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Inductive And Deductive Reasoning In Mathematics Of Female Middle School Students

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Abstract

This study seeks to identify the level of mathematical reasoning (inductive and deductive reasoning) among Saudi female middle school students in mathematics. A survey method was used to achieve the objectives of the study, where a questionnaire was distributed to 500 female students in the 8th grade in the city of Hail. The results indicate that the level of mathematical reasoning of the participants was weak (M = 3.88), where the inductive reasoning (M = 2.24) came first followed by the deductive reasoning (M = 1.64). Based on the results, the current study recommends the need to spread awareness of the importance of developing inductive and deductive reasoning among female middle school students in learning mathematics, adopting educational programs that contribute to the development of both types of reasoning, and directing those in charge of preparing mathematics curriculum to the importance of including both inductive and deductive reasoning in their textbooks.

Keywords: Mathematical reasoning, Inductive reasoning, Deductive reasoning, Female students, Middle school, Saudi Arabia

Introduction:

Learning in the modern digital age is different from other eras, and it has become the students' task to learn how to learn, how to think, and how to produce knowledge themselves. This led to the birth of different curricula such as the innovative curriculum, the electronic curriculum, and the interactive curriculum that allows the student to learn interactively through experimentation with the learning educational material (Alqasim & Asiri, 2016).

Educators and mathematicians have paid attention to mathematical reasoning. It is the foundation on which the human mind builds to reach solutions to a specific topic (Almahzari & Talhi, 2016). Given the importance of mathematical reasoning in the educational process, many studies have dealt with it, such as Omar (2015), Almaqed (2016), and Alorini (2017). All these studies emphasized the importance of mathematical reasoning and the necessity of developing it among students. Also, the Mathematics National Council of Teachers (NCTM) recommended educational programs through which the learners could improve their mathematical reasoning, and having the ability to analyze and evaluate the mathematical reasoning of others (NCTM, 2000).

Although the development of mathematical reasoning is one of the most important goals that the teaching of mathematics seeks to achieve, there are great difficulties faced by students in schools to reach this goal (Alsayari, 2015).

Study problem:

The current study aims to investigate the level of mathematical reasoning among female second

year middle school students in Saudi Arabia. Wherefore, the study problem can be identified in the following question: What is the level of mathematical reasoning among 8th grade female students in the city of Hail?

Theoretical Framework

Definition of mathematical reasoning:

This type of thinking focuses on the use of mathematical equations and reliance on symbols, theories, and proofs in judging the relationships between things (Abdel Fattah, 2012).

Jaafar (2013) defines mathematical reasoning as a set of mental processes that center on specific mathematical problems that aim to produce ideas that are used as a means or strategy to solve those problems. Mathematical thinking is also defined as a mental process specific to mathematics, represented in the ability of students to face a new problem and develop appropriate solutions for it (Alhobby, 2018). It is also defined as that process that aims to search for systematic and organized solutions to problems through the use of quantitative and spatial relations (Long & Jiar, 2014).

Considering the foregoing, mathematical reasoning procedurally is defined in this study as the mental activity carried out by female 8th grade students to confront a mathematical situation, solve a mathematical problem, or make a specific decision by employing inductive reasoning or deductive reasoning or both. Mathematical thinking is measured by the score that is obtained by the student in the test prepared for this purpose.

Inductive reasoning:

Alghamdi (2020) indicated that inductive reasoning is the ability of students to reach general judgments of a specific reality based on special cases. Waleed (2019) defined it as deriving a general rule or extracting a general characteristic from several special cases. Abu Jazar (2018) indicated that it is a method in which the individual moves from the part to the whole and from the particular to the general. Abu Safiya (2018) stated that induction is the thinking that takes place from the specific to the general or from the particulars to the universals, whereby a general rule is reached from observing individual facts. Inductive reasoning is defined in this study as the female student's ability to reach general judgments based on specific cases and facts.

Almaliki (2016) indicated that the sub-skills of inductive reasoning can be identified in the following forms:

1- Analysis by understanding each individual case separately.

2- Extracting provisions or rules related to a group of cases.

3- Inferring common characteristics among all individual cases.

4- Formulating a rule for the common characteristics of individual cases.

Deductive reasoning:

Alghamdi (2020) defined deductive reasoning as the ability of students to distinguish between what is right and wrong based on certain facts. Waleed (2019) defines it as applying the general result to individual cases. That is, it is a thought process in which the learner's mind shifts from the general rule, the general principle, or the abstract law to the specific example, the specific case, or the tangible case. Almaliki (2016) believes that deductive reasoning is the skill of applying the general rule, or the general law, to an individual case of the cases to which the rule or law applies. Deductive reasoning is defined in this study as the female student's ability to draw conclusions and special facts through the application of general laws.

Abu Hamad (2016) confirmed that the results of the deductive are truer than the results of the uncertain induction because the results of the deductive are based on the existing proven

premises, but this feature makes its results simple.

Almaliki (2016) indicated that deductive reasoning includes the following sub-skills:

1- Determine the basic components of the general rule.

2- Distinguish the relationship between the general rule and the special cases.

3- Determine the individual case to which the general rule applies.

4- Applying the general rule or the law to the individual case.

Literature Review

Many educational research have focused on studying inductive and deductive reasoning due to its importance in the educational process. Qassi (2014) aimed to measure the extent to which fifth grade primary students acquired the mathematical reasoning skills contained in the new mathematics curriculum in Algeria. The analytical descriptive approach was used, and a test was prepared to measure the extent to which 514 students acquired these skills (inductive reasoning and deductive reasoning). The results showed a low percentage of pupils' acquisition of mathematical reasoning skills, and this weakness was explained by the difficulty of mathematics, and the ineffectiveness of the teaching methods used.

Alsayari (2015) sought to identify the level of mathematical reasoning possessed by secondary school students in the city of Tabuk, Saudi Arabia. The descriptive method was used. The study tool, which was a test, was applied to a sample of 444 male and 224 female students. The study found that the level of possession of mathematical reasoning by sample individuals was weak.

The study of Almasa'fa (2017) aimed to identify the level of first-year secondary students in Jordan in mathematical reasoning. The descriptive analytical method was used with a sample of 100 male and female students. A test was used to measure the mathematical reasoning of the participants. The results showed that the level of mathematical reasoning of the participants was medium, in which inductive reasoning was higher than deductive reasoning.

Najem (2018) studied the level of mathematical reasoning and its relationship to achievement in mathematics among tenth grade students in Jordan. The descriptive correlational method was used with a sample of 491 male and female students. The study tools consisted of an achievement test in mathematics, and a mathematical reasoning test (inductive reasoning and deductive reasoning). The results of the study indicated that the students' performance was average in the mathematical reasoning test, where their performance in the induction test was higher. The results also indicated that there were no statistically significant differences between the average scores of males and the average scores of females in the same test.

Methodology

Due to the nature and objectives of this study, the descriptive survey method was used to identify the level of mathematical reasoning (inductive reasoning and deductive reasoning) of the participants. The descriptive survey method is used to study the phenomena that exist in a group of people, in a specific place, and at a specific time, with the aim of systematic analysis and interpretation of those phenomena (Darwish, 2018).

Research population:

The population of this study consists of all female students of the 8th grade in the city of Hail, Saudi Arabia, in the academic year 2019/2020.

Research sample:

Educational studies recommend that the appropriate sample size in descriptive studies is 15% of the original study population (Khader, 2013). Therefore, the sample of this study

consisted of 500 female students in public middle schools in the city of Hail.

Instrumentation:

A test was prepared to measure the level of mathematical thinking using the following steps:

1. The objective of the test was determined to measure the level of mathematical reasoning of 8th grade female students.

2. The types of mathematical reasoning were identified, namely inductive thinking and deductive thinking.

3. In its initial form, the test consisted of 11 multiple-choice items. The test items were distributed as follows (induction = 6, deductive = 5).

Test validity:

The apparent validity method was used to verify the validity of the test, where the test was presented to a group of experts to ensure the clarity of the test items linguistically, its suitability to the level of the participants, and the extent to which the test was able to measure the level of mathematical reasoning of the students. All expert comments have been considered and some paragraphs have been redrafted. The final test consists of 11 items.

Pilot study:

To verify the clarity of the test instructions and its linguistic integrity, a pilot study was conducted on 40 female students from the study population who were not a part of this study sample. The average time that students took to complete the test was 45 minutes. The internal consistency, discrimination and difficulty coefficient for each question of the test, and test reliability were calculated after analyzing the pilot study.

Internal consistency:

To verify the internal consistency of the test, Pearson's correlation coefficient was used to study the correlation between each item and the domain to which it belongs. Also, the correlation of the two domains of the test with the total score of the test was verified.

Table 1: Pearson correlation coefficient results

Domain	Item	Correlation coefficient	Item	Correlation coefficient
Inductive reasoning	1	0.647**	4	0.516**
	2	0.541**	5	0.417**
	3	0.294	6	0.501**
Deductive reasoning	7	0.388**	10	0.477**
	8	0.685**	11	0.498**
	9	0.681**		

Note. ** p-value is significant at 0.05

Table 1 indicates the validity and relevance of the test items as all correlation coefficient values were positive and statistically significant at the level of 0.05. However, item 3 in the inductive reasoning domain had a correlation coefficient of 0.294, which is a non-significant value. Item 3 has been removed as eighty percent of experts agree that it should be removed.

Table 2: Correlation coefficients of test domains with the total score

Domain	Correlation coefficient
Inductive reasoning	0.746**
Deductive reasoning	0.754**

Note. ** p-value is significant at 0.05

Table 2 indicates the validity and relevance of the test items, where all correlation coefficients with the total score of the test were significant at the level of 0.05.

Difficulty and discrimination coefficients:

The difficulty and discrimination coefficients for the test items are calculated in Table 3.

Table 3: Difficulty and discrimination coefficients for test items

Item	Difficulty coefficient	Discrimination coefficient	Item	Difficulty coefficient	Discrimination coefficient
1	20	45.5	7	67.5	30
2	67.5	63.6	8	47.5	63.6
3	85	27.3	9	57.5	72.7
4	22.5	36.4	10	62.5	36.4
5	65	27.3	11	47.5	48.2
6	62.5	45.5			

Table 3 indicates the fit of difficulty and discrimination coefficients for all test items. The value of difficulty and discrimination coefficients are appropriate when ranging from 20% to 85% (Al-Kilani et al., 2008).

Test reliability:

To verify the reliability of the test, a correlation coefficient was calculated using the Split-half method, which was 0.648, and the Spearman-Brown coefficient was calculated for the test, which was 0.627. Therefore, the reliability of the test was verified.

Consequently, the final form of the test consists of 10 items (see Table 4).

Table 4: Items of the test in its final form

Domain	Items	Item number in the test	%
Inductive reasoning	5	1-5	50
Deductive reasoning	5	6-10	50
Total	10		100

Results and Discussion:

To answer the research question, "What is the level of mathematical reasoning among 8th grade female students in the city of Hail?" means and standard deviations were calculated for the level of inductive reasoning and deductive reasoning of the sample. The level is high when the student achieved (75% or more), medium when they achieved (50% - less than 75%), low when they achieved (25% - less than 50%), and very low when they achieved (less than 25 %) of the total score.

Table 5: Sample responses to inductive reasoning

Item	M	Weighted Mean	SD	%	Level
1	0.56				
2	0.49				
3	0.60	2.24	1.245	44.8%	Low
4	0.24				
5	0.35				

Note. mean score out of (5).

Table 5 indicates that the students' level of inductive reasoning is low (% of weighted mean = 44.8%) because it is less than the hypothetical mean of 50%. This result shows a weak level of participants' possession of inductive reasoning. Most of the participants in this study (n = 148) got (2 out of 5), representing 29.6% of the participants, while 20 of the sample got (5 out of 5), which represents 4% of the participants.

Table 6: Sample responses to the deductive reasoning

Item	M	Weighted Mean	SD	%	Level
6	0.36				
7	0.34				
8	0.25	1.64	1.255	32.8%	Low
9	0.41				
10	0.27				

Note. mean score out of (5).

Table 6 indicates that the students' level of deductive reasoning is low (% of weighted mean = 32.8%) because it is less than the hypothetical mean of 50%. This result indicates a weak level of deductive reasoning among the participants. Most of the female students participating in this study (n = 165) got (1 out of 5), representing 33% of the participants, while 18 of the participants got (5 out of 5), which represents 3.6% of the sample.

Table 7: Mean scores of participants for mathematical reasoning

Domain	M	%	SD	Level	order
Inductive reasoning	2.24	44.8%	1.245	Low	First
Deductive reasoning	1.64	32.8%	1.255	Low	Second
Total	3.88	38.8 %	2.50	Low	

Note. mean score out of (10).

Table 7 shows the weak level of mathematical reasoning among the respondents, with a mean score of 38.8%, which is lower than the hypothetical mean of 50%. Table 7 also shows that the order of the participants' mathematical reasoning skills was as follows: inductive reasoning, followed by deductive reasoning. Perhaps the reason for this result is due to the accumulated weakness of the students during their previous learning period. In addition, the reason for this result may also be attributed to the inability of mathematics teachers to develop the mathematical reasoning of their students due to the large content of the course, and the teachers' focus on fulfilling all the topics in the textbook.

The result of this study is consistent with the results of many studies (e.g., Alsayari, 2015; Hirzalla, 2016; Qassi, 2014), which confirmed that the low level of mathematical reasoning may be due to the education system that focuses on achievement tests without focusing on the diversity of teaching methods, understanding knowledge rather than memorizing it, and developing higher thinking skills among students. Mathematics teachers focus their attention on covering course topics without allocating time to train students in mathematical reasoning. In addition, as a result of the accumulated weakness of students across the different academic levels, most of the teachers' attention is focused on raising the level of academic achievement among students without caring about developing their mathematical reasoning (inductive reasoning, deductive reasoning).

Conclusion:

This study aimed to investigate the level of mathematical reasoning (inductive reasoning, deductive reasoning) among 8th grade female students in the city of Hail, Saudi Arabia. The results of the study revealed that the participants had a low level of mathematical reasoning. The results also indicated that inductive thinking was higher than deductive thinking among female students. This study offers several recommendations for those interested in mathematical reasoning. First, it recommends that the Ministry of Education in Saudi Arabia stress the importance of spreading a culture of mathematical reasoning among middle school students. Secondly, it recommends that universities and institutes engage in the preparation of study programs that help in the development of inductive and deductive reasoning. Third, it recommends that teachers and educators be aware of the importance of preparing educational activities that help develop students' mathematical reasoning. This study also presents many suggestions for conducting research and future studies on verifying the level of male and female students' possession of mathematical reasoning at different academic levels, studying the effectiveness of some electronic programs for developing students' mathematical reasoning, and investigating the impact of educational environments on improving and developing students' mathematical reasoning.

References

1. Abdel Fattah, R. (2012). Developing innovative and creative thinking skills for managers. Arab group experts.
2. Abu Hamad, K. (2016). The impact of problem-centered learning on developing mathematical thinking skills among male 9th graders in gaza [Unpublished Master Thesis]. Islamic University of Gaza.
3. Abu Jazar, K. (2018). Impact of employing (SWOM) strategy on developing mathematical thinking skills among ninth grade female students in rafah governorate [Unpublished Master Thesis]. Islamic University of Gaza.
4. Abu Safiya, S. (2018). Effect of employing klausmeier model in developing mathematical concepts and mathematical thinking among elementary fourth grade students in gaza [Unpublished Master Thesis]. Islamic University of Gaza.
5. Alhobby, H. (2018). The impact of using writing for learning on developing mathematical thinking skills among eighth female graders in Gaza [Unpublished Master Thesis]. Islamic University of Gaza.
6. Alghamdi, M. (2020). Achievement in mathematics and its relationship to thinking skills: a field study on fifth-grade primary students in Jeddah governorate schools. Mathematics Education Journal, 23(1), 143–168. https://doi.org/10.21608/ARMIN.2020.80905
7. Al-Kilani, A., Al-Taqi, A., & Adass, A. (2008). Measurement and evaluation in teaching and learning. United Arab Company for Marketing and Supplies.
8. Almaqed, R. (2016). The effect of using directed survey strategy in developing mathematical problem solving and mathematical thinking at the fourth-grade students in UNRWA schools in Gaza [Unpublished Master Thesis]. Al-Azhar University - Gaza.
9. Almahzari, A., & Talhi, A. (2016). Mathematical thinking and its relation to the two sides of the brain in the first grade secondary students in the capital sanaa secretariat. Journal Alandalus for Humanities and Social Sciences, 15(12), 37–82. https://doi.org/10.35781/1637-015-012-002
10. Almaliki, A. (2016). The effect of constructive educational software on developing mathematical thinking skills among the intermediate second-grade students. Journal of Education, 171(1), 182–215. https://doi.org/10.21608/JSREP.2016.48411
11. Almasa'fa, A. (2017). Mathematical thinking skills of 11th grade students in jordan and their relation to student's gender and branch. Zarqa Journal for Research and Studies in Humanities, 17(1), 150–161.
12. Alorini, H. (2017). The effectiveness of using differentiated education in the development of some mathematical thinking skills of intermediate school students in Riyadh city. Journal of Educational and Psychological Sciences, 10(4), 1169-1218.
13. Alqasim, W., & Asiri, M. (2016). The curricula in the light of contemporary global climates. Rawabt for Publishing and Information Technology.
14. Alsayari, A. (2015). The degree of possession of mathematical thinking skills by secondary school students in the city of Tabuk [Unpublished Master Thesis]. Tabuk University.
15. Darwish, M. (2018). Research Methods in the Humanities. Aloma Publisher.
16. Hirzalla, H. (2016). Mathematical thinking and its relationship to attitudes

towards mathematics among the tenth-grade students in the public schools of Tulkarem governorate. Journal of Al-Quds Open University for educational and psychological research and studies, 4(15), 45-82.

17. Jaafar, N. (2013). The effectiveness of some brain-based learning strategies in teaching mathematics to develop the mathematical thinking skills of students in the first cycle of basic learning. Reading and Knowledge Journal, 138, 17–36.
18. Khader, M. (2013). Preparing research and scientific theses from idea to conclusion. Al-Azhar university.
19. Long, C., & Jiar, Y. (2014). Mathematical thinking and physics achievement of secondary school students. Sains Humanika, 2(4), 231-237.
20. Najem, K. (2018). The level of mathematical thinking and its relationship with mathematics achievement of tenth grade students in jordan. Journal of Mathematics Education, 21(10), 6–29. https://doi.org/10.21608/ARMIN.2018.81669
21. NCTM. (2000). Principle and standards for school mathematics. Reston: VA.
22. Omar, A. (2015). The effect of instructional program based on mathematical power on achievement and mathematical thinking among seventh grade students in nablus governorate. [Unpublished Master Thesis]. An-Najah National University.
23. Qassi, S. (2014). The extent to which fifth grade pupils acquire the mathematical thinking skills included in the new mathematics curriculum. Journal of Humanities and Social Sciences, (14), 169-182.
24. Waleed, B. (2019). The effect of Posner's model on the mathematical thinking of second-grade female students. Educational Studies Journal, 12(48), 1-24.