# Study of doing simple practical work by inquiry method on attitude of one grade high school students in chemistry course

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**Abstract**. *Chemistry is one of the sciences which students feel it hard because they should image reactions and molecular behaviour in them. In fact doing chemistry in labs cause better learning and promote student's abilities such as questioning, investigating, discussing and so on because it makes their attitude enhance and they like learning. For this purpose, inquiry approach is selected in 4 levels. This study is focuses on attitude of high school students who learn chemistry through inquiry approach. For this study, 120 students were chosen who were in first year of high school and divided into 2 main groups (traditional and inquiry groups). Our results show every level of inquiry had different effect on student's attitude. Highest score in attitude was for highest level of inquiry teaching method where the students had more freedom in their experiments and lowest one was lowest level which had no difference with traditional approach.*

**Keywords.** Chemistry education, High school, Attitude, Inquiry method.

## 1. Introduction

In recent years, science inquiry has been the focus of researchers and K–12 practitioners. According to the National Science Education Standards [1], an inquiry-based learning environment encourages opportunities for children to learn science, learn to do science, and learn about science. Science inquiry encourages the development of problem solving, communication, and thinking skills as students pose questions about the natural world and then seek evidence to answer their questions. Particularly, efforts have been focused on improving inquiry skills for students from non mainstream backgrounds who have traditionally been underserved in the education system [2-4]. The ability to question, hypothesize, design investigations, and develop conclusions based on evidence gives all students the problem-solving, communication, and thinking skills that they will need to take their place in the 21st century world [1].

Teachers of science at all levels have come to the conclusion that students need much more experience in “doing” science. Most agree that exercises based in inquiry, where students use their laboratory skills to answer a pertinent question, are the most valuable. Unfortunately, many older laboratory manuals and books are limited in their ability to give students this experience; rather, students follow a cookbook-type procedure, taking measurements prescribed by the instructions for the procedure and answering a number of questions at the end. The reason that they need each data point or measurement may not always be clear. The decisions regarding what to measure and when to measure are already made for them [5].

## 2. Inquiry definition

The idea of inquiry in science education is not new. Researchers have argued its importance since the middle of the last decade when science education was found to have a serious flaw. From the nineteenth century until today’s reform movement, several people, including Dewey, Schwab, and Rutherford, emphasized the role of inquiry in science teaching and education [6].

Dewey is frequently cited by science educators as a pioneer in education who emphasized the role of inquiry in science education. Dewey stated that science teaching overemphasized the “accumulation of ready-made material with which students are to be made familiar, not enough as a method of thinking, an attitude of mind, after the pattern of which mental habits are to be transformed” [7].

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During the 1960s, Joseph Schwab suggested that science should be presented as inquiry and students should carry out inquiry activities [8]. As an alternative to the teaching of science as a presentation of facts already known, Schwab (1960) put forward enquiry (his choice of spelling) as a way of teaching classroom science. He emphasized, “We need to imbue our courses and exposition with the colour of science as enquiry. We need to give the student an effective glimpse of the vicissitudes of research [9].

Numerous definitions can be found in the education literature. Flick (2002) provided a three part definition that includes the process of how modern science is conducted, an approach for teaching science, and knowledge about the nature of science [10]. Other definitions encompass processes, such as using investigative skills; actively seeking answers to questions about specific science concepts; and developing students’ ability to engage, explore, consolidate, and assess information [11]. Inquiry is agreed upon as student centred or open when students generate a question and carry out an investigation, teacher guided when the teacher selects the question and both students and teacher decide how to design and carry out an investigation, and teacher centred or explicit when the teacher selects the question and carries out an investigation through direct instruction or modelling [1].

Additionally, students engaged in simple inquiry engage in processes such as observing, comparing, contrasting, and hypothesizing. Students engaged in full inquiry use these skills in the context of well-structured, science-subject-matter knowledge and the ability to reason and apply scientific understanding to a variety of problems [1]. Settlage (2003) suggested that the commonly held framework of science inquiry has remained essentially the same from the middle of the previous century until today: Inquiry begins with a question based on observation, which ultimately leads to a conclusion based on evidence. However, Keys and Bryan (2001) challenged the notion that there is a simple, preconceived framework of inquiry waiting to be discovered by students. Based on a constructivist view of inquiry, Keys and Bryan proposed that inquiry is individually constructed by each student based on his or her interaction with the physical world and abstract ideas. Rather than a lock-step trip through the various components of the inquiry process, Keys and Bryan assumed that students construct their own knowledge about science, about how scientists work, and about the inquiry process as they interact with their peers, their teacher, and the classroom context [12].

A critical challenge in the study of science inquiry is the lack of a clear or agreed upon conception of what science inquiry involves. The National Science Education Standards provide a definition modelled after the work of scientists:

Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world [1].

## 3. Inquiry models

The NSES uses inquiry in three different ways: scientific inquiry, inquiry learning, and inquiry teaching [13].

The use of “scientific inquiry” in the NSES reflects an understanding of “‘science as process,’ in which students learn such skills as observing, inferring, and experimenting” and is independent of instructional strategy.

"Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" [1].

When inquiry is used in the manner of “inquiry learning,” it refers to a learning process wherein students are engaged. This active learning process reflects the nature of scientific inquiry [13]. The NSES rest on the premise that learning science requires students’ involvement both in “Hands-on” and “Minds-on” activities.

Some of the descriptions of inquiry as teaching as depicted by NSES include: (a) Inquiry as the activities in which students develop knowledge and understandings of scientific ideas, as well as an understanding of how scientists study the natural world; (b) Inquiry as activities that involve students in generating authentic questions from their experiences; (c) Inquiry as activities that provide a basis for observation, data collection, reflection, and analysis of firsthand events and phenomena; (d) Inquiry as activities that encourage the critical analysis of secondary sources--including media, books, and journals in a library.

A classification scheme developed by Herron (1971) based on the work of Schwab [8] is useful in assessing the levels of inquiry, or degree to which laboratory activities promote student inquiry.

Characterized by four distinct levels of inquiry, or openness, the classification scheme differentiates each level of inquiry by the information and support provided to the students as part of the laboratory activity [14]. In other words, an activity's level of inquiry is determined by whether the problem, procedure, and solution are text directed or open for the student to establish. We use this classification for our survey (table 1).

**Table 1. Levels of Inquiry**

| Level | problem | procedure | solution |
|---|---|---|---|
| 0 | given | given | given |
| 1 | open | given | given |
| 2 | open | open | given |
| 3 | open | open | open |

Perhaps the best example of inductive inquiry is the Inquiry Development Program developed a number of years ago by J. Richard Schumann (fig.1). Schumann produced a number of inquiry programs designed to help students find out about science phenomena through inquiry:

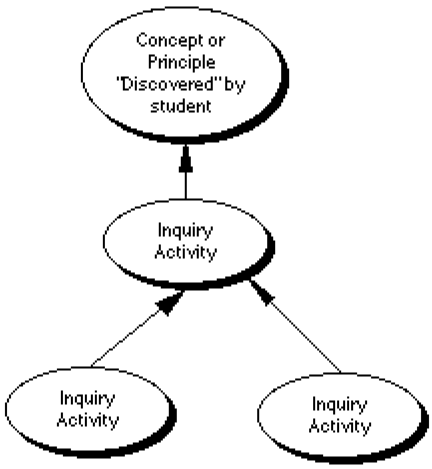


**Fig.1. Inductive inquiry diagram**

Another form of inquiry teaching is deductive inquiry, which we can contrast with inductive inquiry (fig.2). In this approach to inquiry, the teacher presents a generalization, principle or concept, and then engages students in one or more inquiry activities to help understand the concept.

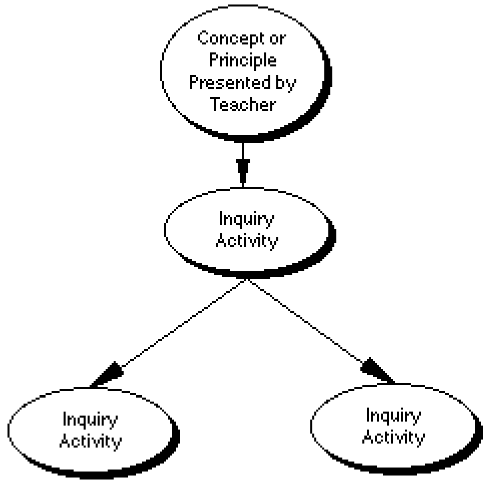


**Fig. 2. Deductive inquiry diagram**

## 4. Methodology

For this survey, 120 students was selected, who were in first year of high school. They divided into 2 groups, inquiry group and traditional group. In every class they put in small groups. Each one should had a representative who allowed to stand up and speak with other groups even to teacher when they should answered.

At first we had a section which we learned safety notations to students and became them familiar with lab tools. In every class students should sat with their groups members so that they can do works with each other and can look class board (fig.3.).

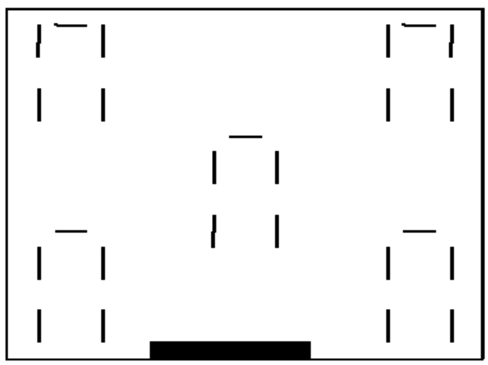

**Fig. 3. Arrangement of students in class**

Before starting, all of students took attitude test. It had 34 questions with 5 answers for every one that were from absolutely agree to absolutely disagree.

The traditional group teaching method was lecture, and every thing was demonstrated for students with teacher. At the end of period they took an attitude test again and their scores were gathered.

For inquiry group we had 4 sections and took this test at the end of each one. As you see above for this method we have 4 levels, so we teach each level in each section. At level 0, teacher says problem, clear it and at the end solve some questions and illustrate them. For level 1, we asked students that each group choose one subject and one picture which they took was important, so we state them and said their notations. In level 2, they should choose a subject from their chemistry book and with any thing they like explained it to class, it was wonderful they made some pictures, tools, even graphs to explain their subject. Because it had a competition sense between them we set times to do it and each group that could done work they get a stars and each one that had less stars should buy ice-cream for others.

In level 3, we wanted they choose a subject and with an experiment show it to class. But before starting they should write their experiment if we confirmed they can come to school lab, otherwise they should go to school library for more studies.

In designing experiment they allowed use every thing that was safe, and write their purpose, tools were needed, steps of doing work and predict what happen? And why?.

At first some of them were confused and said it is boring.

"What is this? We never have chemistry like this"

"Sorry; I think it is your work not students, if we knew these why we come in school?"

"It is so boring and hard you wanted we write lab book"

Yes! These are their chiding when we said design your experiment. But it's not from all of them. In forth section they came to class with papers many of them were allowed to go to lab and start work. A few of them had safety problems so groups members should correct, they allowed to come into lab and if they know what is wrong and correct it can do their experiment in extra time.

Working in groups let students to learn from each other, correct their plans and think. Our more problems with student was in level 3, somebody did not know how look for a experiment, someone did not write and some students could not conclusion. But being in groups gave them a fortune to learn these.

"I ever know answers but did not know how to explain it; I learned it with my friends when we were taking about our work".

"At first it was terrible for me to think alone, but now I fill it is necessary".

"It was a bit hard but wonderful"

## 5. Data analysis

The analysis of the results in this study was done in 2 aspects.

1: comparing attitude scores of students in 2 main groups, traditional and inquiry.

2: comparing attitude scores between inquiry levels.

As you see in table 2, the students who were in inquiry group have better senses in learning chemistry than traditional method. Our attitude test had 34 questions which it's answered were arranged by likert scale.

According our results in table. 2, using inquiry method in doing made simple practical works intend to increase chemistry attitude sense between students. As shown in table 3, the difference attitude test results between inquiry and traditional groups are meaningful. As a result, by using inquiry method, the attitude of learners increases by doing some simple activities in chemistry.

## 6. Conclusion

The purpose of this study was establishing inquiry method on high school class and surveying what is the sense of students when they learn chemistry in this manner? For subject that we selected we spent just one section more than traditional classes, but at the end of survey students liked to resumed it for more class times.

It is important that we do not forget in every class you my have some willing students, somebody who do not learn or participate in class arguments; but we think with hands- on teaching strategies like inquiry method in class you know them and how many they are? But in traditional classes can you say how many students do you have that are willing in your class?

However we should know that there are times when it is more appropriate to give students a procedure; for example when a particular technique is being taught. There are also benefits to students learning how to read and perform a given set of steps. Students can still experience in-depth analysis and understanding

**Table 2. t test results of pre and post attitude test in inquiry group**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Pre and post attitude test (inquiry group) | Equal variances assumed | 20.138 | .000 | -13.1 | 118 | .000 | -30.567 | 2.31195 | -35.144 | -25.988 |
| | Equal variances not assumed | .00000 | | -13.1 | 99.83 | .000 | -30.567 | 2.31195 | -35.151 | -25.973 |

**Table 3. Comparing attitude scores of students in 2 main groups, traditional and inquiry (level 3) by using t test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Attitude post test (Inquiry method ( after level 3) and traditional method) | Equal variances assumed | 44.516 | .000 | 24.250 | 118 | .000 | 54.6333 | 2.25292 | 50.1719 | 59.0947 |
| | Equal variances not assumed | | | 24.250 | 78.031 | .000 | 54.6333 | 2.25292 | 50.1481 | 59.1185 |

with good questioning and discussion after a non-inquiry lab.

Therefore, inquiry-based approaches should be used as often as is practical. If students perform even a few inquiry-based labs each year throughout their middle school and high school careers, by graduation they will be more self-confident, critical-thinking people who are unafraid of "doing science" [15].

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