

# On thesis statements

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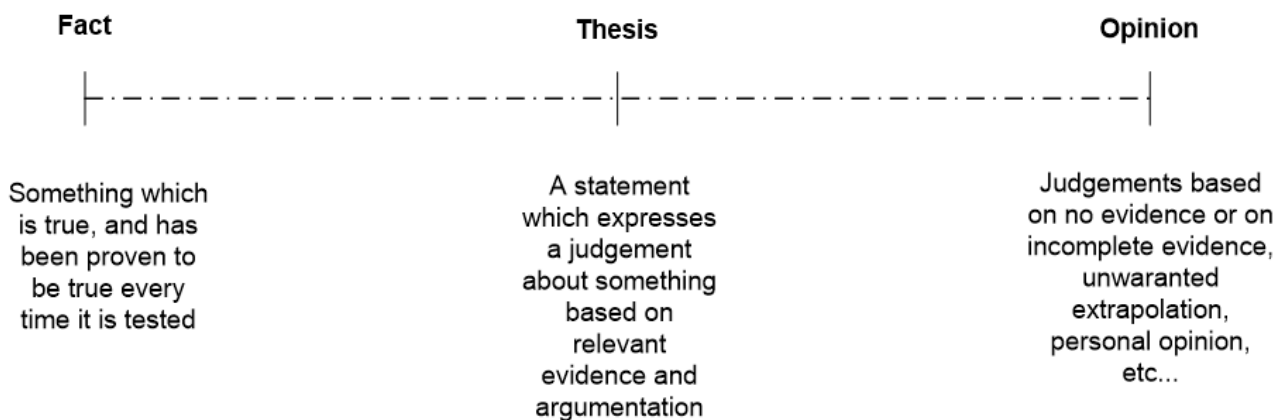
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## 1. Introduction: What is a thesis?

Here we will go through how to identify thesis statements as seen in example texts on mathematics. First we make a distinction between opinion, thesis and fact:

- *Opinion*: “I don’t know if this is true, but I believe it is.”
- *Thesis (or hypothesis)*: “This is something I can prove is true because I can test it by conducting an experiment and accumulating evidence in support of my thesis (this is done by analysing the data collected as a result of running the experiment).”
- *Fact*: “This has already been proved true.”

As a help we can use the diagram below to guide us when thinking about what a thesis statement is:



More specifically a thesis is something:

1. which makes a claim or states a clear position on a phenomenon, for example: “the extension of a spring is directly proportional to the force applied” (this is Hooke’s law).
2. which can be confirmed via experimentation, and can be verify by other people by repeating or replicating your research;
  - a. to introduce methods, data, results from articles
  - b. we are not collecting data, so the data comes from other sources.
3. for which there is evidence, your own (collected directly from experiment), or other peoples’ (presented in their papers).
4. which can be critically evaluated and argued in favour of, on the basis of the evidence.

Therefore, we might say that

**“Hard/Strong” thesis statement is a claim as to the truth of something, which can be critically argued for, and for which there is clear evidence.**

An artificial example of such a thesis might be as follows:

“Previous work by Carter (1900) showed that it was possible to develop a measure of tastiness. This work was applied to the study of the tastiness of peanut butter sandwiches (Smith (1950) and Jones (2000)) where a measure of tastiness of 7% was found. In this paper I will show that the use of cooking method X and the ingredients of strawberry jam and brown bread leads to an improvement in the tastiness (variable) of peanut butter sandwiches of 10%.”

As another example, consider the topic of the declining shark population. The following are statements ranking from “no thesis” to “strong” in terms of the definition above:

- **No thesis:** There are reasons why shark populations are in decline.
- **Mild:** Overfishing of sharks has led to a world-wide decline in shark population.
- **Mild:** Changing technology and lack of international cooperation may lead to the extinction of sharks.
- **Strong:** Great white shark population in the coastal seas of Australia has decreased by 30% in the last 10 years due to poaching.

This last example can be said to be strongly worded because it specifies i) the type of shark being studied, ii) the location of the study, iii) the amount of change, iv) the period of time over which the change has occurred, and v) the cause of the change.

Sometimes theses are not as “strongly” worded or phrased as above. We therefore need to properly understand the aim of a thesis, and then look to see if the wording, phrasing, language, etc., intends to mean a thesis.

So how can we describe the aim of a thesis in broader and more fundamental terms? Maybe as follows: a thesis says that

under certain conditions or in a certain physical or computational/digital environment, something always happens, and this thing can be tested in such a way as to provide evidence

This broad description of the aim of a thesis will be useful when analysing the examples to come.

## 2. Examples from the literature

### 2.1. Operational research/Management science

The following text comes from (ref)

“A critical path scheduling problem, called a “divisible activity” model, is investigated in which a single activity can have its completion time divided up and allocated to different 'locations' along the project path. A new algorithm for determining the allocation of such a “divisible activity” model is given, with the aim of minimizing total project time. Although the algorithm is very similar to those used in network-flow type problems, the final results are shown to improve efficiency of the overall running of the project.” (ref)

#### Analysis

Topic sentence: Statement of the specific type of critical path problem to be studied.	A critical path scheduling problem, called a “divisible activity” model, is investigated
Methodology/approach: Description of the method to be considered.	in which a single activity can have its completion time divided up and allocated to different 'locations' along the project path.
Original contribution to knowledge: The creation of a new algorithm.	A new algorithm for determining the allocation of such a “divisible activity” model is given,
Thesis: This could form part of a thesis	with the aim of minimizing total project time.
Comparison with similar algorithms.	Although the algorithm is very similar to those used in network-flow type problems,
Thesis: This could form part of the thesis.	the final results are shown to improve efficiency of the overall running of the project.

Taking the two thesis parts together we could construct a *strong thesis statement* to be

“We create a new algorithm for determining the allocation of “divisible activities” which minimizes total project time and improves efficiency of the overall running of the project by 10%.”

## 2.2. Business analytics

The following text comes from Zadeh and Jeyaraj (2018).

“Organisations utilise social media technologies for various customer engagement and external-facing activities in recent years. This research examines the extent to which the business strategies and social media strategies of organisations are aligned. Using a sample of 33 organisations competing in the information technology industry, the business strategies were operationalised using data extracted from the annual 10-K reports while the social media strategies were identified from the Twitter feeds. Topic modelling with latent semantic analysis revealed six different orientations in the business and social media strategies of organisations, which were used to evaluate alignment. This study also identified clusters of organisations with varying levels of alignment. Implications for research and practice are discussed.”

### Analysis

Topic sentence (acts as general information).	Organisations utilise social media technologies for various customer engagement and external-facing activities in recent ...
Aim of the paper.	This research examines the extent to which the business strategies and social media strategies of organisations are aligned.
Methodology.	Using a sample of 33 organisations competing in the information technology industry, the business strategies were operationalised using data extracted from the annual 10-K reports while the social media strategies were identified from the Twitter feeds. Topic modelling with latent semantic analysis revealed six different orientations in the business and social media strategies of organisations, which were used to evaluate alignment.
Part of the aim of the paper: a sub-aim	This study also identified clusters of organisations with varying levels of alignment.
Thesis	No “hard/strongly” worded thesis.

### 2.3. Software engineering

The following text comes from Podgurski and Clarke (1990).

“A formal, general model of program dependences is presented and used to evaluate several dependence-based software testing, debugging, and maintenance techniques. Two generalizations of control and data flow dependence, called weak and strong syntactic dependence, are introduced and related to a concept called semantic dependence. Semantic dependence models the ability of a program statement to affect the execution behavior of other statements. It is shown, among other things, that weak syntactic dependence is a necessary but not sufficient condition for semantic dependence and that strong syntactic dependence is a necessary but not sufficient condition for a restricted form of semantic dependence that is finitely demonstrated. These results are then used to support some proposed uses of program dependences, to controvert others, and to suggest new uses.”

#### Analysis

Topic sentence and aim of the paper.	A formal, general model of program dependences is presented and used to evaluate several dependence-based software testing, debugging, and maintenance techniques.
Developing the idea of the topic sentence: three examples.	Two generalizations of control and data flow dependence, called weak and strong syntactic dependence, are introduced and related to a concept called semantic dependence. Semantic dependence models the ability of a program statement to affect the execution behavior of other statements.
Applications.	These results are then used to support some proposed uses of program dependences, to controvert others, and to suggest new uses.
Thesis.	It is shown, among other things, that weak syntactic dependence is a necessary but not sufficient condition for semantic dependence and that strong syntactic dependence is a necessary but not sufficient condition for a restricted form of semantic dependence that is finitely demonstrated.

## 2.4. Mechanical Engineering: Elasticity of beams

The following text comes from Lim (2018).

“This article presents an alternate final solution to the deflection profile of a simply supported beam under sinusoidal load based on the theory of elasticity. It begins with a review of the same problem found in typical graduate textbooks, which ends with an elasticity solution that is valid only for moderately thick beams, and thereafter provides an alternative ending for providing a more accurate deflection profile that is valid for very thick beams. Plotted results show evidence on the deficiency of the textbook solution for very thick beams, thereby limiting its use as a verifier for the Mechanics of Materials solution. Unlike the existing simplified elasticity model, the exact model does not reduce to the Mechanics of Materials model when the Poisson’s ratio of the beam material is  $-1$ . In addition to being a better verifier to the Mechanics of Materials solution, the proposed exact elasticity solution can be easily reduced to the simplified elasticity solution that is currently adopted in some graduate textbooks.”

### Analysis

Topic sentence.	This article presents an alternate final solution to the deflection profile of a simply supported beam under sinusoidal load based on the theory of elasticity.
Summary of current approaches	It begins with a review of the same problem found in typical graduate textbooks, which ends with an elasticity solution that is valid only for moderately thick beams, and thereafter provides an alternative ending for providing a more accurate deflection profile that is valid for very thick beams.
Identifying problems in current approaches.	Plotted results show evidence on the deficiency of the textbook solution for very thick beams, thereby limiting its use as a verifier for the Mechanics of Materials solution.
Thesis (but not strongly worded as such): The solution corrects the above problem.	Unlike the existing simplified elasticity model, the exact model does not reduce to the Mechanics of Materials model when the Poisson’s ratio of the beam material is $-1$ . In addition to being a better verifier to the Mechanics of Materials solution, the proposed exact elasticity solution can be easily reduced to the simplified elasticity solution that is currently adopted in some graduate textbooks.

## 2.5. Mechanical engineering: Simulation of robot arms

The following text comes from Taylan-Das and Dulger (2005).

“A complete mathematical model of SCARA robot (Serpent 1) is developed including servo actuator dynamics and presented together with dynamic simulation in this paper. The equations of motion are derived by using Lagrangian mechanics. Dc servo motors driving each robot joint is studied with PD controller action. Serpent 1 robot is instructed to achieve pick and place operations of three different size cylindrical objects through assigned holes. The performance of robot-actuator-control system is examined with numerical simulation and experimentally verified. The results of experimentation are given with comments. An agreement between the model and the experiments is certainly obtained herein.”

### Analysis

Topic sentence which also describes the aim of the paper.	A complete mathematical model of SCARA robot (Serpent 1) is developed including servo actuator dynamics and presented together with dynamic simulation in this paper.
Mathematical/experimental method used.	The equations of motion are derived by using Lagrangian mechanics. Dc servo motors driving each robot joint is studied with PD controller action. Serpent 1 robot is instructed to achieve pick and place operations of three different size cylindrical objects through assigned holes. The performance of robot-actuator-control system is examined with numerical simulation and experimentally verified.
Thesis	None, but it looks like “An agreement between the model and the experiments is certainly obtained herein.” Could be turned into a thesis? How so?

## 2.6. Mathematics Education

The following text comes from Tisdell (2017).

Knowing an equation has a unique solution is important from both a modelling and theoretical point of view. For over 70 years, the approach to learning and teaching ‘well-posedness’ of initial value problems (IVPs) for second- and higher-order ordinary differential equations has involved transforming the problem and its analysis to a first-order system of equations. We show that this excursion is unnecessary and present a direct approach regarding second- and higher-order problems that does not require an understanding of systems.”

### Analysis

Topic sentence, stating the importance of an aspect of maths.	Knowing an equation has a unique solution is important from both a modelling and theoretical point of view.
Some history about how the general maths topic has been taught in the past.	For over 70 years, the approach to learning and teaching ‘well-posedness’ of initial value problems (IVPs) for second- and higher-order ordinary differential equations ...
Specific approach used in the past.	... has involved transforming the problem and its analysis to a first-order system of equations.
Statement against the past method.	We show that this excursion is unnecessary ...
Thesis.	... and present a direct approach regarding second- and higher-order problems that does not require an understanding of systems.

## 2.7. Mathematics: Ordinary differential equations

The following text is something I invented.

In this paper we study the reduction of 3<sup>rd</sup> order ordinary differential equation to a system of 1<sup>st</sup> order ordinary differential equation via the X transformation. Under suitable condition of boundedness and convergence we prove that such a reduced system is solved more efficiently (i.e. in a polynomial time) compared to standard methods.

### Analysis

Topic sentence: aim of the paper.	In this paper we study the reduction of 3 <sup>rd</sup> order ordinary differential equation to a system of 1 <sup>st</sup> order ordinary differential equation
Method: Specific method.	via the X transformation.
Specifying assumptions, conditions or constraints	under suitable condition of boundedness and convergence
Thesis (here, a theorem)	we prove that such a reduced system is solved more efficiently (i.e. in a polynomial time) compared to standard methods

### 3. Exercises

Consider the texts below. Can you identify a thesis in each of these?

#### 3.1. Statistics education

“This paper presents a survey of the reported research about students' errors, difficulties and conceptions concerning elementary statistical concepts. Information related to the learning processes is essential to curricular design in this branch of mathematics. In particular, the identification of errors and difficulties which students display is needed in order to organize statistical training programmes and to prepare didactical situations which allow the students to overcome their cognitive obstacles. This paper does not attempt to report on probability concepts, an area which has received much attention, but concentrates on other statistical concepts, which have received little attention hitherto.” (Batanero et al., 1994).

### *3.2. Mathematics education (differential equations)*

“A study of first-year undergraduate students’ interpretational difficulties with first-order ordinary differential equations (ODEs) in modelling contexts was conducted using a diagnostic quiz, exam questions and follow-up interviews. These investigations indicate that when thinking about such ODEs, many students muddle thinking about the function that gives the quantity to be determined and the equation for the quantity’s rate of change, and at least some seem unaware of the need for unit consistency in the terms of an ODE. It appears that shifting from amount-type thinking to rates-of-change-type thinking is difficult for many students. Suggestions for pedagogical change based on our results are made.” (Rowland and Jovanoski, 2004)

### *3.3. Statistics research*

“In this article, we propose an outlier detection approach in a multiple regression model using the properties of a difference-based variance estimator. This type of a difference-based variance estimator was originally used to estimate error variance in a non-parametric regression model without estimating a non-parametric function. This article first employed a difference-based error variance estimator to study the outlier detection problem in a multiple regression model. Our approach uses the leave-one-out type method based on difference-based error variance. The existing outlier detection approaches using the leave-one-out approach are highly affected by other outliers, while ours is not because our approach does not use the regression coefficient estimator. We compared our approach with several existing methods using a simulation study, suggesting the outperformance of our approach. The advantages of our approach are demonstrated using a real data application. Our approach can be extended to the non-parametric regression model for outlier detection.” (Park and Kim, 2018)

### *3.4. Mathematics education (teacher education)*

“The purpose of this exploratory study was to develop a model to examine teachers’ instructional practice in secondary school mathematics in relationship underlying cognitions. The instructional practice and cognitions of seven experienced seven beginning teachers of secondary school mathematics were examined as a basis the creation of the model. To examine instructional practice a Phase-Dimension Framework for the Examination of Mathematics Teaching was developed. Data were obtained observations, lesson plans, videotapes and audiotapes of structured interviews course of one semester. The value of the model lies in its

usefulness as a guide for teachers to reflect on their instructional practice and underlying cognitions in a structured, comprehensive manner.” (Artzt and Armour-Thomas, 1999)

### Exercise

Choose a paper of your own and identify the author’s thesis. What is s/he claiming? What is it that s/he is saying will work, or will work better than, or is an improvement on, or is more efficient, etc.?

## **4. The language/discourse of a thesis**

The aim of the examples above is to show you the *underlying principle* of what makes a *thesis*. This underlying principle is what you should aim to learn and understand. Then you will know *how* to write a thesis. The underlying principle illustrates a certain style of writing or phrasing which distinguishes a thesis from other types of writing.

There are two factors (at least) which make a thesis statement:

- particular vocabulary: the vocabulary of a topic + action words (verbs);
- the way in which the statement is phrased in-and-of-itself, as well as how this statement follows on from the preceding text. In other words, the text preceding a statement acts as context and can influence whether or not that statement is a thesis statement.

### Example 2.1: Language analysis

“... the final results are shown to improve efficiency of the overall running of the project.”

### Example 2.6: Language analysis

“... present a direct approach regarding second- and higher-order problems that does not require an understanding of systems.”

### Example 2.7: Language analysis

“... we prove that such a reduced system is solved more efficiently (i.e. in a polynomial time) compared to standard methods.”

Note that thesis statements can be written in very different styles depending on the discipline you are working in. Scientific disciplines usually make more categorical, definitive thesis statements such as “We will show that ... is more efficient by 10%”, or “We improve channel

capacity by using ... The resulting improvement is of the order of 10%", or "This new design minimises deviation such that ..."

In mathematics, there is no such things as a thesis in the way we are discussing it here. There are only theorems. And theorems are always followed by proofs of the correctness of the theorem. In this case there is no debate or argument about a theorem. It is a fact, proven to be so.

For example,

- The fundamental theorem of arithmetic says that any integer can be factored into prime powers, e.g.  $60 = 2^2 \times 3 \times 5$ . This theorem is always true.
- The fundamental theorem of algebra says that any polynomial can be factorised into complex factors, e.g.  $x^3 + x^2 + x + 1 = (x + i)(x - i)(x + 1)$ . This theorem is always true.
- The fundamental theorem of calculus says that integration is the reverse of differentiation, and that the value of the definite integral is equal to the antiderivative evaluated at the boundaries of the interval of integration. Under certain conditions, this theorem is always true.

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