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# Exploring the Moderating Role of Demographic Variables in the Relationship between Scientific Curiosity and Creativity among Secondary School Students

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## ABSTRACT

This research investigates how considering demographic factors that may moderate the connection between Scientific Curiosity and Scientific Creativity among secondary school students. Factors such as gender, grade level, type of school, family structure, parental education and occupation influence Scientific Curiosity and Scientific Creativity independently and may affect the strength of their relationships. The aim is to analyze these relationships among 8th and 9th graders using structural regression analysis, with data collected from 200 students in Bilaspur, Chhattisgarh, India, who were surveyed using standardized scales for scientific curiosity (Xavier 2010) and scientific creativity (W. Hu & Adey, 2002a) Moderation analysis reveals that demographic variables significantly moderate the relationship between scientific creativity and scientific curiosity, indicating that students are better at turning curiosity into innovative scientific work. The findings emphasize the universal importance of fostering curiosity to enhance creativity in science education, irrespective of demographic factors. This underscores the need for the paper to discuss implications for curriculum design and teaching practices, along with suggestions for future research.

**Keywords:** Scientific Creativity, Scientific Curiosity, Demographic variables, Moderation.

## INTRODUCTION

Scientific curiosity, the intrinsic desire to acquire scientific knowledge (J. Jirout & Klahr, 2012), is considered a vital predictor of scientific creativity, which refers to generating novel and useful ideas within scientific contexts (W. Hu & Adey, 2002a). Research has established a positive association between scientific curiosity and creativity in educational contexts (Baram-Tsabari & Yarden, 2009; Kang et al., 2009). However, the extent to which demographic factors moderate this relationship remains underexplored, particularly within the secondary school context in India. Understanding whether variables such as gender, class, type of institution, family structure, and parental education and occupation influence the curiosity–creativity linkage can inform equitable educational interventions. This study hypothesizes that demographic variables do not significantly moderate the relationship between scientific curiosity and scientific creativity among secondary school students.

### Scientific Curiosity

Curiosity is a trait that every human being possesses. However, given our interest in curiosity as related to the engagement in science practices, we posited that a person might have science-specific curiosity, and those aspects of curiosity may in fact be domain-specific. Studies have found that more curious students tend to have higher achievement or more academic success. (Arnone et al., 1994)found that more curious first- and second-grade students in a museum study scored higher on a content-oriented post-test than the less curious students. Jirout & Klahr, (2012),found that curiosity and achievement were independent, although curiosity was correlated with asking more questions; children who were more curious also recognized the questions that were more effective. Engagement of curious students with the course material and discussions of content appeared to stimulate learning in challenging situations (Kashdan & Silvia, 2009). In summary, through exposure to learning environments that stimulate curiosity and support for its expression, the students may further explore content areas as well as participate in discussions that increase interest and understanding in formal and informal settings.

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### Scientific Creativity

Scientific creativity refers to the ability to generate original and valuable ideas in the domain of science, often involving problem identification, hypothesis generation, and innovative experimentation (W. Hu & Adey, 2002b). It plays a crucial role in advancing scientific knowledge, enabling learners to apply concepts creatively to solve real-world problems, thereby fostering deeper understanding and scientific literacy (Kind & Kind, 2007). Scientific creativity is not solely reliant on cognitive abilities but is also influenced by motivational, environmental, and affective factors that encourage curiosity and exploration, making it essential to cultivate it in educational settings to develop scientifically literate and innovative citizens (Barbot et al., 2011).

## METHODOLOGY

### Sample

The participants included 200 students from the 8th and 9th grade of four middle schools in Bilaspur city, Chhattisgarh, India. These schools are private and government secondary schools that were chosen at random. 50% (F=100) of the students are female and 50% (M=100) are male.

### Instruments

- The scientific curiosity Inventory was originally developed by Dr. B. Suresh & Tessy Xavier (2010), Govt. College of Teacher Education, Thiruvananthapuram, Kerala.
- Scientific Creativity was measured through the Scientific Creativity (SC) test (Hu & Adey, 2002).

## OBJECTIVES

To study the moderating effect of demographic variables (gender, class, type of institution, family structure, mother's education, father's education, mother's job, father's job) in the relationship between scientific curiosity and the scientific creativity of secondary school students.

### HYPOTHESIS ($H_{01}$)

There is no significant moderating effect of demographic variables (gender, class, family structure, school types, parental education, and parental job) in the relationship between scientific curiosity and scientific creativity of secondary school students.

To study the moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students.

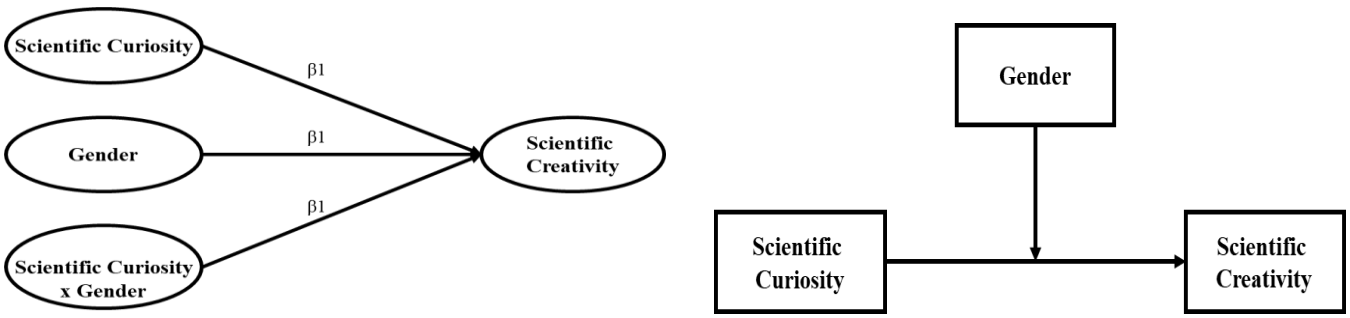


Fig. 1. Statistical and Conceptua diagram of moderating effect of gender in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.1:** There is no significant moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students.

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**Table 1:** The moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 1: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.26 | 0.07 | 212.84 | 4.57 | 3.00 | 196.00 | 0.00* |

* Significant at 0,05 level

Table 1.1: Model

| Dependent Variable | Model | β | SE | t | p |
|---|---|---|---|---|---|
| Scientific Creativity | Constant | 60.64 | 1.47 | 41.21 | 0.00 |
| | Scientific Curiosity | 1.30 | 0.59 | 2.21 | 0.03 |
| | Gender | 0.70 | 2.07 | 0.34 | 0.74 |
| | Interaction | 0.33 | 0.80 | 0.41 | 0.68 |

Table 1.1: Test(s) of highest order unconditional interaction(s)

| | $R^2$-chng | F | df1 | df2 | p |
|---|---|---|---|---|---|
| X*W | 0.00 | 0.17 | 1.00 | 1.96 | 0.68 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Gender (W)

Moderation analysis was conducted to test of the moderation effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students. In order to perform the analysis, scientific curiosity, gender and their interaction (scientific curiosity and gender) were regressed on scientific creativity. The result that emerged from the interaction moderation effect indicated that scientific curiosity and gender did not have a significant effect on scientific creativity ((β=0.33, t=0.41, p>0.05). Model summary provides a summary of the model with R, $R^2$, F—statistics, and p-value for the overall model. The table 1. reveals that the model is significant where R=0.26, $R^2$=0.07, F=4.57, which is significant at 0,05 level (p<0.05). F change also reveals the significant moderation effect of gender in the in the relationship between scientific curiosity and scientific creativity of secondary school students. Again, change in the R square helped in explaining additional variance. $R^2$ change value is 0.00, which is not significant (p > 0.05). It indicates that gender accounted for 0 percent variance in the scientific creativity of secondary school students. Therefore, null hypothesis is not rejected. It is finally be interpreted that there is not significant moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students. Further, the moderation effect of gender in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

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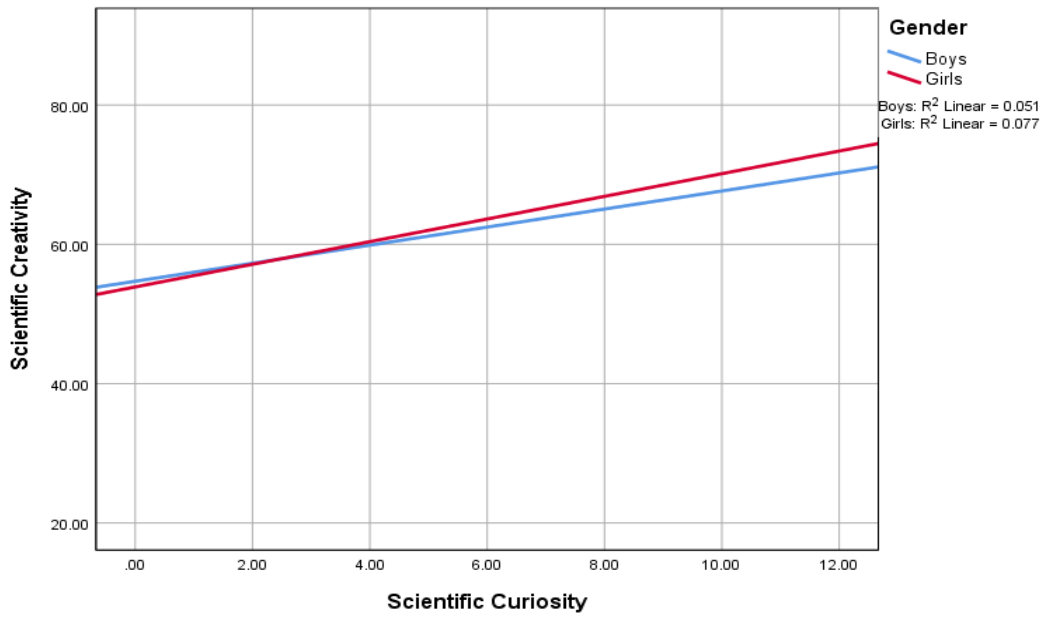


Fig.2. Moderating effect of gender on scientific curiosity and scientific creativity

To study the moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students.

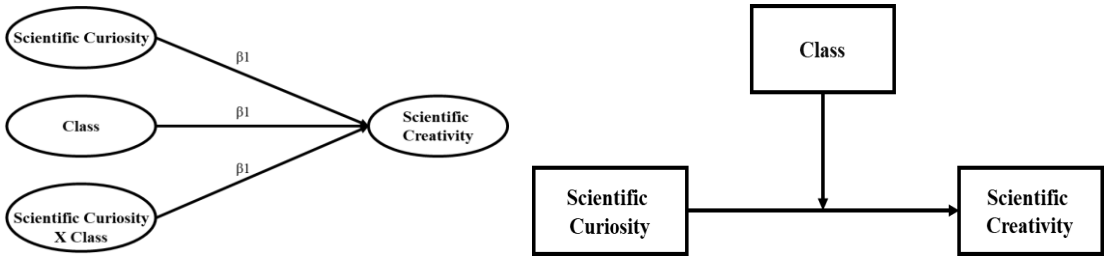


Fig. 3. Statistical and Conceptual diagram of moderating effect of class in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.2:** There is no significant moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students.

***Table 2:*** The moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 2: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.82 | 0.33 | 0.11 | 203.38 | 7.82 | 3.00 | 0.00* |

* *Significant at 0,05 level*

Table 2.1: Model

| Dependent Variable | Model | β | SE | t | p |
|---|---|---|---|---|---|
| Scientific Creativity | Constant | 60.95 | 1.41 | 45.30 | 0.00 |
| | Scientific Curiosity | 1.44 | 0.57 | 2.54 | 0.01 |
| | Class | -6.20 | 2.03 | 3.06 | 0.00 |

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| | | | | | |
|---|---|---|---|---|---|
| | Interaction | -0.17 | 0.78 | 0.22 | 0.82 |

Table 2.2: Test(s) of highest order unconditional interaction(s)

| | $R^2$-chng | F | df1 | df2 | p |
|---|---|---|---|---|---|
| X*W | 0.00 | 0.05 | 1.00 | 196.00 | 0.82 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Class (W)

Moderation analysis was conducted to test of the moderation effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students. In order to perform the analysis, scientific curiosity, class and their interaction (scientific curiosity and class) were regressed on scientific creativity. The result that emerged from the interaction moderation effect indicated that scientific curiosity and class did not have a significant effect on scientific creativity (β=-0.17, t=0.22, p>0.05). Model summary provides a summary of the model with R, $R^2$, F—statistics, and p-value for the overall model. The table 2. reveals that the model is significant where R=0.82, $R^2$=0.33, F=203.38, which is significant at 0,05 level (p<0.05). F change also reveals the significant moderation effect of class in the in the relationship between scientific curiosity and scientific creativity of secondary school students. Again, change in the R square helped in explaining additional variance. $R^2$ change value is 0.00, which is not significant (p > 0.05). It indicates that class accounted for 0 percent variance in the scientific creativity of secondary school students. Therefore, null hypothesis is not rejected. It is finally be interpreted that there is not significant moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students Further, the moderation effect of class in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

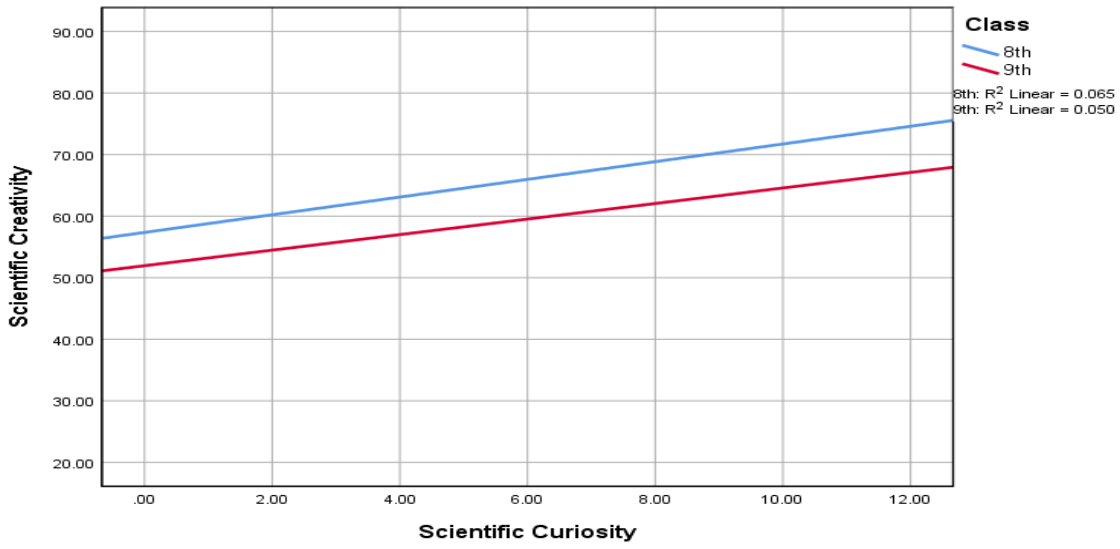


Fig.4. Moderating effect of class on scientific curiosity and scientific creativity

To study the moderating effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students.

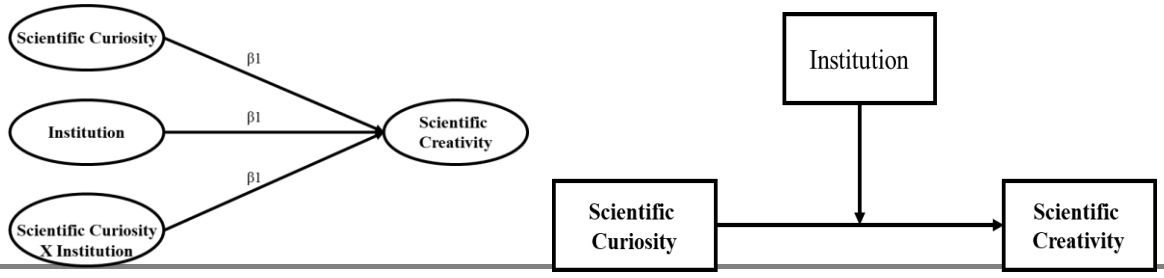

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Fig. 5. Statistical and Conceptual diagram of moderating effect of institution in the relationship between scientific curiosity and scientific creativity

**$H_{03}$.3:** There is no significant moderating effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students.

**Table 3:** The moderating effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 3: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.39 | 0.16 | 192.41 | 11.99 | 3.00 | 196.00 | 0.00* |

* Significant at 0,05 level

Table 3.1: Model

| *Dependent Variable* | *Model* | *β* | *SE* | *t* | *p* |
|---|---|---|---|---|---|
| Scientific Creativity | Constant | 56.89 | 1.35 | 42.05 | 0.00 |
| | Scientific Curiosity | 1.37 | 0.49 | 2.78 | 0.01 |
| | Institution | 9.17 | 2.01 | 4.57 | 0.00 |
| | Interaction | -0.61 | 0.79 | 0.76 | 0.45 |

Table 3.2: Test(s) of highest order unconditional interaction(s)

| | $R^2$-chng | F | df1 | df2 | *p* |
|---|---|---|---|---|---|
| X*W | 0.00 | 0.58 | 1.00 | 196.00 | 0.45 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Institution (W)

Moderation analysis was conducted to test of the moderation effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students. In order to perform the analysis, scientific curiosity, institution and their interaction (scientific curiosity and institution) were regressed on scientific creativity. The result that emerged from the interaction moderation effect indicated that scientific curiosity and institution did not have a significant effect on scientific creativity ($\beta$=-0.61, t=0.76, p>0.05). Model summary provides a summary of the model with R, $R^2$, F—statistics, and p-value for the overall model. The table 3, reveals that the model is significant where R=0.39, $R^2$=0.16, F=11.99, which is significant at 0,05 level ($p<0.05$). F change also reveals the significant moderation effect of institutions in the relationship between scientific curiosity and scientific creativity of secondary school students. Again, the change in the R square helped in explaining additional variance. $R^2$ change value is 0.00, which is not significant ($p > 0.05$). It indicates that institutions accounted for 0 percent variance in the scientific creativity of secondary school students. Therefore, the null hypothesis is not rejected. It is finally be interpreted that there is not significant moderating effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students. Further, the moderation effect of institution in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

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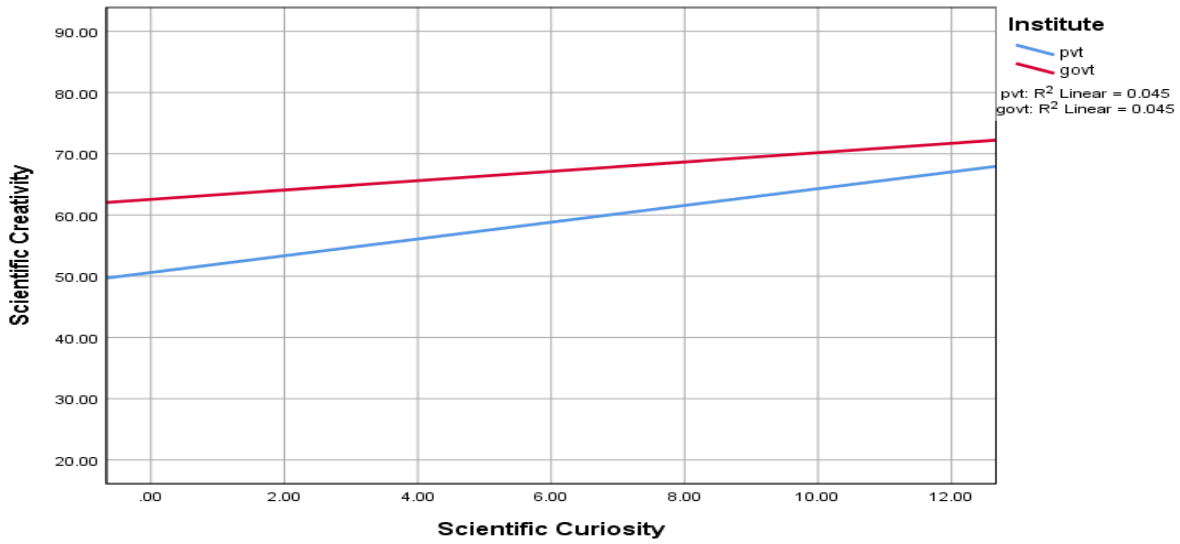


Fig.6. Moderating effect of institution on scientific curiosity and scientific creativity

To study the moderating effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students.

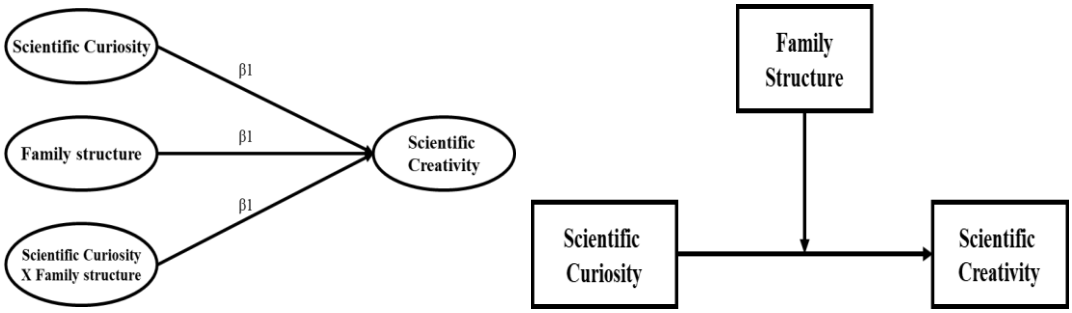


Fig. 7. Statistical and Conceptual diagram of moderating effect of family structure in the relationship between scientific curiosity and scientific creativity

**$H_{04}$.4:** There is no significant moderating effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students.

**Table 4:** The moderating effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 4: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.30 | 0.09 | 207.54 | 6.35 | 3.00 | 196.00 | 0.00* |

* Significant at 0,05 level

Table 4.1: Model

| Dependent Variable | Model | β | SE | t | *p* |
|---|---|---|---|---|---|
| Scientific Creativity | Constant | 58.10 | 1.66 | 34.98 | 0.00 |
| | Scientific Curiosity | 2.09 | 0.64 | 3.25 | 0.00 |
| | Family structure | 4.45 | 2.11 | 2.11 | 0.4 |

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| | | | | | |
|---|---|---|---|---|---|
| | Interaction | -0.86 | 0.82 | 1.05 | 0.30 |

Table 4.2: Test(s) of highest order unconditional interaction(s)

| | $R^2$-chng | F | df1 | df2 | *p* |
|---|---|---|---|---|---|
| X*W | 0.01 | 1.10 | 1.00 | 196.00 | 0.30 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Family Structure (W)

Moderation analysis was conducted to test of the moderation effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students. In order to perform the analysis, scientific curiosity, family structure and their interaction (scientific curiosity and family structure) were regressed on scientific creativity. The result that emerged from the interaction moderation effect indicated that scientific curiosity and family structure did not have a significant effect on scientific creativity (β=-0.86, t=1.05, p>0.05). Model summary provides a summary of the model with R, $R^2$, F—statistics, and p-value for the overall model. The table 4. reveals that the model is significant where R=0.30, $R^2$=0.09, F=6.35, which is significant at 0,05 level (p<0.05). F change also reveals the significant moderation effect of family structure in the in the relationship between scientific curiosity and scientific creativity of secondary school students. Again, change in the R square helped in explaining additional variance. $R^2$ change value is 0.01, which is not significant (p > 0.05). It indicates that family structure accounted for 1 percent variance in the scientific creativity of secondary school students. Therefore, null hypothesis is not rejected. It is finally be interpreted that there is not significant moderating effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students. Further, the moderation effect of family structure in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

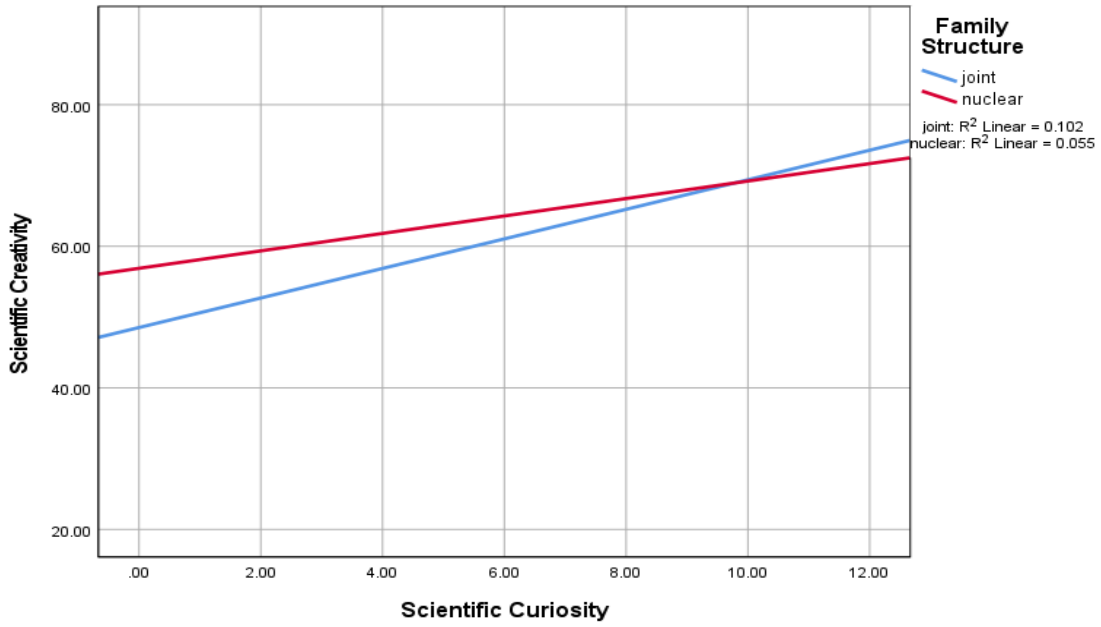


Fig.8. Moderating effect of family structure on scientific curiosity and scientific creativity

To study the moderating effect of mother's education in the relationship between scientific curiosity and scientific creativity of secondary school students.

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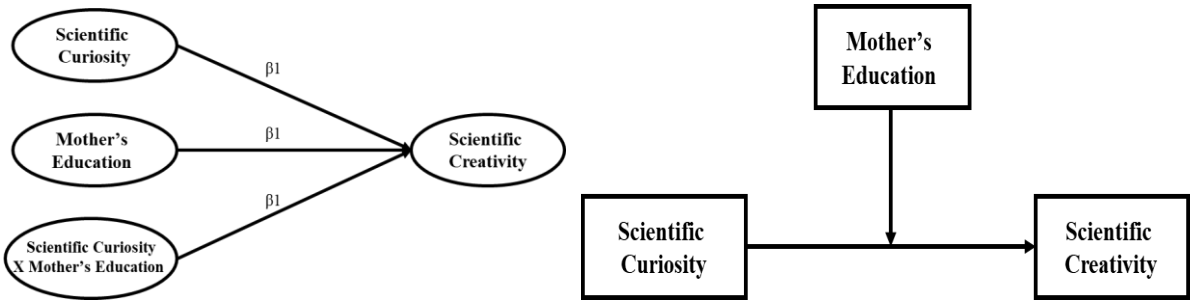


Fig. 9. Statistical and Conceptual diagram of moderating effect of mother's education in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.5:** There is no significant moderating effect of mother's education in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 5: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.33 | 0.11 | 204.76 | 4.80 | 5.00 | 194.00 | 0.00* |

*Significant at 0,05 level

Table 5.1: Model

| | β | SE | t | p |
|---|---|---|---|---|
| Constant | 58.67 | 1.47 | 39.79 | 0.00 |
| Scientific Curiosity | 0.43 | 0.55 | 0.77 | 0.44 |
| W1 | 4.49 | 2.69 | 1.67 | 0.10 |
| W2 | 3.48 | 2.34 | 1.49 | 0.14 |
| Int_1 | 2.05 | 1.11 | 1.84 | 0.07 |
| Int_2 | 1.87 | 0.88 | 2.12 | 0.04* |

- Int_1: Scientific Curiosity x W1
- Int_2: Scientific Curiosity x W2
- *Interaction is significant at the 0.05 level

Table 5.2: Test(s) of highest order unconditional interaction(s)

| | $R^2$-chng | F | df1 | df2 | p |
|---|---|---|---|---|---|
| X*W | 0.03 | 3.02 | 2.00 | 194.00 | 0.05* |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Mother's Education (W)

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Table 5.3: Mother's Education

| Mother Ed$^n$ | Effect | SE | t | *p* |
|---|---|---|---|---|
| Mothers Ed$^n$ 0-5 | 0.43 | 0.55 | 0.77 | 0.44 |
| Mothers Ed$^n$ 5-10 | 2.47 | 0.97 | 2.56 | 0.01* |
| Mothers Ed$^n$ above 10 | 2.30 | 0.69 | 3.33 | 0.00* |

* Mother Ed$^n$ Significant at 0,05 level

Model summary provides a summary of the model with $R^2$, $R^2$, F—statistics, and p-value for the overall model. The table 5. reveals that the model is significant where R=0.33, $R^2$=0.11, F=4.80, which is significant at 0.05 level ($p<0.05$). Table 6.1 reveals the beta coefficient with the impact of scientific curiosity, mother's education, and the interaction effects to asses if there is moderation or not.

**(a) For Interaction1,** the p-value is 0.07, which is not significant ($p>0.05$), which means that the interaction effect of scientific curiosity and students having mothers' education 5 to 10 is not significant.

**(b) Interaction2:** The p-value is 0.04, which is significant ($p<0.05$), which means that the impact of the interaction effect of, scientific curiosity and students having mothers' education above 10 is significant. Henceforth, it can be interpreted that the impact of scientific curiosity on scientific creativity in students having mothers' education above 10 is considerably different (higher) from the students with mothers' education class 0 to 5. Test of unconditional interaction shows that the change in $R^2$ ($R^2$=0.03) that occurred due to interaction is also significant ($p<0.05$) Further, the moderation effect of mother's education on the relationship between scientific curiosity and scientific creativity is represented in the following graph.

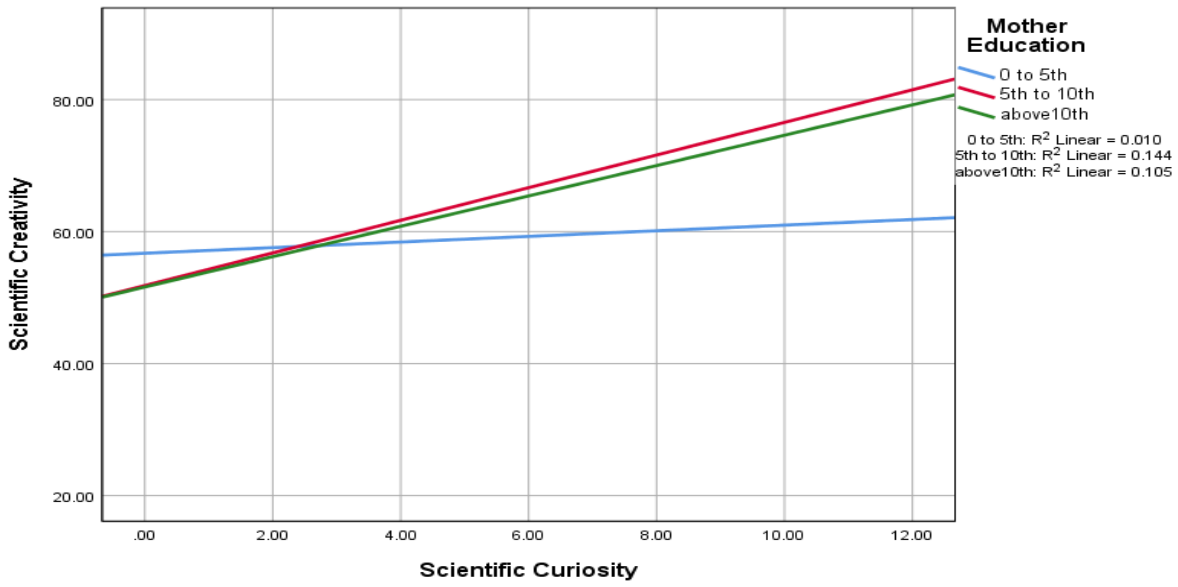


Fig.10. Moderating effect of mother's ed$^n$ on scientific curiosity and scientific creativity

To study the moderating effect of father's education on the relationship between scientific curiosity and scientific creativity of secondary school students.

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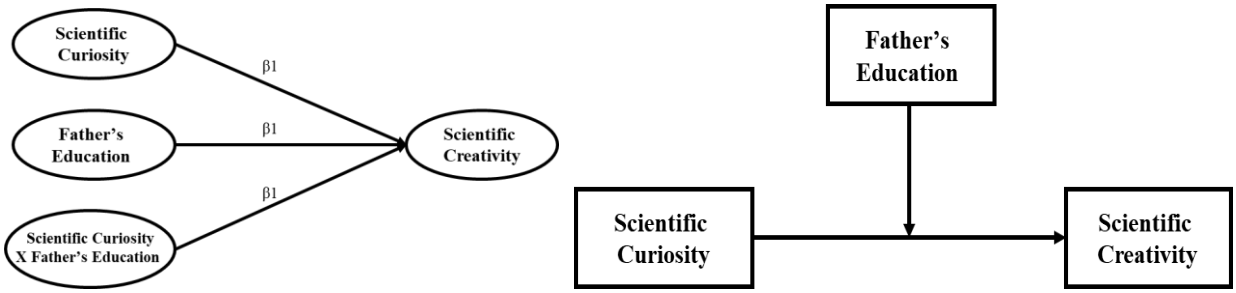


Fig. 11. Statistical and Conceptual diagram of moderating effect of father's education in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.6:** There is no significant moderating effect of father's education in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 6: Model summary

| R | R-sq | MSE | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|---|
| 0.33 | 0.11 | 204.59 | 4.83 | 5.00 | 194.00 | 0.00* |

*Significant at 0,05 level

Table 6.1: Model

| | β | SE | t | *p* |
|---|---|---|---|---|
| Constant | 59.95 | 1.71 | 35.16 | 0.00 |
| Scientific Curiosity | 0.09 | 0.66 | 0.14 | 0.89 |
| W1 | -0.84 | 2.47 | -0.34 | 0.73 |
| W2 | 3.22 | 2.47 | 1.30 | 0.19 |
| Int_1 | 1.59 | 0.99 | 1.60 | 0.11 |
| Int_2 | 2.38 | 0.92 | 2.58 | 0.01* |

- Int_1: Scientific Curiosity x W1
- Int_2: Scientific Curiosity x W2
- *Interaction is significant at the 0.05 level

Table 6.2: Test (s) of highest order unconditional interaction(s):

| | R2-chng | F | df1 | df2 | *p* |
|---|---|---|---|---|---|
| X*W | 0.03 | 3.41 | 2.00 | 194.00 | 0.03* |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Father Ed$^{n}$ (W)

*Significant at 0,05 level

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Table 6.3

| Father Edⁿ | Effect | SE | t | *p* |
|---|---|---|---|---|
| Fathers Edⁿ 0-5 | 0.09 | 0.66 | 0.14 | 0.89 |
| Fathers Edⁿ 5-10 | 1.68 | 0.75 | 2.25 | 0.03 |
| Fathers Edⁿ above 10 | 2.47 | 0.65 | 3.80 | 0.00* |

*Significant at 0,05 level

Model summary provides a summary of the model with $R^2$, $R^2$, F—statistics, and p-value for the overall model. The table 6. reveals that the model is significant where R=0.33, $R^2$=0.11, F=4.83, which is significant at 0,05 level ($p<0.05$). Table 6.1. reveals the beta coefficient with the impact of scientific curiosity, father education, and the interaction effects to asses if there is moderation or not.

**(a) For Interaction1,** the p-value is 0.11, which is not significant ($p>0.05$), which means that the interaction effect of scientific curiosity and students having fathers' education 5 to 10 is not significant.

**(b) Interaction2:** The p-value is 0.01, which is significant ($p<0.05$), which means that the impact of the interaction effect of, scientific curiosity and students having fathers' education above 10 is significant. Henceforth, it can be interpreted that the impact of scientific curiosity on scientific creativity in students having fathers' education above 10 is considerably different (higher) from the students with having father's education class 0 to 5. Test of unconditional interaction shows that the change in $R^2$ ($R^2$=0.03) that occurred due to interaction is also significant ($p<0.05$). Further, the moderation effect of father's education on the relationship between scientific curiosity and scientific creativity is represented through the following graph.

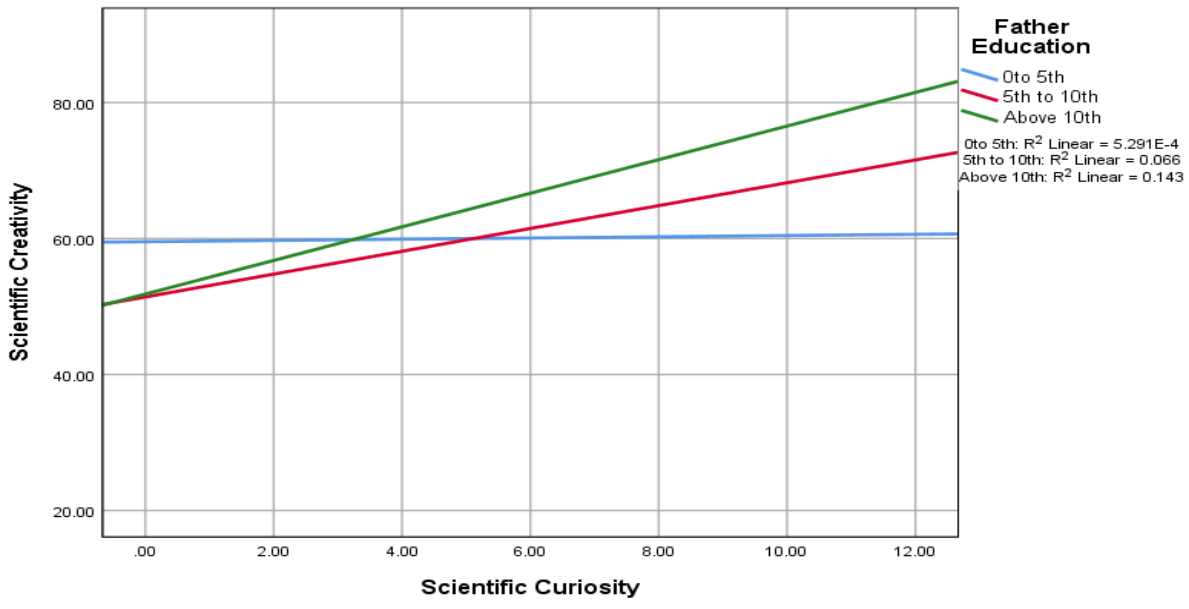


Fig.12. Moderating effect of father's edⁿ on scientific curiosity and scientific creativity

To study the moderating effect of mother's job in the relationship between scientific curiosity and scientific creativity of secondary school students.

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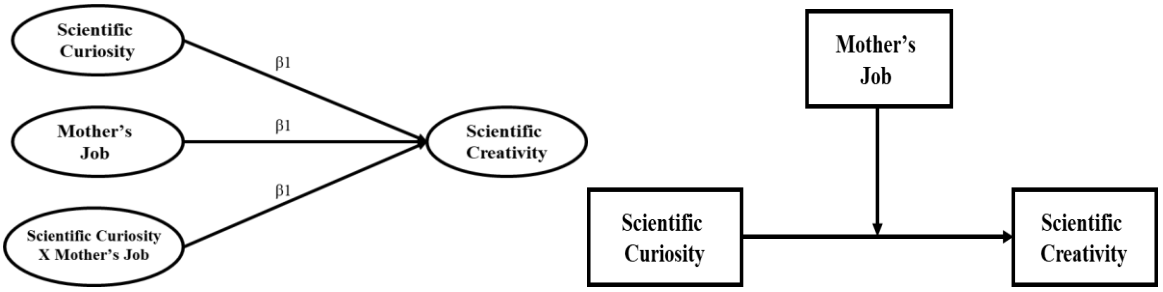


Fig. 13. Statistical and Conceptual diagram of ffect of mother's job in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.7:** There is no significant moderating effect of mother's job in the relationship between scientific curiosity and scientific creativity of secondary school students.

Table 7: Model summary

| R | R-sq | MSE | F | df1 | df2 | *p* |
|---|---|---|---|---|---|---|
| 0.33 | 0.11 | 205.08 | 4.73 | 5.00 | 194.00 | 0.00* |

*Significant at 0,05 level

Table 7.1: Model

| | β | SE | t | *p* |
|---|---|---|---|---|
| Constant | 65.10 | 2.44 | 26.64 | 0.00 |
| Scientific Curiosity | 0.81 | 1.05 | 0.77 | 0.44 |
| W1 | -2.18 | 3.24 | -0.67 | 0.50 |
| W2 | -6.43 | 2.78 | -2.31 | 0.02 |
| Int_1 | -0.27 | 1.33 | -0.20 | 0.84 |
| Int_2 | 1.19 | 1.17 | 1.02 | 0.31 |

- Int_1: Scientific Curiosity x W1
- Int_2: Scientific Curiosity x W2

Table 7.2: Test(s) of highest order unconditional interaction(s)

| | $R^2$change | F | df 1 | df 2 | *p* |
|---|---|---|---|---|---|
| X*W | 0.01 | 1.41 | 2.00 | 194.00 | 0.25 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Mother Job (W)

Model summary provides a summary of the model with $R^2$, $R^2$, F—statistics, and p-value for the overall model. Table 7 reveals that the model is significant where R=0.33, $R^2$=0.11, F=4.73, which is significant at 0,05 level

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($p<0.05$). Table 7.1 reveals the beta coefficient with the impact of scientific curiosity, the mother's job, and the interaction effects to asses if there is moderation or not.

**(a)** For Interaction1, the p-value is 0.84, which is not significant ($p>0.05$), which means that the interaction effect of scientific curiosity and students having a mother's job is not significant.

**(b)** Interaction 2: The p-value is 0.31, which is not significant ($p>0.05$), which means that the impact of the interaction effect of, scientific curiosity and student having mothers 'no job is not significant. Henceforth, it can be interpreted that the impact of scientific curiosity on scientific creativity in students having mothers' no job is considerably not different from the students of have mother's job.

The test of unconditional interaction shows that the change in $R^2$ ($R^2=0.01$) that occurred due to interaction is not significant ($p>0.05$). Further, the moderation effect of mother's job in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

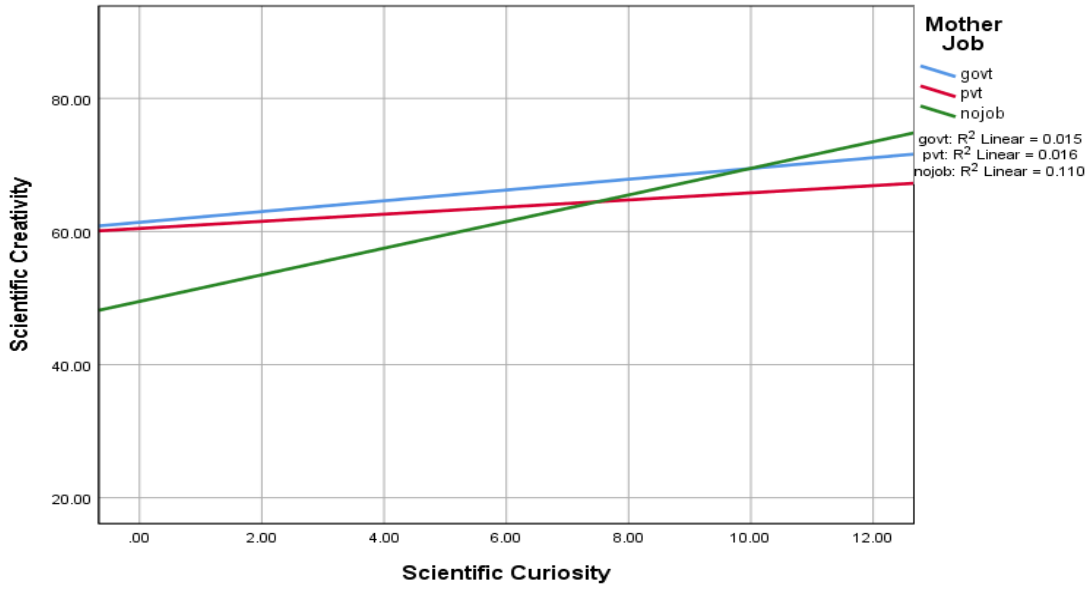


Fig.14. Moderating effect of mother's job on scientific curiosity and scientific creativity

To study the moderating effect of father's job in the relationship between scientific curiosity and scientific creativity of secondary school students.

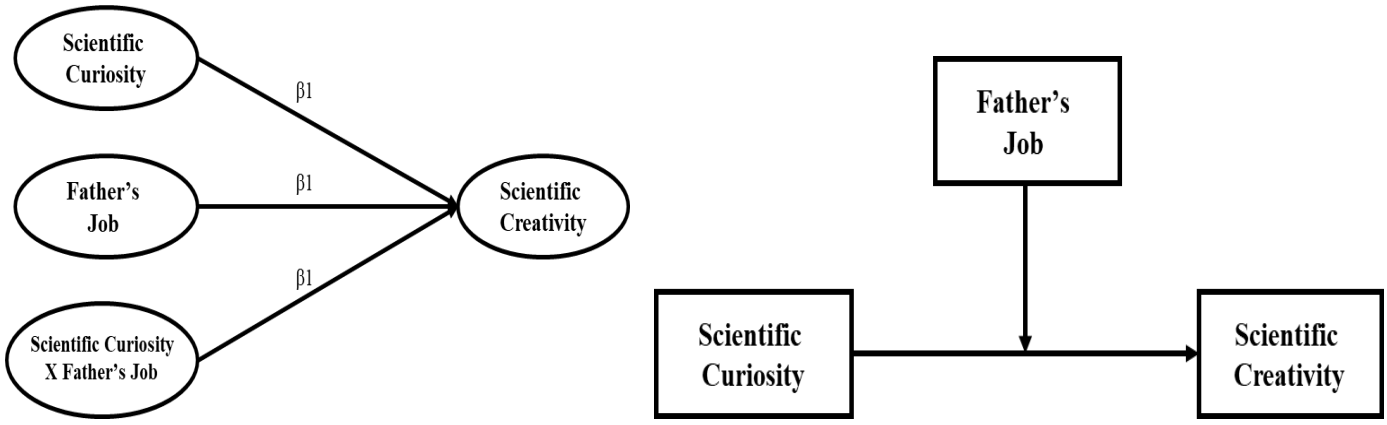


Fig. 15. Statistical and Conceptual diagram of moderating effect of father's job in the relationship between scientific curiosity and scientific creativity

**$H_{01}$.8:** There is no significant moderating effect of father's job in the relationship between scientific curiosity and scientific creativity of secondary school students.

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Table 8: Model summary

| R | R-sq | MSE | F | df1 | df2 | *p* |
|---|---|---|---|---|---|---|
| 0.28 | 0.08 | 212.01 | 3.30 | 5.00 | 194.00 | 0.01* |

*Significant at 0,05 level

Table 8.1: Model

| | β | SE | t | *p* |
|---|---|---|---|---|
| Constant | 61.98 | 2.17 | 28.53 | 0.00 |
| Scientific Curiosity | 2.15 | 0.85 | 2.53 | 0.01 |
| W1 | -0.80 | 2.63 | -0.31 | 0.76 |
| W2 | -3.06 | 2.95 | -1.04 | 0.30 |
| Int_1 | -1.16 | 1.02 | -1.14 | 0.26 |
| Int_2 | -0.20 | 1.17 | -0.17 | 0.86 |

- Int_1: Scientific Curiosity x W1
- Int_2: Scientific Curiosity x W2

Table 8.2: Test (s) of highest order unconditional interaction(s)

| | $R^2$change | F | df1 | df2 | p |
|---|---|---|---|---|---|
| X*W | 0.01 | 0.87 | 2.00 | 194.00 | 0.42 |

- Focal predict: Scientific Curiosity (X)
- Moderate variable: Father Job (W)

Model summary provides a summary of the model with $R^2$, $R^2$, F—statistics, and p-value for the overall model. The table 8 reveals that the model is significant where R=0.28, $R^2$=0.08, F=3.30, which is significant at 0,05 level ($p<0.05$). Table 8.1. reveals the beta coefficient with the impact of scientific curiosity, father's job, and the interaction effects to asses if there is moderation or not.

**(a) For Interaction1**, the p-value is 0.26, which is not significant ($p>0.05$), which means that the interaction effect of scientific curiosity and students having father's job is not significant.

**(b) Interaction 2:** The p-value is 0.86, which is not significant ($p>0.05$), it means that the impact of the interaction effect of, scientific curiosity and the student having father's no job is not significant. Henceforth, it can be interpreted that the impact of scientific curiosity on scientific creativity in students having father's no job is not considerably different from the students having a father's job. Test of unconditional interaction shows that the change in $R^2$ ($R^2$=0.01) occurred due to interaction is not significant ($p>0.05$). Further, the moderation effect of father's job in the relationship between scientific curiosity and scientific creativity is represented through the following graph.

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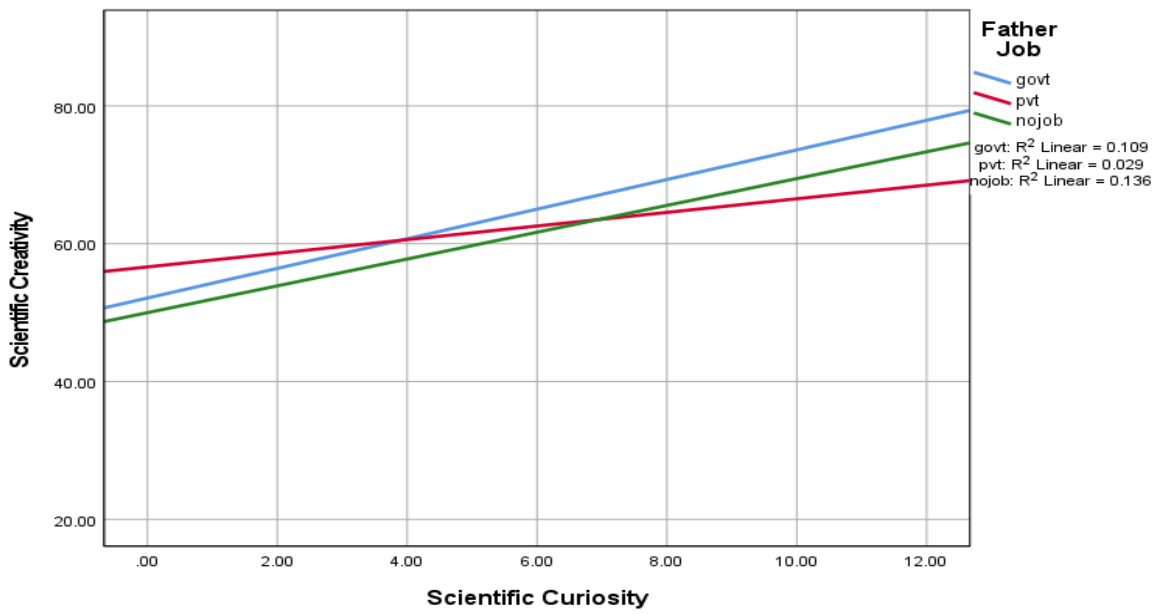


Fig.16. Moderating effect of father's job on scientific curiosity and scientific creativity

## RESULTS, AND DISCUSSION

The first null hypothesis was that there is no significant moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted, so secondary school students do not significantly moderate the effect of gender in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by Alencar (1975), Gralewski & Karwowski (2013), Nakano & Noh & Lee (2020), Saxena et al., (2024) Wu & Chang (2023), and (Bart et al., 2015) , who also reported that there was no significant moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Baer & Kaufman (2008), Baquedano & Acedo Lizarraga (2012), Morais & Almeida (2019), Rejskind et al., (1992),where they found the significant moderating effect of gender in the relationship between scientific curiosity and scientific creativity of secondary school students.

The second null hypothesis was that there is no significant moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted, so secondary school students do not significantly moderate the effect of class in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by W. Hu et al., (2010), Jia et al., (2023), and Xu et al. (2024), who reported that there was no significant moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Affandy et al. (2024), Niclòs et al. (92023), Tytler (2014), Xu et al. (2024), where they found the significant moderating effect of class in the relationship between scientific curiosity and scientific creativity of secondary school students.

The third null hypothesis was that there is no significant moderating effect of institution in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted, so secondary school students are not significantly moderating the effect of institution in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by Feist (1998), Gurnon et al., (2013), Hemlin, (2009) Lehmann & Gaskins (2019), and (Brown, 2020), who also reported that there was no significant moderating effect of institution in the relationship between scientific curiosity and the scientific creativity of secondary school students. However, this result conflicts with the studies conducted byJ. Johnson & Watts (2018) McClellan et al., (2024), Scheffer et al., (2017), Turner (2014), Wylie (2015), where they found the significant moderating effect of institutions in the relationship between scientific curiosity and scientific creativity of secondary school students.

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The fourth null hypothesis was that there is no significant moderating effect of Family Structure in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted, so secondary school students do not significantly moderate the effect of Family Structure in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by Johnson & Watts (2018), who reported that there was no significant moderating effect of Family Structure in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Junge et al., (2021), Kim (2021) , where they found the significant moderating effect of family structure in the relationship between scientific curiosity and scientific creativity of secondary school students.

The fifth null hypothesis was that there is no significant moderating effect of mothers' education in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is not accepted so secondary school students significantly moderate the effect of mothers' education in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by (Kashdan et al., 2018; Usta & Akkanat, 2015) who also reported that there was a significant moderating effect of mothers' education in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Ali et al., (2021), Patel et al., (2018), and (Wang et al., 2022), where no significant moderating effect of mothers' education on the relationship between scientific curiosity and scientific creativity of secondary school students.

The sixth null hypothesis was that there is no significant moderating effect of fathers' education in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is not accepted, so secondary school students significantly moderate the effect of fathers' education in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by Shah et al., (2018), reported that there was a significant moderating effect of fathers' education in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Blake & Burkett (2017); Shah et al., (2018) , where they found the not non-significant moderating effect of fathers' education in the relationship between scientific curiosity and scientific creativity of secondary school students.

The seventh null hypothesis was that there is no significant moderating effect of the mother's job in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted, so secondary school students do not significantly moderate the effect of mothers' jobs in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by Cheng et al. (2020), Franklin (1985), who reported that there was no significant moderating effect of the mother's job in the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by Singh & Gupta (2012), where found the significant moderating effect of mother's job on the relationship between scientific curiosity and scientific creativity of secondary school students.

The eighth null hypothesis was, that there is no significant moderating effect of a father's job in the relationship between scientific curiosity and scientific creativity of secondary school students. The analysis reveals that the null hypothesis is accepted so secondary school students are not significantly moderating the effect of a father's job in the relationship between scientific curiosity and scientific creativity. This result is consistent with the studies conducted by (Silvia & Christensen, 2020), reported that there was no significant moderating effect of the father's job on the relationship between scientific curiosity and scientific creativity of secondary school students. However, this result conflicts with the studies conducted by (X. Hu et al., 2023; PATEL, 2013) where they found the significant moderating effect of fathers' jobs in the relationship between scientific curiosity and scientific creativity of secondary school students.

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**Educational Implications**

Educators can design curiosity-driven learning interventions without heavily tailoring them based on demographic factors, making implementation scalable and equitable.

The school heads should take the initiative to develop a friendly academic environment, which could promote healthy student-teacher and student-student interaction. They should encourage teachers the promote curiosity and scientific creativity among the learners rather than mere achievement. They should ensure the availability of the required infrastructure, which could promote meaningful learning. The school head should encourage parental involvement in promoting 21st-century skills among the students.

## CONCLUSION

This study contributes to the understanding of the intricate connections between scientific curiosity and scientific creativity among secondary school students. This study demonstrates that scientific curiosity significantly enhances creativity among secondary school students, but the relationship is not uniform across demographic groups. Differences based on variables such as gender, age, and socio-economic status influence how curiosity translates into creative expression. These findings emphasize the importance of adopting inclusive, curiosity-centered pedagogical strategies.The findings emphasize the need for a holistic approach to science education that nurtures curiosity and fosters creative thinking to prepare students for successful engagement in scientific explorations. The results of the present study are aligned with the recommendations of the National Education Policy, 2020 (NEP-2020) as NEP-2020 strongly focused on “how to learn” rather than “what to learn” and the development of 21st-century skills like problem-solving, process skills, critical thinking, collaboration, and creativity.

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