

## **–The Influence of Inductive Reasoning Thinking Skill on Enhancing Performance**

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### **Abstract**

The study was inclined to finding out what inductive reasoning skill can do in enhancing students' performance and achievement. The subject of inductive reasoning attracted more and more scholars in the 21<sup>st</sup> century, and it can be easily recognised worldwide that the development of students' thinking skills is on the top list of educational tasks. This study presented several points of views of scholars about the definition of inductive reasoning skill and presented as well an intensive and a most debatable model which is Klauer's theory. The study approached the literature as a multi-dimensional phenomenon, which addressed both theoretical and applied research. It is assumed that enhancing students' thinking skills is possible even in lower grades. Some scholars go even further than that by adding that doing efficient early interventions could significantly be beneficial in later school years. Academic performance emerged as a significant indicator of inductive reasoning thinking skill. Implications of the study for practice are discussed.

**Keywords:** Thinking skills, inductive reasoning, enhancement, performance.

### **Introduction**

The development of students' thinking skills is on the top list of educational tasks and it can be easily recognised worldwide. The purpose of this development is to enhance and support development at any degree (Bottino et al., 2007). In addition, one of the most important educational aims is fostering the development of thinking skills (Resnick, 1987; Molnár et al., 2013).

Klauer & Phye (2008) indicated that about a hundred years ago, empirical research was commenced on inductive reasoning in the case of intelligence research which happened with Spearman when he figured out that his general intelligence factor (see also Csapó, 1997) is basically determined by inductive processes, "education of relations." Afterwards, inductive processes have been identified by dimension analytic research as central intellectual factors identified as reasoning, or fluid intelligence.

Some researchers found a relationship between inductive reasoning and intelligence. In addition, inductive reasoning plays a significant role in acquisition of new knowledge and skills (Goldman & Pellegrino, 1982).

## **Aims And Scope**

This study presented Klauer's theory of inductive reasoning as one of the most outstanding and debatable model. It aimed at finding out what inductive reasoning skill can do in enhancing students' performance and achievement by reviewing previous studies and pointing out their results and remarks. The study, considered to be the first to the author's knowledge and leading of its kind, also highlighted the importance of inductive reasoning. Therefore, this is a qualitative research study using content analysis, and it is appropriate due to the exploratory nature of the research.

## **Inductive Reasoning**

A general thinking skill is called inductive reasoning (Pellegrino & Glaser, 1982; Ropo, 1987; Molnár et al., 2013) and it is one of the basic thinking processes (Klauer & Phye, 2008; Molnár et al., 2013). It also has connection to almost all thinking skills of higher order (Csapó, 1997; Molnár et al., 2013; Schubert et al., 2012) like general intelligence (Klauer & Phye, 2008), knowledge acquisition and application (Hamers, De Koning & Sijtsma, 2000), analogical reasoning (Goswami, 1991), and problem solving (Klauer, 1996; Tomic, 1995). Several studies have been established based on these procedures of knowledge. "The inductive method, or teaching by examples, is one of the oldest methods of instruction" (Csapó, 1997: 610). Csapó (1997) also added that it is considered as a long-lasting or continuous philosophical problem.

In order to understand the full meaning of inductive reasoning, some scholars identified it in its contrast to deductive reasoning, where "Induction means establishing, deduction means applying rules" (Shye, 1988). Therefore, one can understand that "inductive reasoning enables one to detect regularities, rules, or generalizations and, conversely, to detect irregularities. This is one way in which we structure our world" (Klauer et al., 2002: 1). It is obvious from the previous quotation that the main purpose of the inductive reasoning is to detect regularities or generalizations.

Another abroad definition for inductive reasoning is that “Induction is the process whereby one generalizes across a limited number of instances, examples, or observations in order to find a description that applies to them all” (Tomic, 1995: 484). Klauer (1989) also defines inductive reasoning as a general principle derived from specific examples. In the same rhythm, Sandberg & McCullough (2010) interpreted inductive reasoning as a process of shifting from specific to general. Other scholars added that inductive reasoning “is described as the generalization of single observations and experiences in order to reach general conclusions or derive broad rules-rule induction” (Molnár et al., 2013). Induction enables inference with the unobserved, formulates novel conclusions about the unknown, and generates new knowledge (Sloman & Lagnado, 2005). These definitions present the diverse variety among scholars in defining induction.

Molnár interpreted Klauer’s (1993) definition of inductive reasoning as “the discovery of regularities through the detection of similarities, dissimilarities, or a combination of both, with respect to attributes or relations to or between objects” (Molnár, 2011: 92). She added that based on this definition, there are six different categories including: generalization, cross-classification, discrimination, system formation, recognizing relations, and discriminating between relations (Molnár, 2011).

### **Klauer’s Model of Inductive Reasoning**

Klauer’s as well as his colleagues’ perspective to inductive reasoning are considered from an educational point of view as a well-structured and detailed theory (Klauer & Phye, 1994; Klauer et al., 2002). Both the developmental training program and the assessment procedure are mainly based on this approach and they can be understood throughout this framework. Klauer starts his theory by giving a definition of inductive reasoning. Then the process moves on to a comprehensive classification of inductive reasoning tasks. It also gives specific processes that one can follow in order to solve these task types. By following up the cognitive process analysis, two comprehensive strategies can be used in solving inductive problems.

As stated by Klauer, “Inductive reasoning consists of detecting regularities and irregularities by finding out:

A: {a1: similarity; a2: difference; a3: similarity and difference}  
of  
B: {b1: attributes; b2: relations}  
with

C: {c1: verbal; c2: pictorial; c3: geometrical; c4: numerical; c5: other} material” (Klauer & Phye, 2008: 87).

Klauer’s definition presents the possibility of inductive reasoning to reveal regularities as well as irregularities and diversities. In other words, if a rule did not cover the whole of a set of elements, it should be ignored in favour of a more suitable one. A total of thirty cases (3 x 2 x 5) could be formulated out of the above facets. The first facet A is that of the comparison which produces regularities. The second facet of the definition B is the category which makes it possible to provide another aspect. All possibilities have been covered by the relations and this shows how far the impact of inductive reasoning could be. The last facet C is the materials. Depending on the nature of the inductive reasoning material, one can choose the suitable category among the given ones in facet C.

The definition shows the strategy that one can follow to reason inductively about a given problem by scrutinizing the attributes of the objects or the relations between them.

**Table 1. Types of inductive reasoning problems (Klauer & Phye, 2008: 88)**

Process	Facet Identification	Item Formats	Cognitive Operation Required
Generalization	a <sub>1</sub> b <sub>1</sub>	class formation	similarity of attributes
		class expansion	
		finding common attributes	
Discrimination	a <sub>2</sub> b <sub>1</sub>	Identifying disturbing items	Discrimination of attributes (concept differentiation)
Cross Classification	a <sub>3</sub> b <sub>1</sub>	4-fold scheme	Similarity and difference in attributes
		6-fold scheme	
		9-fold scheme	
Recognizing Relationships	a <sub>1</sub> b <sub>2</sub>	series completion	Similarity of relationships
		ordered series	
		analogy	
Differentiating Relationships	a <sub>2</sub> b <sub>2</sub>	disturbed series	Differences in relationships
System Construction	a <sub>3</sub> b <sub>2</sub>	matrices	Similarity and difference in relationships

Both A and B represent the central part of the definition. The output of these two facets is six classes of inductive reasoning as shown in Table 1. The relationships among these six major varieties of inductive reasoning tasks are classified in Figure 1.

**Figure 1. Genealogy of tasks in inductive reasoning (Klauer & Phye, 2008: 87)**

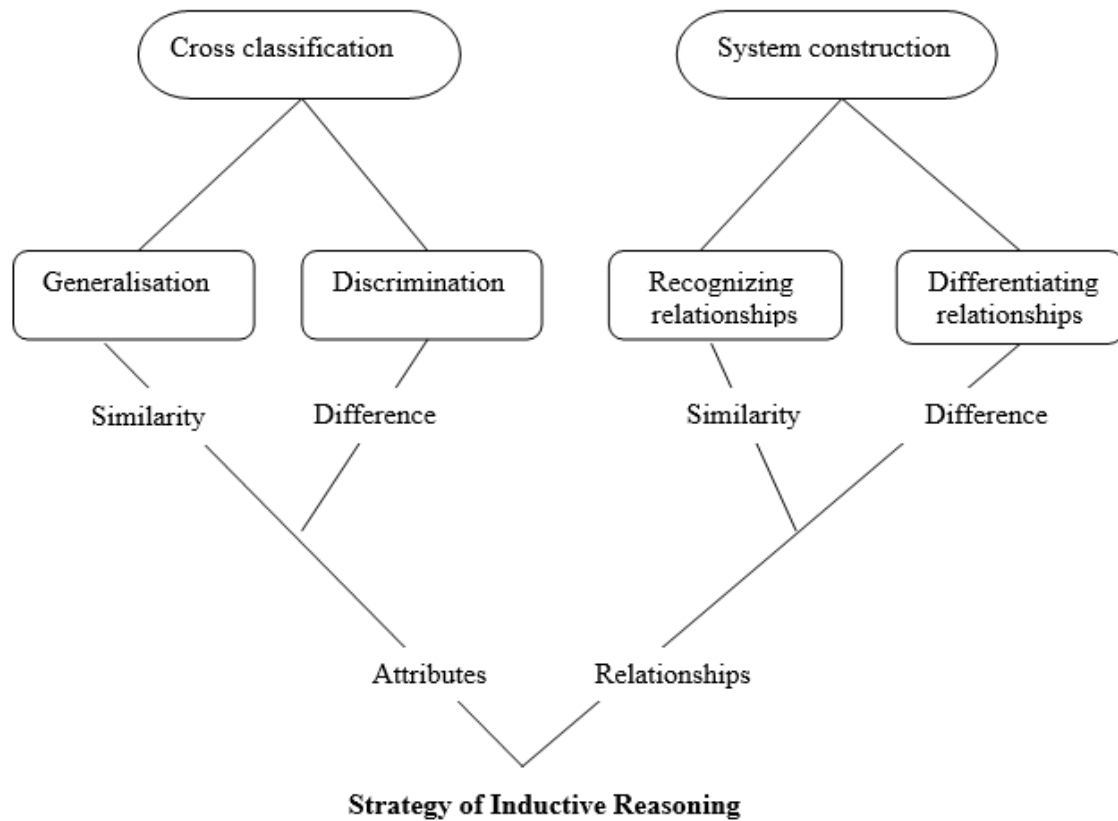


Figure 1 shows two separate branches and each one of them gives a separate branch once again depending on the need of either similarities or differences. Both of the similarities and differences meet again in some cases. The differentiation similarity between the attribute and the relations branches causes a symmetrical figure. This definition gives the possibility to design an analytic strategy to be able to solve any kind of inductive reasoning problem (Klauer & Phye, 2008).

**Figure 2. The heuristic strategy which is used by people as well.**

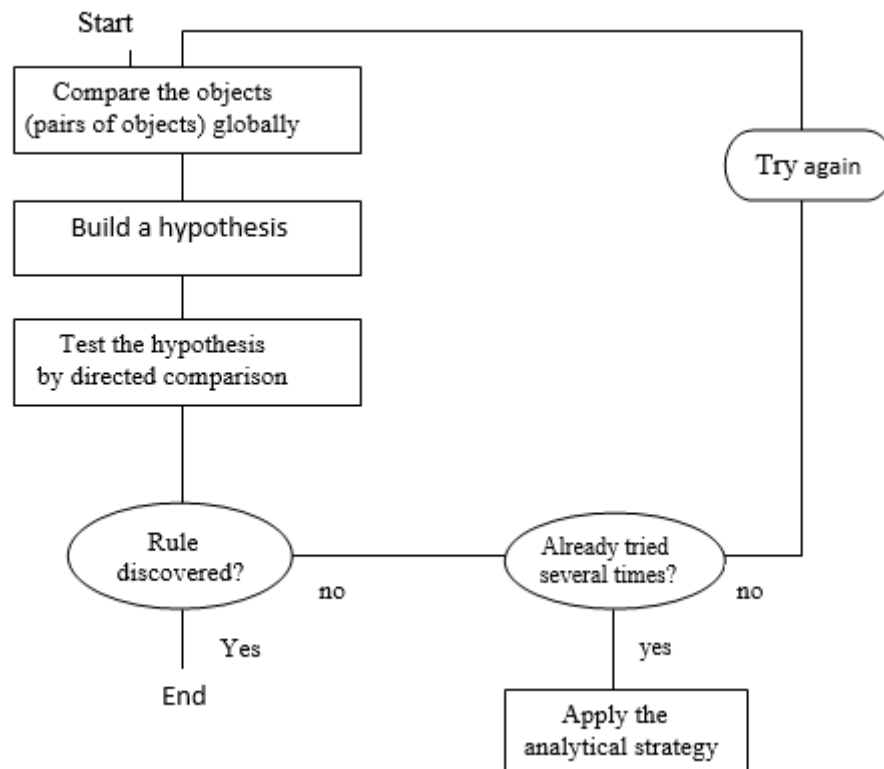


Figure 2. Heuristic or hypothesis – guided strategy of inductive reasoning (Klauer & Phye, 2008: 89)

This strategy is basically about building a hypothesis by starting a global inspiration of the task. The quality of the tested hypothesis determines the speed in finding the solution.

### Enhancing Inductive Reasoning Explicitly

Results and remarks of some studies can be illustrated based on the fact that the current study is based on Klauer’s definition of inductive reasoning; therefore, we have to take a look at his cognitive training programme for children I (Denktraining für kinder I) which is based on his theory of inductive reasoning (Klauer, 1989, 1991). The main aim of his work was to identify the similarities between attributes and relations, and to present the way to solve identified problems by inductive reasoning. The results presented by Klauer & Phye (2008) were gotten from 74 training experiments over a 3600 participants who were children from different age groups. The main findings of Klauer’s explicit teaching method can be summarised by stating

that the programme has a reasonable transfer effect on fluid intelligence and various academic subjects (Klauer & Phye, 2008).

Bottino et al. (2007) designed a project for first graders to foster their reasoning abilities by engaging them in a number of computer games. The impact of the results was positive; it was mainly on students' logical and strategic reasoning. Using software programs added another value which helps to reinforce the relations between the teacher and his students.

Another program on fostering first graders' inductive reasoning is Molnár's (2011) training program which was based on Klauer's definition of inductive reasoning. The results show a significant improvement on all six basic structures of inductive reasoning skills. Regarding gender, there were no relations between the effectiveness of the program and gender variable. Also, the effect was similar on both genders (males and females). Other studies proved the correlation between the improvement of inductive reasoning and successful learning of school subjects like second languages (Csapó & Nikolov, 2009). These studies suggested the possibility of developing inductive reasoning skills in early school age. Furthermore, the development is also observed on pupils with special needs such as low achieving students (Hotulainen et al., 2016).

## **Why Inductive Reasoning?**

Inductive reasoning is closely connected to intelligence and the relationship between them is so far strong (Klauer et al., 2002; Csapó, 1997). In addition, acquisition of new knowledge and skills is also considered as an important role that inductive reasoning plays in enhancing and developing students' performance (Goldman & Pellegrino, 1982). There are several advantages that can be acquired by implementing inductive reasoning on school children regarding knowledge: "inductive reasoning is one of the mental tools that is used not only to acquire new knowledge, but also to make the acquired knowledge more readily applicable in new contexts" (Csapó, 1997: 612).

Inductive reasoning is a helpful procedure that is useful in making predictions about new hypothesis set by researchers. "Inductive reasoning involves making predictions about novel situations based on existing knowledge" (Hayes et al., 2010: 278). From all of the previous definitions of inductive reasoning, one can understand that the procedure of implementing inductive reasoning is practical where a researcher can choose specific number of students



and then generate the outcomes of the whole region that have the same characteristics of the tested group. The test can be delivered to students by asking them several questions or by giving them a group of pictures or numbers to do a specific calculation or matching... etc. These activities can be presented by a specific computer program. Then at the end of the test, the researcher will get a final result for each student and, in general, these results are accurate and correct in all details.

There are many reasons for emphasising the importance of induction; here are the main ones: first of all, inductive reasoning works in potentiality and approximate reasoning as well as daily reasoning. We practise this kind of reasoning in our daily life activities in order to reach a specific and certain conclusion; for instance, in the expectance of the taste of a meal, weather it is going to be tasty or not (Heli, 2001).

The second reason for studying induction according to Heli (2001) is that induction is an activity which has many cognitive facets. He provides various kinds of examples regarding this reason; saying that someone could easily give a group of students some easy questions and these questions can be delivered to them by using cartoon pictures. In the case of adults, one can provide them with several arguments and their mission is to reach a reason-based judgment. He added that it is not possible to reach a confirmed result since induction itself is not absolute by nature. That has been proven by several studies set by researchers where they are still finding new results. Tomic (1995) demonstrates this reason by pointing out that “induction enables us to make predictions about new possibilities—to anticipate results, as it were.”

Reason number three: induction is connected to several types of cognitive activities including decision making, categorisation and probability as well as similarity judgments (Hayes et al., 2010).

The last but not the least: Heli (2001: 1) presented in his study that “the study of induction has the potential to be theoretically revealing. Because so much of people's reasoning is actually inductive reasoning, and because there is such a rich data set associated with induction, and because induction is related to other central cognitive activities, it is possible to find out a lot about not only reasoning, but also cognition more generally by studying induction”.



The prominence of inductive reasoning development in knowledge acquisition and application has been pointed out in the findings of previous studies (Bisanz, Bisanz & Korpan, 1994; Hamers, De Koning & Sijtsma, 2000; Klauer, 1990). Not only that, but also in the development of expertise (Cheng & Holyoak, 1985). Thus, one of the advantages of developing inductive reasoning is acquiring a deeper understanding of the subject matter in the classroom (Molnár, 2011). For that, it is suggested that school curriculum should contain these thinking skills (de Konig, 2000; Resnick, 1987) and it should be included in learning activities in school (Molnár, 2011).

## **Conclusion And Recommendations**

There is a diversity of opinion among scholars in defining inductive reasoning skill. The most suitable, practical, and well developed is Klauer's theory. It offers a definition which classifies all tasks of inductive reasoning and it also specifies the processes that can solve inductive problem tasks. This process of solving is a prescription to an effective and efficient way to solve inductive problems.

The results of the empirical studies on the field of inductive reasoning were positive in general. Development was noticed by the studies on various parts of students' cognitive skills i.e. students' logical and strategic reasoning, as well as fluid intelligence and various academic subjects. Here, to distinguish inductive reasoning from other reasoning skills and to know its exact influence, it is suggested to know the extent to which inductive reasoning really fostered students' cognitive skills like fluid intelligence. Furthermore, developing inductive reasoning skill in early ages is possible and it has been suggested by scholars to do efficient early interventions which could significantly return in later school years.

The importance of induction appears regarding its intensive usage in daily life activities and its strong relation to other cognitive activities. It is also practical in gathering data and generalizing it. All of that makes it handy and useful for researchers. Regarding the educational field, previous studies demonstrated the importance of inductive reasoning in several serious educational aspects such as acquiring knowledge and understanding the subject matter in the classroom. In addition, a general thinking process is about finding similarities and differences in relations and attributes. In this regard, the psychological concepts of Klauer's theory are practical and applicable in everyday classroom teaching and it is also handy to all school subjects.

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## **HOW TO CITE THIS PAPER**

Mousa, M. (2017). The Influence of Inductive Reasoning Thinking Skill on Enhancing Performance. *International Humanities Studies*, 4(3), 37-48.

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