"In knowledge there is always a trade-off between accuracy and simplicity." Evaluate this statement in relation to two areas of knowledge.

Einstein once said: "Everything should be made as simple as possible, but not simpler" (Poole, Michael). In saying this, I believe that he meant knowledge, in its ideal form, should be simple while maintaining a high level of accuracy. This quote is interesting as it implies that the simplicity of knowledge is good; oversimplification, however, may lead to negative results. His statement, with which I strongly agree, also goes hand in hand with Occam's Razor, which is one of the main beliefs of modern natural science (NS), states "entities should not be multiplied beyond necessity" (Gibbs, Phil), as the over complication of the methodology leads to unnecessary complicated experiments, which could result in inaccurate results.

This raises some interesting questions which we need to consider when we simplify knowledge. Is there a trade off between simplicity and accuracy? How will this impact us? For this essay I will be investigating the following knowledge question: **"To what extent is there a trade off between simplicity and accuracy when using language for the generation of new knowledge claims in mathematics and the natural Sciences?"** Simplicity can be defined as being easily understood, for example in Maths, addition is simple as it is easy to understand, while integration is more complex as it is harder to understand; accuracy can be defined as the state representing reality. Language refers to the method of communication, which can take multiple forms, e.g. symbols and words. Language as a WOK allows specific meaning to be conveyed, as each form carry specific meanings and connotations. Simple language within an AOK means language, which can easily be understood by someone with a limited understanding of the field, therefore using the most basic level of language in the specific AOK, this may or may not be accurate.

In mathematics the use of simplistic language does not affect the accuracy of the knowledge. In mathematics language is used to communicate mathematical ideas. Arguably, mathematics itself is a language as it communicates ideas by using specific notations. Mathematicians tend to prefer the shortest proof as it generally turns out to be the most elegant one; proofs that are simple yet effective. This is due to the methodology of mathematics which relies on a system of axioms and postulates created by humans, unlike the NS which relies on sensory perception and equipment. Axioms and postulates are self-evident truths which are assumed to be true, from which we can deduce generations of new knowledge claims. This makes fields of mathematics objective, logically enclosed systems in which everyone follows the same set of rules. Within this system, a single piece of knowledge can be produced in various ways. Consider Pythagoras' Theorem, which can be proven using different methods. Simpler proofs include simple uses of geometric properties, generally includes squares. However, this can be proven in far more complex ways such as representing the lines (a and b) as vectors and taking their dot products, assuming they are perpendicular to each other. Both are accurate and valid within mathematics, even with different levels of simplicity. As all proofs lead to the same conclusion, it can be said that the use of simplistic language does not hinder the accuracy of knowledge.

It is important to note, however, that mathematics, being a human endeavor, has many different axiomatic systems, each of which may produce different results. Therefore different set of axioms may tend to contradict each other. For example, a triangle has 180 degrees in Euclidean geometry, whereas it has more than 180 degree in Spherical geometry. It is important to consider what system is used, as it may result in different findings. All of these different systems combine to form mathematics.

However, even with the objective and reliable nature of mathematics, it is still possible for simple language to be less accurate in comparison to a more complex language. Returning to the Pythagorean theorem example, both proofs are valid and acceptable, however the proof using vectors can be seen as being more accurate in the sense that it not only does it prove it for two dimensions like the geometric proofs but it proves the theorem for any number of dimensions. Complex mathematical proofs tend to have such an advantage over simple ones, as their complexity allows them to extend otherwise simple results. Additionally, mathematical models, which are expressed in more complex language may be able to obtain more accurate results than simpler ones as they are able to account for more. For example, the first attempts at working out the maximum number of moves needed to solve the Rubik’s cube was arrived at by dividing the rotational combinations of the Rubik’s cube to four (mathematical) groups, Morwen Thistlethwaite argued that the cube can be solved in 52 or less moves (Scherphuis, Jaap). More people improved on his model by further complicating his algorithm, considering even more configurations of the cube. This led to the discovery of 20 as the god number, the maximum number of turns required to solve the cube. The simplicity of mathematical language could in some cases limit its accuracy especially for applied mathematics such as mathematical modelling, where we may require more information. In these cases, further complicating mathematical models such as incorporating more data sets or variables, allow us to approximate reality better, producing even more accurate results.

In the NS there is a trade off between the simplicity of language and accuracy of generation of knowledge claims. The NS aims to describe our universe, through exploring its law through experimentation. The language used in the NS are very specific to the field, which are not opened to interpretations, so much that the language used varies between the sciences, because each science has their own specific terminology, thus allowing scientists to accurately and effectively communicate between each other using specific vocabularies to suit their area of study. For example in my Physics IA, I investigated the nature of a bouncing ball. Presumably, if a scientist were to explain this phenomena in simple language in order to communicate it to a non-scientist, he/she would say that the rebound height of the golf ball gets smaller the more it bounces. This, however, is a simple generalisation, and not too accurate in conveying the essence of the phenomenon because it is open to different interpretations. While the statement is generally valid, it does not directly link the variables, as in fact the relationship of successive rebound heights is exponential, and can even be shown mathematically by Newton's mathematical law, yielding the relation: $Cr = \frac{\sqrt{h}}{\sqrt{H}}$, which is far more accurate than a qualitative description of the ball’s bouncing. This signifies the importance of the use of complex language in the NS; quantitative accuracy is lost in the use of simple language, when one tries to describe phenomena in layman’s terms. This means that the simplicity of language used in the NS can impact knowledge generation.

In some specific instances, however, there isn't a trade off between simplicity and accuracy in varying the language used in the NS; only the simplicity of the language just changes the amount of knowledge conveyed. For example, we might express a chemical reaction using simple language by writing the reactants and products out:

$$\text{Sodium hydroxide} + \text{Hydrochloric Acid} \rightarrow \text{Sodium Chloride} + \text{Water}.$$

A more complex, as it requires a deeper understand of chemistry, way of showing this reaction would be:

$$\text{NaOH(aq)} + \text{HCl (aq)} \rightarrow \text{NaCl(s)} + \text{H2O(l)},$$

as it requires a deeper understand of chemistry. This tells us more information such as the states of the elements and the ratio of the elements or ions in a substance. There are two hydrogen atoms for every oxygen atom in the symbol equation, which we would otherwise not have known in the word equation. Other cases besides this allow us to see the mole ratios of the chemicals using their stoichiometric coefficients. Although both word and symbol equations are equally correct, the complex symbolic language conveys extra information. In this case, there is no tradeoff in the sense that both equations show an accurate representation of the chemical reaction. This implies that the type of information, its purpose and the target audience are important factors to consider when determining the use of language in NS, since what is perceived is communicated without variation.

In conclusion in mathematics the simplicity of the language in which ideas are conveyed does not affect the accuracy of these ideas in a large sense; this is due to the nature of mathematics and how it is carried out. Its deductive methods allow for the derivation of identical results, in which case accuracy is not sacrificed. However, more complex language tends to be more useful as their complexity allows them to incorporate more information. This is especially important for applied mathematics, since more complex language means that more variables are considered, so generated knowledge is more accurate. In the NS the use of simplistic language can seen as a handicap as it is open to interpretation. However, more complex language, such as scientific field-specific vocabulary is far more accurate as each word has a specific definition, where there is no room for interpretation, allowing for specific relationships and findings to be communicated accurately. These points are important to consider when gaining knowledge, because while we want to learn it in the simplest way possible, likely using the simplest language, this has certain effects on the accuracy of the knowledge gained which vary according to the AOKs. Therefore it is of importance to be aware of the consequences of simplified language, as when applying this knowledge in a real life situation it may not work as effectively due to the simplification, as key knowledge is lost.

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