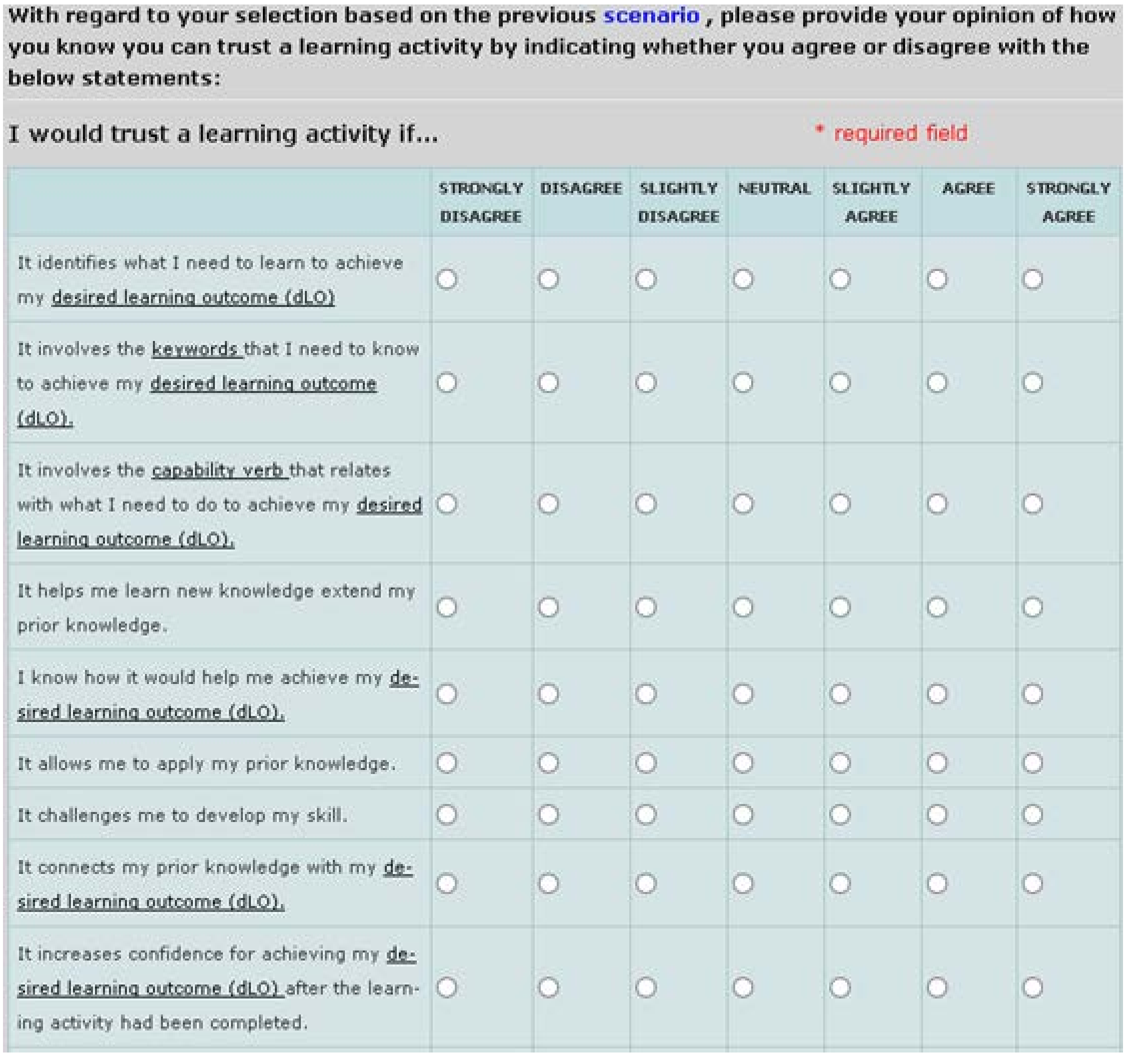
Figure A-10: The interface to give degree of trust in the learning activity in LOTB

UC-06: Give the reasons to trust in learning activity

The participants were asked to act as a student to give the reasons to trust in learning activity that the student selected in UC-04. Figure A-11 shows the interface to this use case in both LOTA and LOTB.

Flows of Events are following:

1. The Use Case starts when the user gives degree of trust in the selected learning activity
2. The applications will display the screen as shown in Figure A-11 for LOTA and LOTB.
3. The student gives the reasons to trust in learning activity that the student selected in UC-04
4. The user selects submit.



With regard to your selection based on the previous scenario , please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the below statements:

I would trust a learning activity if... * required field

	STRONGLY DISAGREE	DISAGREE	SLIGHTLY DISAGREE	NEUTRAL	SLIGHTLY AGREE	AGREE	STRONGLY AGREE
It identifies what I need to learn to achieve my desired learning outcome (dLO)	○	○	○	○	○	○	○
It involves the keywords that I need to know to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It involves the capability verb that relates with what I need to do to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It helps me learn new knowledge extend my prior knowledge.	○	○	○	○	○	○	○
I know how it would help me achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It allows me to apply my prior knowledge.	○	○	○	○	○	○	○
It challenges me to develop my skill.	○	○	○	○	○	○	○
It connects my prior knowledge with my desired learning outcome (dLO).	○	○	○	○	○	○	○
It increases confidence for achieving my desired learning outcome (dLO) after the learning activity had been completed.	○	○	○	○	○	○	○

Figure A-11: The interface to give degree of trust in the learning activity in LOTB

UC-07: Calculate the degree of trustworthiness of learning activity using expert whole learning path

For the Use Case occurs in LOTA, the program will retrieve the data from UC-01 to calculate the degree of trustworthiness of the selected learning activity using expert whole learning path. The selected learning activity comes from UC-04.

UC-08: Calculate the degree of trustworthiness of learning activity using student's learning path

For the Use Case occurs in LOTB, the program will retrieve the data from UC-01 and UC-03 to calculate the degree of trustworthiness of the learning activity using student's learning path. The selected learning activity comes from UC-04. The student's learning path comes from UC-03

UC-09: Calculate (Predict) the degree of student's trust in the selected learning activity

For the Use Case occurs in LOTA, the program will retrieve the data from UC-02 and UC-06 to calculate (predict) the degree of student's trust in the selected learning activity. For the Use Case occurs in LOTB, the program will retrieve the data from UC-02 and UC-07 to calculate (predict) the degree of student's trust in the selected learning activity.

UC-10: Collect a degree of student's Trust from student and Degree of student's Trust from Model in database

For the Use Case occurs in both LOTA and LOTB, the program will collect a degree of student's trust from student, degree of student's trust from LOT model, and their related data in database.

Appendix B Pilot of the LOT model application

THANK YOU for participating in this experiment

Please evaluate your experience and help us improve our experiment to you by completing this short survey.

There are 3 sections that will take you less than 5 minutes to complete.

* This field is required

Questions about LOT tool

SECTION 1 BACKGROUND INFORMATION

Q1 How good at the drawing ERD are you?*

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very good

SECTION 2 OVERALL OPINIONS ABOUT THE LOT TOOL

Instructions

There are 3 steps for using the LOT tool

1. Choose information from the scenario.
2. Choose the learning activity that you have.
3. Indicate your agreement with the outcome of the LOT tool

Q2 How well did you understand the instructions?*

	1	2	3	4	5	
Not very well	○	○	○	○	○	Very well

Scenario

Please assume you are a 1st year student in Software Engineering at the University of Gryffindor. You need to draw an Entity Relationship Diagram (ERD) for your homework. You do not have knowledge about ERDs. You know a little bit about data modeling. You have to figure out how to draw an ERD your-self.

You have your own idea about an appropriate learning activity. However, you are not sure how much you can trust your own idea. You will use the LOT tool to help you.

Q3 How well did you understand the scenario?*

	1	2	3	4	5	
Very poorly	○	○	○	○	○	Very well

Q4 How realistic was the scenario?*

	1	2	3	4	5	
Unrealistic	○	○	○	○	○	Realistic

Q5 How easy was it for you to create an image of the scenario in your mind?*

	1	2	3	4	5	
Very difficult	○	○	○	○	○	Very easy

The desired learning outcome (dLO) is a learning outcome describes what you want to learn or achieve

Q6 How well did you understand the meaning of the desired learning outcome (dLO)?*

	1	2	3	4	5	
Very poorly	○	○	○	○	○	Very well

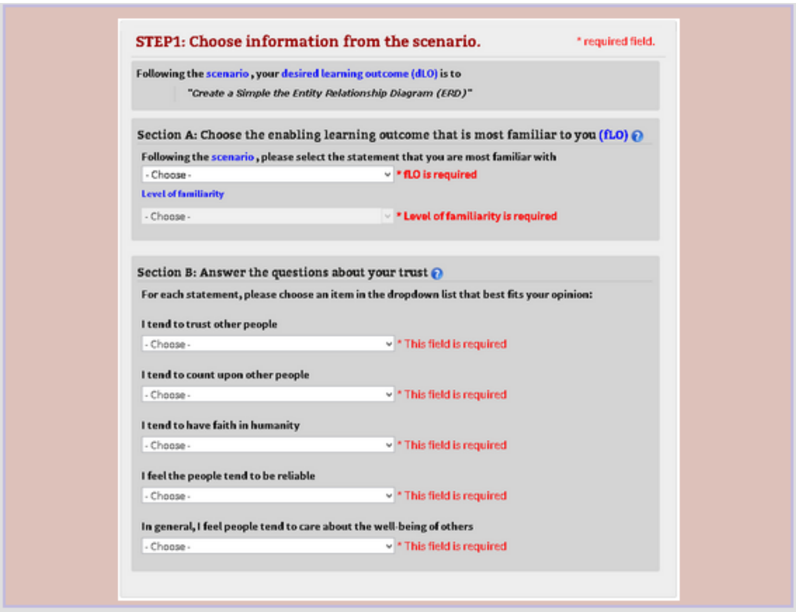
Q7 What is the desired learning outcome (dLO) of the student in the scenario?

The most familiar learning outcome (fLO) is the learning outcome that you know about it because you have learnt about it or experienced it before

Q8 How well did you understand the meaning of the familiar learning outcome (fLO)?*

	1	2	3	4	5	
Very poorly	○	○	○	○	○	Very well

Q9 What is the familiar learning outcome (fLO) of the student in the scenario?



STEP1: Choose information from the scenario. * required field.

Following the scenario, your desired learning outcome (dLO) is to
"Create a Simple the Entity Relationship Diagram (ERD)"

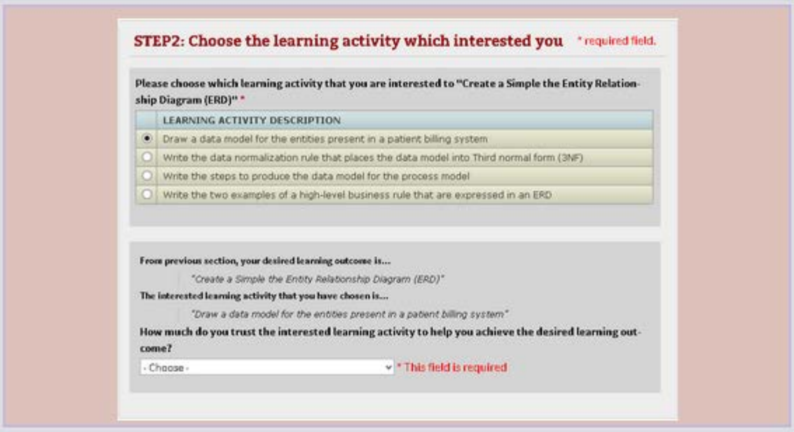
Section A: Choose the enabling learning outcome that is most familiar to you (fLO)
Following the scenario, please select the statement that you are most familiar with
- Choose - * fLO is required
Level of familiarity
- Choose - * Level of familiarity is required

Section B: Answer the questions about your trust
For each statement, please choose an item in the dropdown list that best fits your opinion:
I tend to trust other people
- Choose - * This field is required
I tend to count upon other people
- Choose - * This field is required
I tend to have faith in humanity
- Choose - * This field is required
I feel the people tend to be reliable
- Choose - * This field is required
In general, I feel people tend to care about the well-being of others
- Choose - * This field is required

Q10 How well did you understand the instructions when you were taking step 1?*

Very poorly 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Very well

Q11 How can it be improved?



STEP2: Choose the learning activity which interested you * required field.

Please choose which learning activity that you are interested to "Create a Simple the Entity Relationship Diagram (ERD)" *

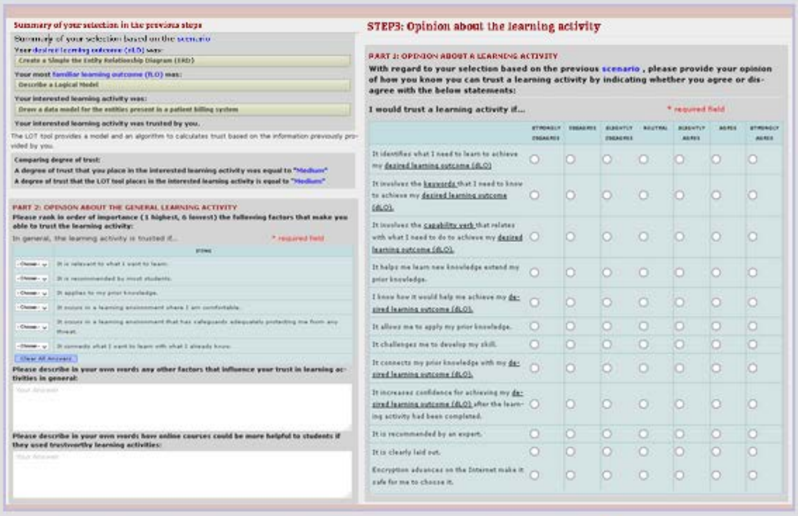
	LEARNING ACTIVITY DESCRIPTION
◉	Draw a data model for the entities present in a patient billing system
○	Write the data normalization rule that places the data model into Third normal form (3NF)
○	Write the steps to produce the data model for the process model
○	Write the two examples of a high-level business rule that are expressed in an ERD

From previous section, your desired learning outcome is...
"Create a Simple the Entity Relationship Diagram (ERD)"
The interested learning activity that you have chosen is...
"Draw a data model for the entities present in a patient billing system"
How much do you trust the interested learning activity to help you achieve the desired learning outcome?
- Choose - * This field is required

Q12 How well did you understand the instructions when you were taking step 2?*

Very poorly 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Very well

Q13 How can it be improved?



Q14 How well did you understand the instructions when you were taking step 3?*

	1	2	3	4	5	
Very poorly	○	○	○	○	○	Very well

Q15 How can it be improved?

SECTION 3 THE LOT VALUE

Q16 Please indicate your opinions about using the LOT tool. Choose the answer that most closely matches your IMMEDIATE OPINION about each attribute. Do not spend long time thinking about each attribute.*

		Very	Fairly	Neither	Fairly	Very	
Appearance of the LOT tool	Boring	○	○	○	○	○	Interesting
The stresses of using the LOT tool	Boring	○	○	○	○	○	Interesting
The sophistication of the LOT tool	Unsophisticated	○	○	○	○	○	Sophisticated
The LOT tool is demonstrated its proficiency in calculating trust degree in learning activity	Incompetent	○	○	○	○	○	Competent
The using of LOT tool gave you such pleasure	Sad	○	○	○	○	○	Happy
I have every confidence in the tool	Unconfident	○	○	○	○	○	Confident
I would find the LOT tool easy to use	Difficult to use	○	○	○	○	○	Easy to use
I would recommend the LOT tool to others	Definitely No	○	○	○	○	○	Definitely Yes

Appendix C Participants Information and Complete questionnaire

C.1 Participants Information & Complete questionnaire for Experiment 1

Welcome to the Learning Outcome-based Trust (LOT) tool

Thank you for visiting the LOT tool. Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to give consent in the LOT tool.

About the Study

Researcher:

Woraluck Wongse-ek

What is the research about?

The purpose of this study is to validate the Learning Outcome-based Trust (LOT) model. The LOT aims to help students assess the trustworthiness of the learning activity so they may select the suitable one.

Why have I been chosen?

You have been chosen to participate in this research because you are a postgraduate student or an academic staff in the computer science and you already know about an Entity Relationship model.

What will happen to me if I take part?

This study will take no longer than approximately 30 minutes. You will be asked to read the instructions for using the LOT tool. You will be asked to filled out a questionnaire to comment on the LOT tool output. There will be three sections in the questionnaire. Section 1 will ask about the scenario. Section 2 will ask you to choose a learning activity. Section 3 will ask you about the output of the LOT tool.

Are there any benefits in my taking part?

By taking part, you have the opportunity to help us develop the new method to assess the trustworthiness of the learning activities in e-learning.

Are there any risks involved?

There is no riskes involved for participants completing the study.

Will my participation be confidential?

Participation will be anonymous.

What happens if I change my mind?

You may withdraw at any time by exiting the webpage.

What happens if something goes wrong?

If you have any concern or complaint with this study please contact me.
Email: wwe1g09@ecs.soton.ac.uk

Where can I get more information?

If you have any further questions please contact me.
Email: wwe1g09@ecs.soton.ac.uk

Figure C-1: Participant information for Experiment 1, part1

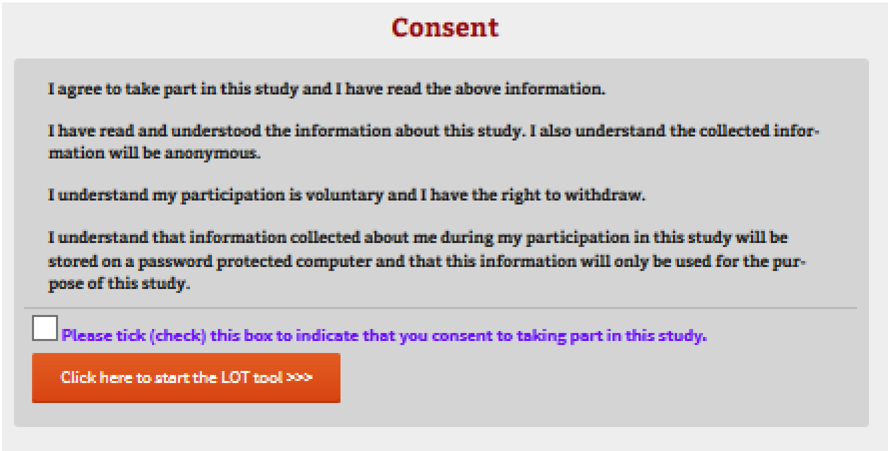


Figure C-2: Participant information for Experiment 1, part2

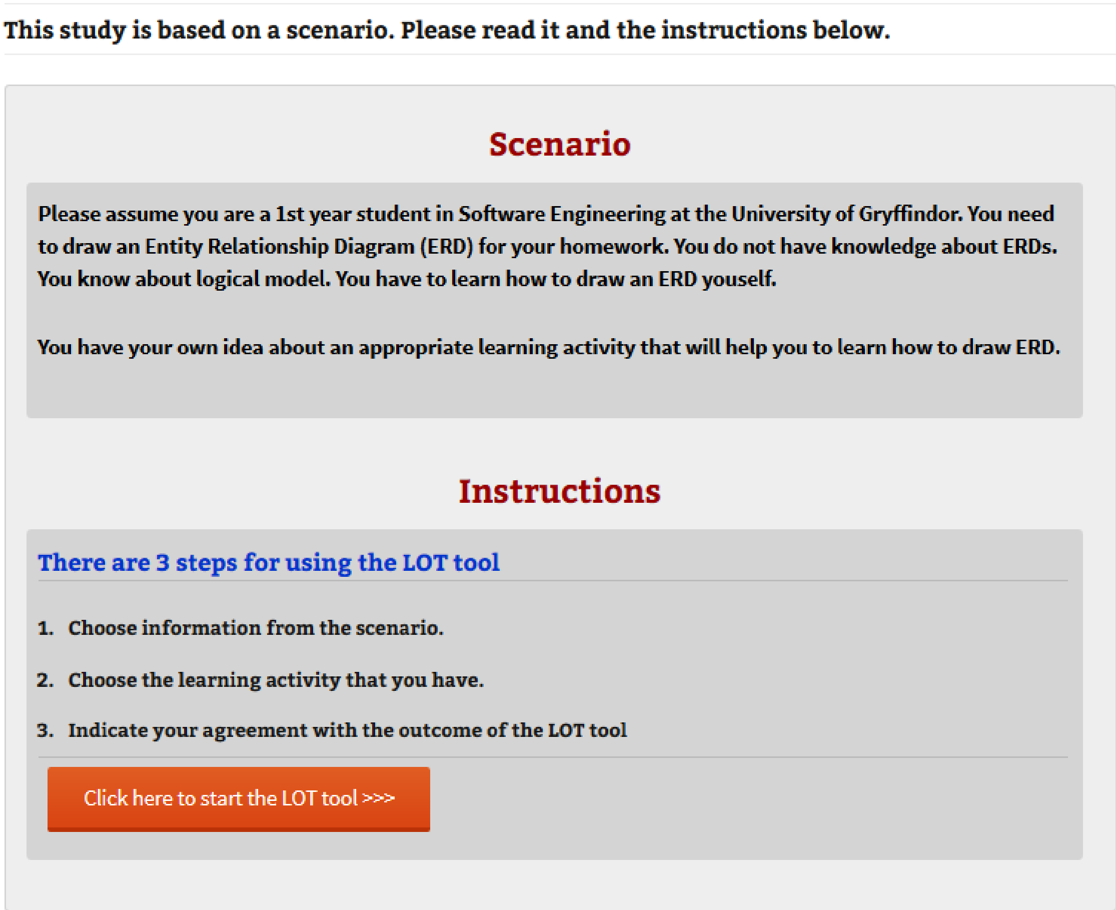


Figure C-3: Participant information for Experiment 1, part3

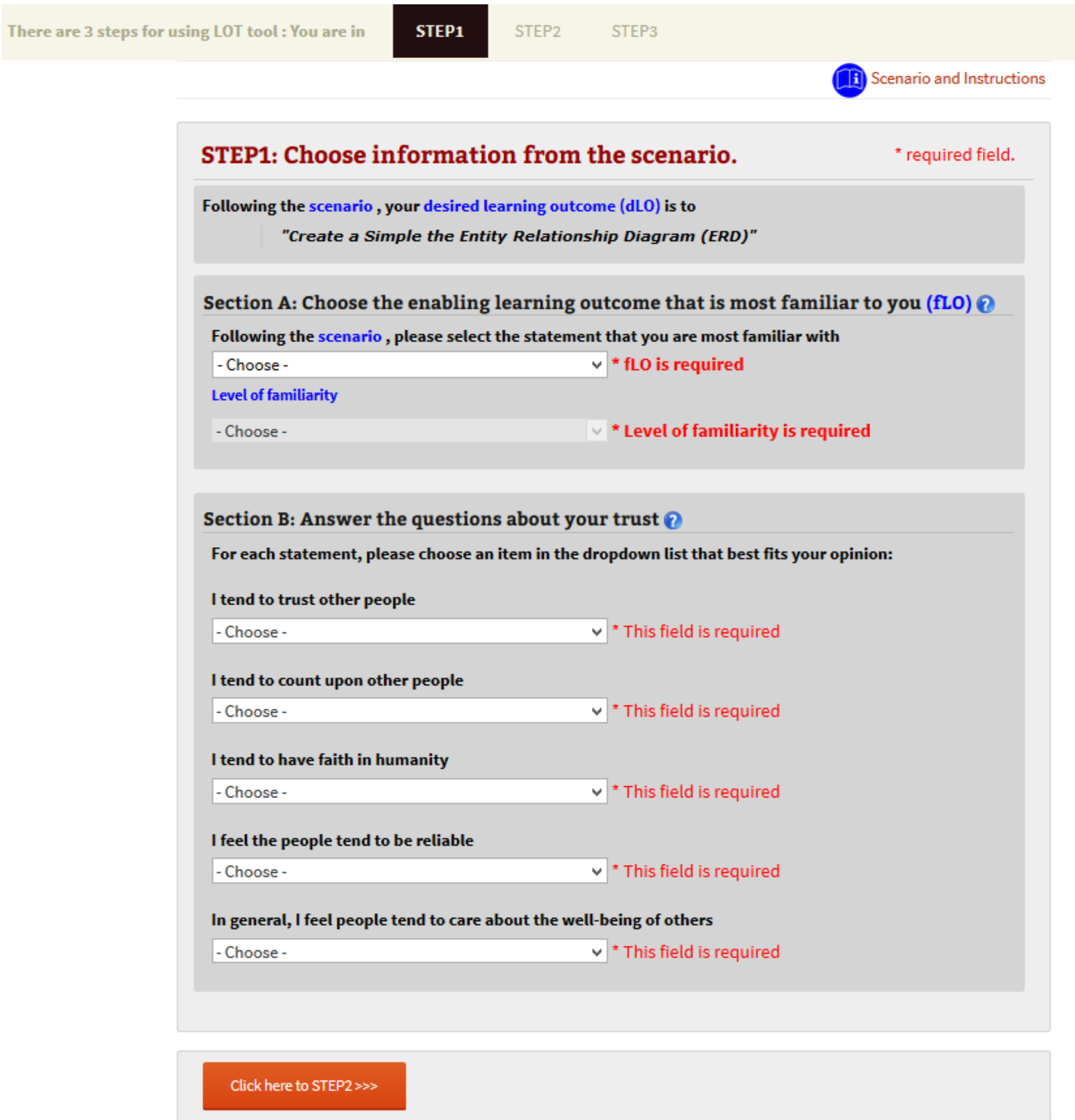


Figure C-4: The questionnaire for Experiment 1, part1. The question to gain a level of participant's knowledge about drawing E-R Diagrams and the questions to gain a level of participant's propensity to trust.

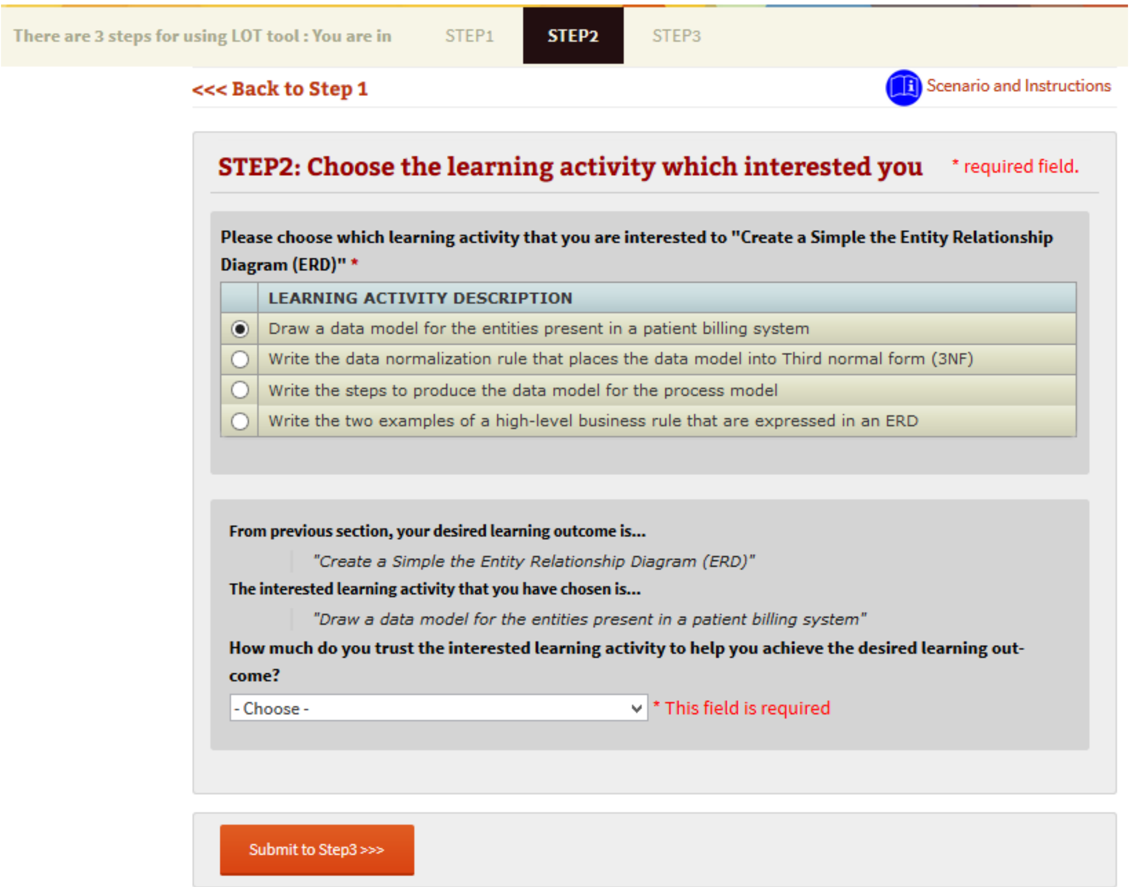


Figure C-5: The questionnaire for Experiment 1, part2, the questions to select the learning activity and gain a degree of participant's trust in the learning activity.

STEP3: Opinion about the learning activity

PART 1: OPINION ABOUT A LEARNING ACTIVITY

With regard to your selection based on the previous scenario , please provide your opinion of how you know you can trust a learning activity by indicating whether you agree or disagree with the below statements:

I would trust a learning activity if... * required field

	STRONGLY DISAGREE	DISAGREE	SLIGHTLY DISAGREE	NEUTRAL	SLIGHTLY AGREE	AGREE	STRONGLY AGREE
It identifies what I need to learn to achieve my desired learning outcome (dLO)	○	○	○	○	○	○	○
It involves the keywords that I need to know to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It involves the capability verb that relates with what I need to do to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It helps me learn new knowledge extend my prior knowledge.	○	○	○	○	○	○	○
I know how it would help me achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It allows me to apply my prior knowledge.	○	○	○	○	○	○	○
It challenges me to develop my skill.	○	○	○	○	○	○	○
It connects my prior knowledge with my desired learning outcome (dLO).	○	○	○	○	○	○	○
It increases confidence for achieving my desired learning outcome (dLO) after the learning activity had been completed.	○	○	○	○	○	○	○
It is recommended by an expert.	○	○	○	○	○	○	○
It is clearly laid out.	○	○	○	○	○	○	○
Encryption advances on the Internet make it safe for me to choose it.	○	○	○	○	○	○	○

Figure C-6: The questionnaire for Experiment 1, part3. The questions to gain the reasons that influenced the participants' trust.

C.2 Participants Information & Complete questionnaire for Experiment 2

Welcome to the Learning Outcome-based Trust (LOT) questionnaire

Thank you for visiting the LOT questionnaire. Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to give consent in the LOT questionnaire.

About the Study

Researcher:

Woraluck Wongse-ek

What is the research about?

The purpose of this study is to validate the Learning Outcome-based Trust (LOT) model. The LOT aims to help students assess the trustworthiness of the learning activity so they may select the most suitable one.

Why have I been chosen?

You have been chosen to participate in this research because of you have knowledge about basic first aid in burns.

What will happen to me if I take part?

This study will take no longer than approximately 15-20 minutes. You will be asked to fill out a LOT model questionnaire. There will be three sections in the questionnaire. Section 1 will ask you to rank the learning activities in order of their trustworthiness. Section 2 will ask you about reasons why you trust the learning activity. Section 3 answers the questions about your trust.

Are there any benefits in my taking part?

By taking part, you have the opportunity to help us develop a new method to assess the trustworthiness of the learning activities in e-learning.

Are there any risks involved?

There are no risks involved for participants completing the study.

Will my participation be confidential?

Participation will be anonymous.

What happens if I change my mind?

You may withdraw at any time by exiting the webpage.

What happens if something goes wrong?

If you have any concerns or complaints with this study please contact me.
Email: wwe1g09@ecs.soton.ac.uk

Where can I get more information?

If you have any further questions please contact me.
Email: wwe1g09@ecs.soton.ac.uk

Figure C-7: Participant information for Experiment 2, part1

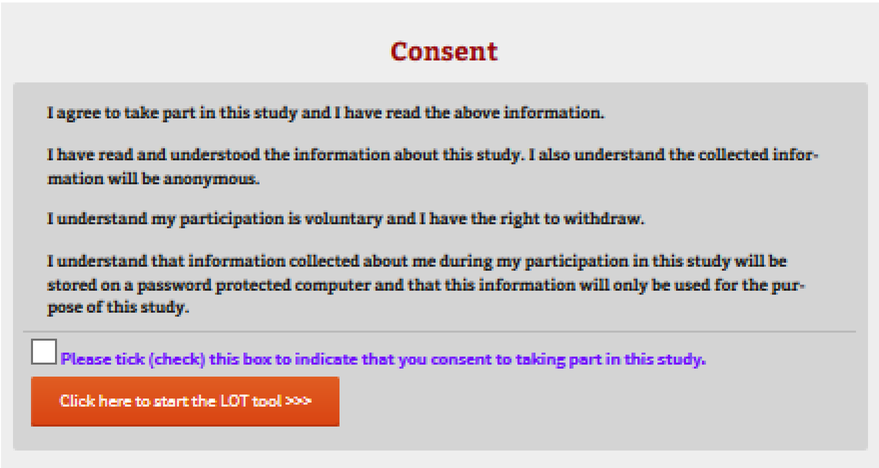


Figure C-8: Participant information for Experiment 2, part2

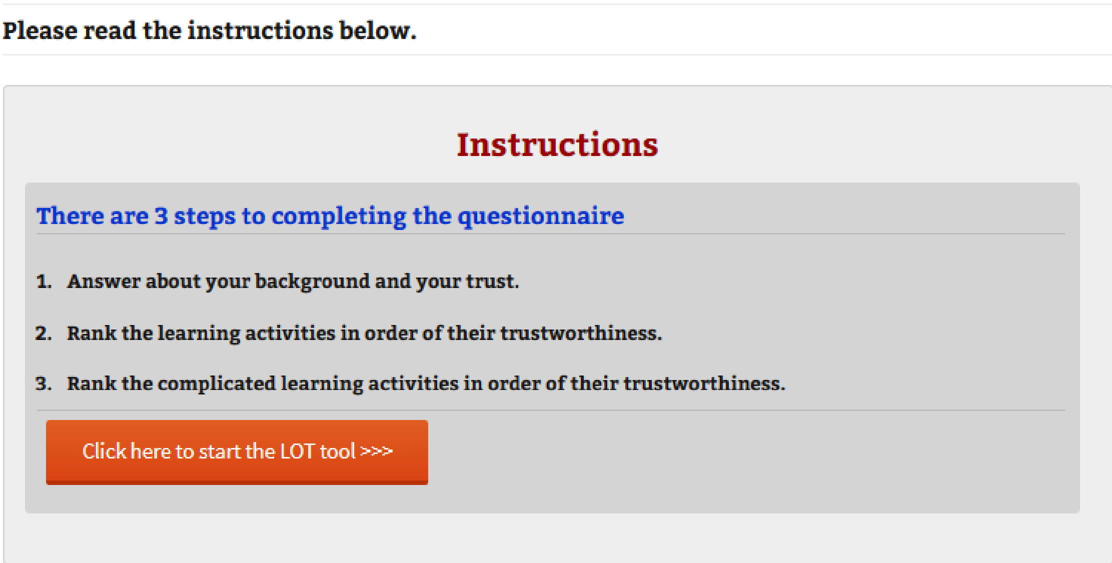
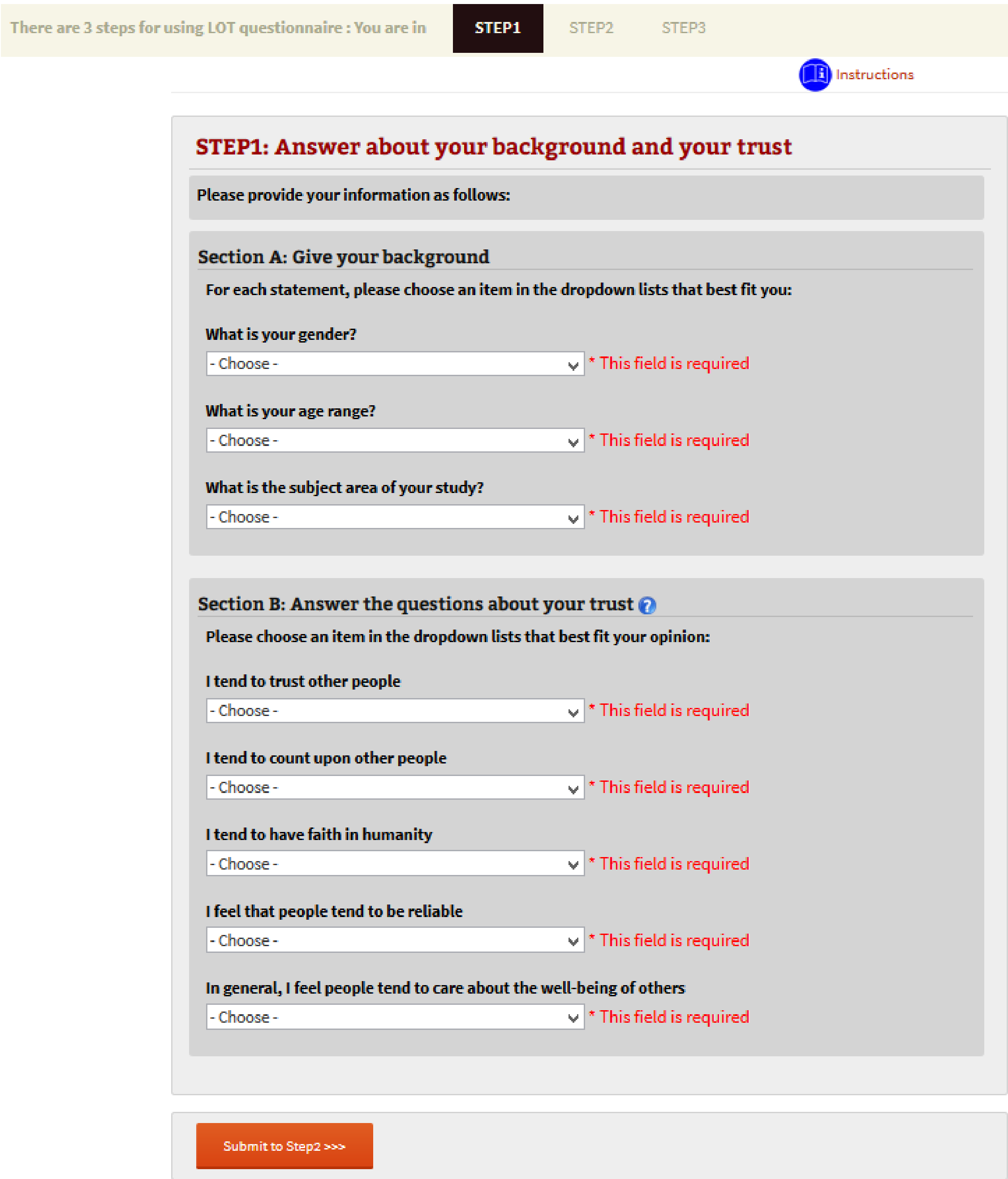


Figure C-9: Participant information for Experiment 2, part3


There are 3 steps for using LOT questionnaire : You are in STEP1 STEP2 STEP3

Instructions

STEP1: Answer about your background and your trust

Please provide your information as follows:

Section A: Give your background

For each statement, please choose an item in the dropdown lists that best fit you:

What is your gender?

- Choose - * This field is required

What is your age range?

- Choose - * This field is required

What is the subject area of your study?

- Choose - * This field is required

Section B: Answer the questions about your trust

Please choose an item in the dropdown lists that best fit your opinion:

I tend to trust other people

- Choose - * This field is required

I tend to count upon other people

- Choose - * This field is required

I tend to have faith in humanity

- Choose - * This field is required

I feel that people tend to be reliable

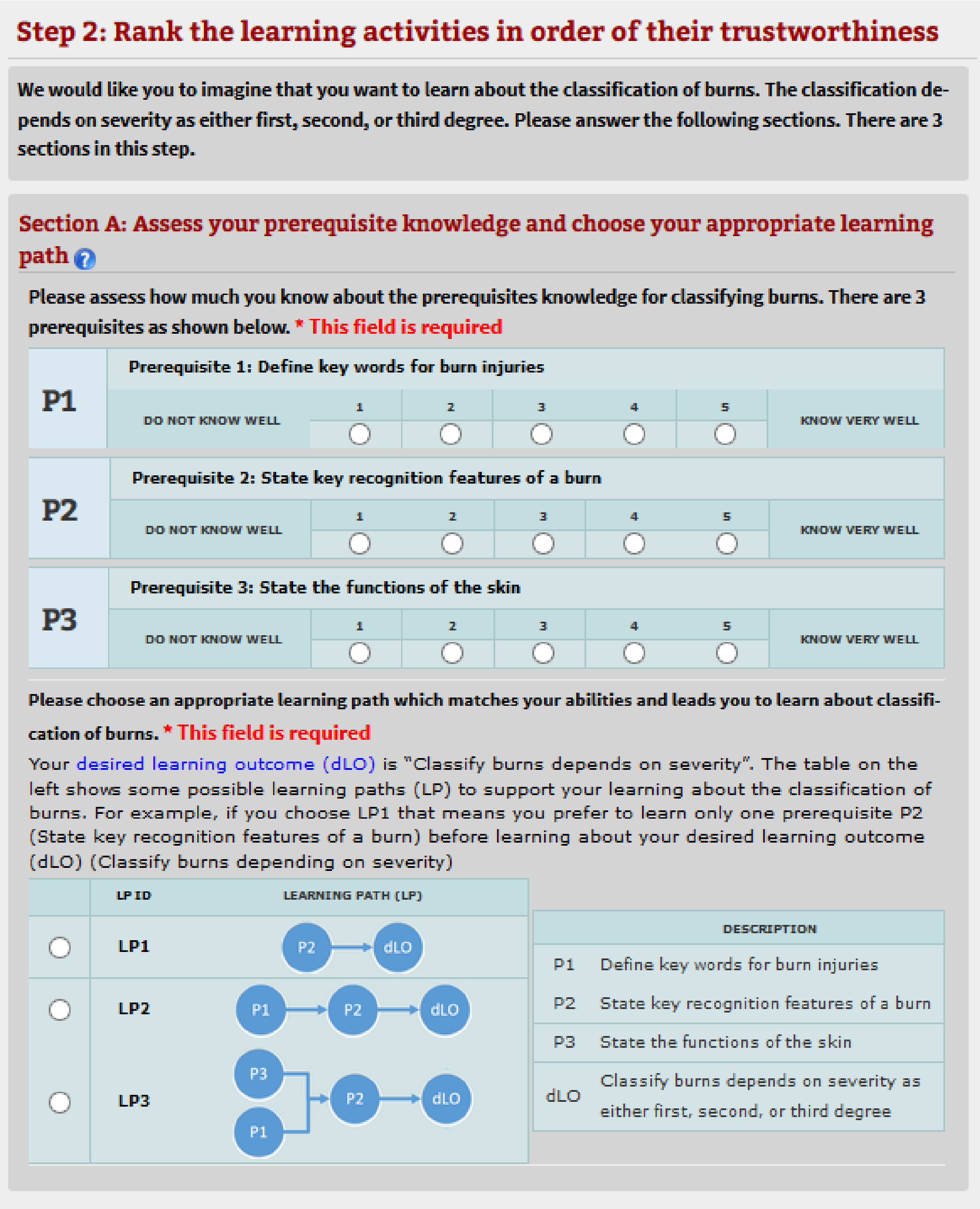
- Choose - * This field is required

In general, I feel people tend to care about the well-being of others

- Choose - * This field is required

Submit to Step2 >>>

Figure C-10: The questionnaire for Experiment 2, part. The questions to gain some participant's background and the questions to gain a level of participant's propensity to trust.



Step 2: Rank the learning activities in order of their trustworthiness

We would like you to imagine that you want to learn about the classification of burns. The classification depends on severity as either first, second, or third degree. Please answer the following sections. There are 3 sections in this step.

Section A: Assess your prerequisite knowledge and choose your appropriate learning path ?

Please assess how much you know about the prerequisites knowledge for classifying burns. There are 3 prerequisites as shown below. * This field is required

	Prerequisite		1	2	3	4	5	
P1	Prerequisite 1: Define key words for burn injuries	DO NOT KNOW WELL	○	○	○	○	○	KNOW VERY WELL
P2	Prerequisite 2: State key recognition features of a burn	DO NOT KNOW WELL	○	○	○	○	○	KNOW VERY WELL
P3	Prerequisite 3: State the functions of the skin	DO NOT KNOW WELL	○	○	○	○	○	KNOW VERY WELL

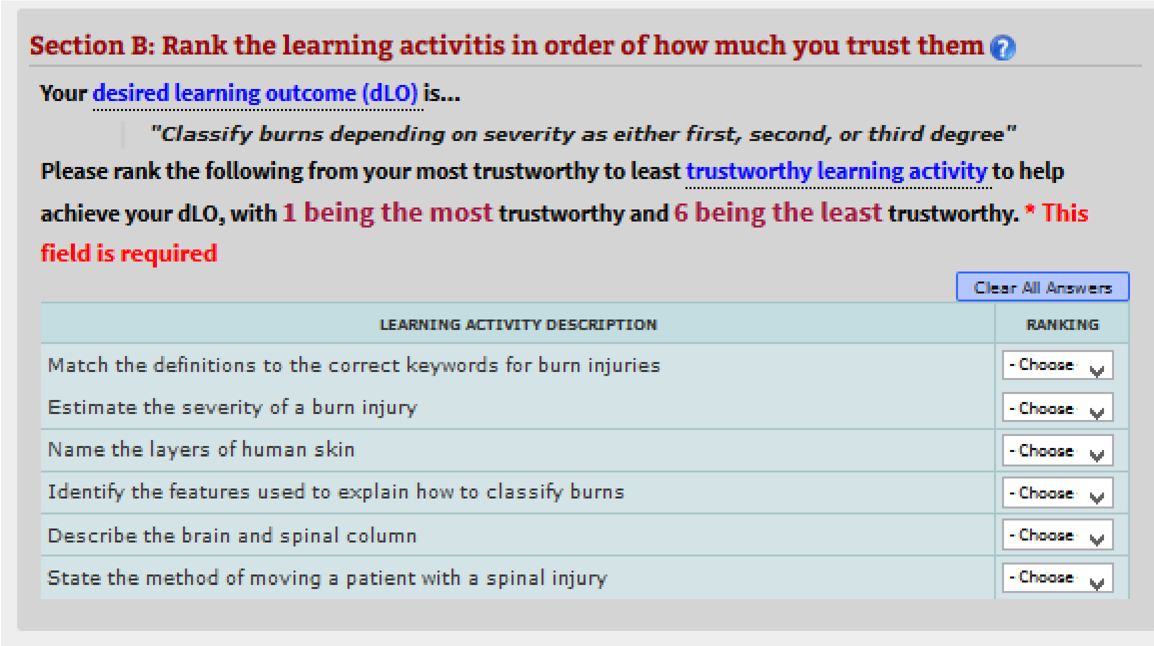
Please choose an appropriate learning path which matches your abilities and leads you to learn about classification of burns. * This field is required

Your desired learning outcome (dLO) is "Classify burns depends on severity". The table on the left shows some possible learning paths (LP) to support your learning about the classification of burns. For example, if you choose LP1 that means you prefer to learn only one prerequisite P2 (State key recognition features of a burn) before learning about your desired learning outcome (dLO) (Classify burns depending on severity)

	LP ID	LEARNING PATH (LP)
○	LP1	P2 → dLO
○	LP2	P1 → P2 → dLO
○	LP3	P3, P1 → P2 → dLO

DESCRIPTION	
P1	Define key words for burn injuries
P2	State key recognition features of a burn
P3	State the functions of the skin
dLO	Classify burns depends on severity as either first, second, or third degree

Figure C-11: The questionnaire for Experiment 2, part2. The questions to gain a level of participant's knowledge about the classification of burn and the participant's learning path.



Section B: Rank the learning activitis in order of how much you trust them

Your desired learning outcome (dLO) is...

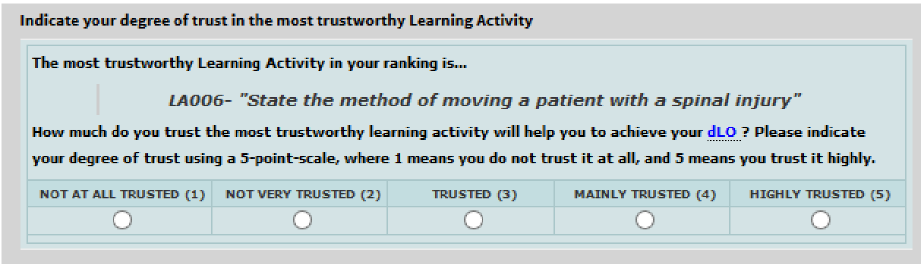
"Classify burns depending on severity as either first, second, or third degree"

Please rank the following from your most trustworthy to least trustworthy learning activity to help achieve your dLO, with 1 being the most trustworthy and 6 being the least trustworthy. * This field is required

Clear All Answers

LEARNING ACTIVITY DESCRIPTION	RANKING
Match the definitions to the correct keywords for burn injuries	- Choose
Estimate the severity of a burn injury	- Choose
Name the layers of human skin	- Choose
Identify the features used to explain how to classify burns	- Choose
Describe the brain and spinal column	- Choose
State the method of moving a patient with a spinal injury	- Choose

Figure C-12: The questionnaire for Experiment 2, part3. The question for selecting learning activity.



Indicate your degree of trust in the most trustworthy Learning Activity

The most trustworthy Learning Activity in your ranking is...

LA006- "State the method of moving a patient with a spinal injury"

How much do you trust the most trustworthy learning activity will help you to achieve your dLO ? Please indicate your degree of trust using a 5-point-scale, where 1 means you do not trust it at all, and 5 means you trust it highly.

NOT AT ALL TRUSTED (1)	NOT VERY TRUSTED (2)	TRUSTED (3)	MAINLY TRUSTED (4)	HIGHLY TRUSTED (5)
○	○	○	○	○

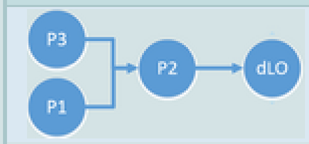
Figure C-13: The questionnaire for Experiment 2, part4. The question to gain a degree of participant's trust in the learning activity.

Section C: Give your reasons why you trust the learning activity

Your desired learning outcome (dLO) is...

> ***"Classify burns depends on severity as either first, second, or third degree"***

Summary of your selection in the previous steps

YOUR LEARNING PATH		PREREQUISITE DESCRIPTION	YOUR LEVEL OF KNOW-HOW IN PRE-REQUISITE
	P1	Define key words for burn injuries	4
	P2	State key recognition features of a burn	3
	P3	State the functions of the Skin	2

the most Trusted Learning Activity in Your Ranking is...

> ***LA006- "State the method of moving a patient with a spinal injury"***

Please provide your reasons why you give the degree of trust in the most trusted learning activity is equal to Mainly trusted (4/5) by indicating whether you agree or disagree with the below statements:

I WOULD TRUST A LEARNING ACTIVITY IF...	NOT VERY INFLUENTIAL 1	2	3	4	5	6	VERY INFLUENTIAL 7
It identifies what I need to learn to achieve my desired learning outcome (dLO)	○	○	○	○	○	○	○
It includes the keywords that I need to know to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It includes the capability verb that relates with what I need to do to achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It helps me learn new knowledge to extend my prior knowledge.	○	○	○	○	○	○	○
I know how it would help me achieve my desired learning outcome (dLO).	○	○	○	○	○	○	○
It allows me to apply my prior knowledge.	○	○	○	○	○	○	○
It challenges me to develop my skills.	○	○	○	○	○	○	○
It connects my prior knowledge with my desired learning outcome (dLO).	○	○	○	○	○	○	○
It increases my confidence about achieving my desired learning outcome (dLO) after the learning activity has been completed.	○	○	○	○	○	○	○
It is recommended by an expert.	○	○	○	○	○	○	○
It is clearly laid out.	○	○	○	○	○	○	○
Encryption advances on the Internet make it safe for me to choose it.	○	○	○	○	○	○	○

Figure C-14: The questionnaire for Experiment 2, part7. The questions to gain the reasons that influenced the participants' trust.

Appendix D Testing for Normality

D.1 Testing for Normality for Experiment 1

		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Students' propensity to trust (PT_{STU})	tp01 - people	.227	36	.000	.886	36	.001
	tp02	.384	36	.000	.754	36	.000
	tp03	.227	36	.000	.902	36	.004
	tp04	.228	36	.000	.873	36	.001
	tp05	.246	36	.000	.887	36	.002
Students' prior knowledge (KW_{STU})	pILOLevel	.202	36	.001	.910	36	.007
Student trust	u_T	.270	36	.000	.803	36	.000

			Kolmogorov-Smirnov			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
Student's perceived trustworthiness	Competence	S_QID01_	.209	35	.000	.851	35	.000
		S_QID02_	.208	35	.001	.877	35	.001
		S_QID03_	.274	35	.000	.862	35	.000
	Benevolence	S_QID04_	.253	35	.000	.868	35	.001
		S_QID05_	.264	35	.000	.853	35	.000
		S_QID06_	.182	35	.005	.910	35	.007
	Integrity	S_QID07_	.228	35	.000	.892	35	.002
		S_QID08_	.241	35	.000	.846	35	.000
		S_QID09_	.218	35	.000	.832	35	.000

D.2 Testing for Normality for Experiment 2

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Students' propensity to trust (PT_{STU})	tp01	.226	50	.000	.873	50	.000
	tp02	.309	50	.000	.795	50	.000
	tp03	.256	50	.000	.891	50	.000
	tp04	.234	50	.000	.855	50	.000
	tp05	.204	50	.000	.897	50	.000
Students' prior knowledge (KW_{STU})	pILOLevelValue	.229	50	.000	.890	50	.000
Student trust	userTrust	.266	50	.000	.803	50	.000

a. Lilliefors Significance Correction

Tests of Normality

			Kolmogorov-Smirnov[a]			Shapiro-Wilk		
			Statistic	df	Sig.	Statistic	df	Sig.
Student's perceived trustworthiness	Competence	S_QID01	.181	50	.000	.892	50	.000
		S_QID02	.212	50	.000	.905	50	.001
		S_QID03	.161	50	.002	.918	50	.002
	Benevolence	S_QID04	.209	50	.000	.884	50	.000
		S_QID05	.214	50	.000	.883	50	.000
		S_QID06	.198	50	.000	.901	50	.001
	Integrity	S_QID07	.158	50	.003	.936	50	.009
		S_QID08	.177	50	.000	.922	50	.003
		S_QID09	.188	50	.000	.900	50	.000

a. Lilliefors Significance Correction

Appendix E Example of ILOs from ACM standards

This appendix shows the example of the intended learning outcomes (ILOs) that were used in the scenario in Section 6.3.2. The ILOs in Table 6-4 belong to the 23 ILOs according to the ACM Computing Curriculum standardised by the ACM Special Interest Group on Information Technology Education (Lunt et al., 2008). The details are listed as follows:

E.1 The ILOs of Data Modelling Module (IM4) for IT

Minimum core coverage time: 6 hours

Topics:

- Conceptual Models
    - Entity relationship diagrams
    - Enhanced entity relationship diagrams
    - Identification of business rules
- Logical models
- Physical models
- Reengineering of databases
- Standardized modeling in IDEF1, UML
    - Patterns and standard models
- CASE tools
- Meta-modeling

Data integration

Data warehouses, Datamarts

Core learning outcomes:

1. Describe and interpret Entity Relationship diagrams.
2. Create a simple Entity Relationship diagram.
3. Describe and interpret Enhanced Entity Relationship diagrams.
4. Select appropriate business rules for a given scenario.
5. Describe the relationship between a logical model and a physical model.
6. Select a pattern or standard model that effectively corresponds to a given scenario.
7. Explain the use of CASE tools in data modelling.
8. Describe data integration.
9. Describe meta-modelling.
10. Describe a data warehouse, its basic structure, etc.

Advanced learning outcomes:

1. Create and design Entity Relationship diagrams.
2. Create and design Enhanced Entity Relationship diagrams.
3. Formulate and explain identification of business rules.
4. Create and evaluate a logical model.
5. Create and evaluate a physical model.
6. Use a given CASE tool.
7. Demonstrate how to reengineer databases.
8. Apply a pattern or standard model to develop a solution for a given scenario.
9. Create and evaluate meta-models.
10. Explain the concept of data integration and its use in the creation of data warehouses and data marts.
11. Change an existing data warehouse.
12. Change an existing data mart.

Appendix F Example of Calculations

This Appendix provided an example of calculating a degree of integrity in learning activity. The learning activity has integrity when it related to some ILO nodes in the learning path. An acceptable relationship between the learning activity and the learning path is the match of the fLO of learning activity and some ILO nodes in learning path. The match score between the fLO and the ILO were calculated based on three dimensions: the capability type, the subject matter type, and the keywords. Cosine similarity was applied to estimate the match score between two strings from the fLO and the ILO in three dimensions.

F.1 Example of calculating the degree of integrity.

Using the scenario in Section 6.3.2 on Page 58 to give more understand about how to calculate a degree of integrity in learning activity.

The scenario is about the student who wonder whether she can trust the learning activity: “Mary is a student who has some knowledge about the logical model, and desires to learn how to draw ER diagram. Mary visits the self-study database course to select a trustworthy learning activity for herself. The self-study database course is comprises the learning activities and their ILOs. All ILOs are based on the IM4 data modelling course of the ACM Computing Curriculum standardised (Lunt et al., 2008) as shown in Appendix E. Mary curious about the learning activity ‘LA033’, whether to trust it. Mary intuitively estimate the likelihood that LA033 could be trusted. Mary search for signs in LA033 when deciding whether to trust it."

LA033 will be perceived as having integrity, if and only if there are some connections between Mary's learning path and LA033. To detect the connections between them, the facilitating ILO (fLO) of LA033 is retrieved and constructed on same structure as the ILOs in Mary's learning path. Table F-1, shows how the fLO of LA033 connects to each ILO node in Mary's learning path by matching capability type, subject matter type, and keywords.

ILOs in learning path	**Description of ILOs in learning path**	**The facilitating ILO (fLO) of the chosen learning activity "LA033"**		
		Capability Type of fLO is Find	Subject Matter Type of fLO is Concept	Keywords of "LA033" are Data model, Entities
		Match scores for capability type btw fLO and ILOs	Match scores for Subject Matter type btw fLO and ILOs	Match scores for keywords btw fLO and ILOs
ILO4	Remember	0	0	0
	Concept	0	1	0
	logical, model	0	0	0
ILO1	Use	0	0	0
	Concept	0	1	0
	Entity, Relationship, Diagram	0	0	There are 1 of 3 keywords that match = 1/3 = 0.3
ILO2	Find	1	0	0
	Concept	0	1	0
	Entity, Relationship, Diagram	0	0	There are 1 of 3 keywords that match = 1/3 = 0.3
ILO3	Find	1	-	0
	Procedure	-	0	0
	Entity, Relationship, Diagram	0	0	There are 1 of 3 keywords that match = 1/3 = 0.3

Table F-1: Example of matching fLO against all ILOs in the learning path, whereas 0 is a match scores of no match between ILO[i] and fLO, and 1 is match scores of there is match between ILO[i] and fLO, when [i] is any ILO ID.

The match scores in Table F-1 are used to find the degrees of similarity as shown in Table F-2. Higher match scores represent greater degrees of similarity. The greatest degree of similarity is utilized to be the degree of integrity in the learning activity. The results in Table F-2 was interpreted as LA033 has integrity because it connects with Mary's learning path and the degree of integrity is equal to 0.78 at ILO2.

Type of ILO	**ILOs in learning path**	**Match scores btw fLO and ILOs from all dimensions**			**Example of Calculating the total match scores or similarity between fILO & ILOs**
		Match scores for capability type	Match scores for Subject Matter type	Match scores for keywords	
pLO	ILO4	0	1	0	(0+1+0)/3 = 0.33
cLO	ILO1	0	1	0.3	(0+1+0.3)/3 = 0.43
cLO	ILO2	1	1	0.3	(1+1+0.3)/3 = 0.78
dLO	ILO3	1	0	0.3	(1+0+0.3)/3 = 0.43

Table F-2: Example of calculation of similarity between ILO of learning activity with all ILO in the learning path.

F.2 Example of the calculation of cosine similarity

The cosine similarity was used to find a match of two strings as shown in Table F-1 and Table F-2. The example of calculation of cosine similarity was shown below:

Cosine similarity was used to estimate the match score between two strings: "Entities" (the keyword of "LA033") and "Entity" (the keyword of ILO2). Cosine similarity between two strings can be computed by computing the cosine of the angle between their vectors:

Given x_1= "Entities" and x_2 = "Entity"

$$Cosine\ Similarity(x_1 + x_2) = \frac{\mathrm{V}(x_1) \cdot \mathrm{V}(x_2)}{|\mathrm{V}(x_1)||\mathrm{V}(x_2)|}$$

Two strings x_1 and x_1 were encoded as the vectors $\mathrm{V}(x_1)$ and $\mathrm{V}(x_2)$ by following steps:

1) Creating a vector of strings

The vector space was based on the 26 English letters of the alphabet. The frequency of each letter is shown within the vector as shown in Table F-3.

Dimension of strings	English alphabet																									
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
Entities	-	-	-	-	2	-	-	-	2	-	-	-	-	1	-	-	-	-	1	2	-	-	-	-	-	-
Entity	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	1	-

Table F-3: the construction of vectors from two strings: “Entities” and “Entity” based on the English alphabet.

The dimension for the two example strings “Entities” and “Entity” is (e,i,n,s,t,y). Thus, their vectors are: $V(x_1)$ = (2,2,1,1,2,0) for “Entities” and $V(x_2)$ = (1,1,1,0,2,1) for “Entity”.

2) Calculating Cosine similarity

The cosine function for these two strings can be calculated as:

The dot product = (2*1) + (2*1) + (1*1) + (1*0) + (2*2) + (0*1) = 9 ;

The magnitude of “Entities” = $\sqrt{2^2+2^2+1^2+1^2+2^2+0^2}$ = $\sqrt{14}$;

The magnitude of “Entities” = $\sqrt{1^2+1^2+1^2+0^2+2^2+1^2}$ = $\sqrt{8}$;

The product of magnitudes = $\sqrt{14} * \sqrt{8}$ = $\sqrt{112}$ = 10.58 ;

Division of the dot product with the product of magnitudes = $\frac{9}{10.58}$ = 0.85.

Thus, Cosine similarity between “Entities” and “Entities” is 0.85 % similar. The result of matching between two strings based on how much Cosine similarity was found. If Cosine similarity is more than 75%, it means that there is an acceptable match between two strings. Thus, there is a match of keywords between the fLO and ILO2; as show in Table F-1.

F.3 Application of cosine similarity in this research.

In the order to analyse whether the facilitating ILO (fLO) of learning activity matched the ILOs in the learning path, the cosine similarity value was used to express match between the fLO and each ILO in the learning activity. They was matched in three dimensions: the capability type, the subject matter type, and the keywords. For example, Table F-1 shown the fLO of the “LA033” was matched to three dimensions of each ILOs in the learning path. Cosine similarity was applied to express match for all three dimensions as shown below:

1) The basic process to match the capability type between the fLO and ILOs in the learning path.:

```
# retrieve the verb of the fLO from the learning activity (LA033)
String fLO_verb = retrieve_ verb_fLO(LA033)

# retrieve all ILOs in the learning path (LP)
Set ILOs = retrieve_ILO("LP")

# find the match scores between the fLO and each ILOs in the LP
For (n = 1 to count(ILOs))
{
    # retrieve the capability type of ILO(n)
    String ILO_cap = retrieve_captype(n)

    # retrieve all verbs that related with the capability type of ILO(n)
    Set ILO_verbs = retrieve_verb(ILO_cap)

   # find the cosine similarity between two verbs from fLO and the capability type of ILO(n)
    For (m = 0 to count(ILO_verbs))
    {
      # if the percent of cosine similarity from two verbs is more than 75%
      If Cosine similarity(ILO_verbs(m), fLO_verb) >= 75%
      # then fLO and ILO(n) have the same capability type
      then fLO_cap = ILO_cap;
          # the match score between fLO and ILO(n) based on capability type is equal to1
            match_cap = 1
      # else the percent of cosine similarity from two verbs is less than 75% ,
          the match scores is equal to 0
      Else match_cap = 0
    }
}
```

2) The basic process to match the subject matter type between the fLO and ILOs in the learning path:

```
# retrieve the subject matter type of the fLO from the learning activity (LA033)
String fLO_sm = retrieve_smtype_fLO(LA033)

# retrieve all ILOs in the learning path (LP)
Set ILOs = retrieve_ILO("LP")


For (n = 1 to count(ILOs))
{
    # retrieve the subject matter type of ILO(n)
    String ILO_sm = retrieve_smtype(n)
    # if the percent of cosine similarity from two subject matter type is more than 75%
    If Cosine similarity(ILO_sm, ILO_sm) > 75%
    # then the match scores for subject matter type is equal to1
    then match_sm= 1;
    # else if there are no match the match scores is equal to 0
    Else match_sm= 0;
}
```

3) The basic process to match the keywords between the fLO and ILOs in the learning path:

```
# retrieve the keywords of the fLO from the learning activity (LA033)
Set fLO_kw = retrieve_kw_fLO(LA033)

# retrieve all ILOs in the learning path (LP)
Set ILOs = retrieve_ILO("LP")
For (n = 1 to count(ILOs))
{
   Set ILO_kw = retrieved_kw(n) # retrieved all keywords that related to ILO(n)
   For (ILO_kw(i) 0 to count(ILO_kw))
        For (fLO_kw(j) 0 to count(fLO_kw))
        {
            If Cosine similarity(ILO_kw(i), fLO_kw(j)) > 75% # if the keyword of fLO matched
           the keyword of ILO
            then match_kw = +1; # then the match scores for subject matter type is equal to1
            Else match_kw = 0 # else if there are no match the match scores is equal to 0
            }
        }
}
If match_kw > 0 then match_kw = match_kw/count(ILO_kw);
```

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