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Comparing Students' Science Motivation and their Achievement in Science Subjects at Secondary Level

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Abstract

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Keywords: Science Motivation, Physics, Chemistry, Biology, Grade Motivation, Career Motivation, Self-Determination, Self-Efficacy, Intrinsic Motivation

Authors:

Muhammad Akram:(Corresponding Author)
Associate Professor, Institute of Education & Research, University of the Punjab, Lahore, Pakistan.
(Email:akram.ier@pu.edu.pk)

Syeda Aliya Fatima: Assistant Professor, Department of Education, Fatimiyah Higher Education System, Karachi, Sindh, Pakistan.

Nazir Ahmad: Associate Professor & Head of Department, Department of Education, Fatimiyah Higher Education System, Karachi, Sindh, Pakistan.

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Title

Comparing Students' Science Motivation and their Achievement in Science Subjects at Secondary Level

Authors:

Muhammad Akram:(Corresponding Author)
Associate Professor, Institute of Education & Research, University of the Punjab, Lahore, Pakistan.
(Email:akram.ier@pu.edu.pk)

Syeda Aliya Fatima: Assistant Professor, Department of Education, Fatimiyah Higher Education System, Karachi, Sindh, Pakistan.

Nazir Ahmad: Associate Professor, HoD, Department of Education, Fatimiyah Higher Education System, Karachi, Sindh, Pakistan.

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Abstract

The study was designed to compare science motivation and science achievement (Physics, Chemistry, and Biology) based on student gender and school location in Okara district. Using the cluster random sampling technique, 1000 students of 10th grade were selected as a sample of this study. An Urdu version of the Science Motivation Questionnaire was developed by the authors and used to collect data about student motivation towards science subjects, i.e., Physics, Chemistry, and Biology. The student achievement data were collected from their respective schools. The scale, which included five factors: self-efficacy, intrinsic motivation, self-determination, grade motivation, and career motivation demonstrated overall high-level reliability (α=.88) with factor-wise reliability ranging from .77 to .82. The study revealed that male students were significantly better than female students in Physics and Chemistry motivation, while female students were better in biology motivation. The recommendations have also been given in the study.

Keywords: Science Motivation, Physics, Chemistry, Biology, Grade Motivation, Career Motivation, Self-Determination, Self-Efficacy, Intrinsic Motivation

Introduction

Educational achievements are the outcomes of activities carried out in educational settings that indicate a person's level of achievement (Hattie, 2009). The world's progress is due to the science education provided in their educational institutions, which explains the importance of science education for every country's progress (Kola, 2013). Science education is critical because it aids in developing a country's infrastructure and many other important areas, such as reasoning, innovative thinking, designing rational solutions to problems, and helping students understand the relationship between science and various fields of life. Motivation is the explanation for behaving or acting in a certain way. Leadership is characterized

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as the driving force behind a person's actions. Motivation is a trait that inspires one to achieve or complete some mission (Broussard& Garrison, 2004). Someone who is not attempting to complete a task is described as unmotivated, whereas who is attempting to achieve or complete a task is described as motivated (Deci& Ryan, 2000). Learning is gaining knowledge or skills through study, practice, or instruction. Most changes in someone's actions result from a learning process (Myers, 2010). Learning is a process that produces long-term improvement in a person's actions (Mukherjee, 1995). Motivation is the psychological process that helps learners meet their needs (Latham, 2003). Education depends on motivation, increasing the desire to learn (Lumsden, 1994). Everyone who begins their education does not complete it due to lacking motivation, and many students fail (Haider et al., 2015; Ahmad et al., 2024).

The motivation factor is essential for student learning at any level of education. Various factors influence students' learning and motivation is one of them that mainly contribute to improving their learning. Extrinsic reinforcements were the subject of early motivation research, and all facets of motivation, including actions and accomplishment, were investigated. Reinforcement contingencies were thought to be a large part of the motivation (Stipek, 1996). Skinners' research focused on constructive and negative reinforcements and the accusation of rewarding people for their accomplishments. Skinner described that learning should be a product of compensation and loss of rights (Ogiamien& Izuagbe, 2016). Achievement goal theory describes that each student differs in their approach to achieving goals, and this variation is linked to various outcomes such as social, motivational, cognitive, and behavioral outcomes (Ali, Shah, & Ahmad, 2023). The theory further also enlightens why people with similar abilities and cognition can achieve different performance levels. Goal orientation is a combination of one's values, attributes, and factors that explain one's behavior or the intent of one's behavior (Akin, 2012). The goal of science education is to increase science literacy among students, which is critical to inspire students to recognize the need for and value of science and make them understand the importance of science education (Arslan et al., 2017). As a result, the learner's mental ability and cognition level should be considered essential for his learning in science subjects, and motivation is the most important of all the effective factors that affect learning (Kuyper et al., 2000; Omar et al., 2013). Motivation is important in improving student learning and developing critical thinking (Tapola& Niemivirta, 2008).

In today's world, students' learning is influenced by three factors: curiosity, motivation, and cognition (Glynn et al., 2011; Stake, 2006; Ahmad, Bibi, &Imran, 2023). The way a student participates in various tasks and other learning processes reveals his motivation. A motivated student often engages in constructive learning and attempts to solve problems using various techniques (Bandura, 1999; Pajares et Al., 2000; Jabeen, Ali & Ahmad, 2023). Motivated students are concerned about their academic achievements; they often strive to complete challenging tasks that require effective skills and make good progress in their studies (Tuan et al., 2005; Stake, 2006). A Bruneian researcher teaching science for over a decade has noticed that her students' lack of enthusiasm to study science contributes to poor results (Chow& Yong, 2013). It has been revealed that science education is essential for expanding information and communication technologies. Various aspects of our lives are linked to science education, such as medicine, architecture, and engineering, and many of the fields might have needed to be developed if science education had not been available (Kola, 2013; Naeem, Ali & Ahmed, 2022). All of the evidence revealed that motivation affects student achievement. The study aimed to compare students' science motivation and academic achievement in science subjects.

Research Question

The following were the research questions of the present study:

1. Is there any significant difference in science motivation of boys and girls in 10th grade in Physics, Chemistry, and Biology?
2. Is there any significant difference in science motivation of 10th-grade students of rural and urban schools in Physics, Chemistry, and Biology?

Review of the Related Literature

Motivation is the most critical factor that affects students' learning and can be described as the capacity to transform their thoughts into actions or to take action (Blair et al., 2010; Haider et al., 2015). When attempting to comprehend motivation, there are many queries to answer in a single brief statement, various lenses to examine, and many nets to drag (Baker& Stevenson, 1986). What an individual can do denotes his capability, while inspiration denotes what he can do. Motivation is a condition that occurs when an inner force energizes a process and persists as well if nothing else with a greater demand arrives (Dornyei& Otto, 1998). Mahadi and Jafari (2012) researched students learning a second language and discovered that motivation is the most important factor while all learners learn differently. Motivation can also be described as a state or power within an individual that propels him toward achieving a goal (Daschler& Niemeyer, 1984; Ahmad et al., 2023). Each person possesses motivation, which enables him to rationalize his behavior (Drummond, 1990). Motivation is described as a dynamic and growing state within an individual that ignites, directs, boosts, initiates, and evaluates sensory and mental procedures by which unconscious wishes and desires are chosen, listed, outfitted, and acted upon as well (Dornyei & Otto, 1998). Additionally, motivation provides a vital foundation for mental growth and procedures such as preparation, sorting, supervision, erudition, and assessment (Pintrich, 1999).

Busato et al. (2000) revealed that mental capacity and enthusiasm for academic achievement are positively associated with educational attainment. Apart from this, there are a few additional variables that affect the student performance of exceptionally gifted learners (Kozochkina, 2009; Haider, Ahmad & Ali, 2024). It was observed in another study that students with greater abilities in learning English spent more time studying, had comparatively better skills in their exams, and increased experience in skimming the listened and written content than learners with lower mental abilities (Stoynoff, 1997; Thomas, Khan & Ahmad, 2022). Stewart et al. (2010) described motivational orientations as an attribute of the motivating force that propels everyone toward target achievement. The motivational orientations are extrinsic and intrinsic motivation, self-efficacy, personal significance, evaluation anxiety, and self-determination. Muller (1998) conducted a study on student achievement to determine the association between parental association and youth in both sexes. Longitudinal research was conducted, and the results revealed gender gaps in mathematics learning and achievement ratings.

Joshi et al. (2012) investigated neuroticism, educational achievement, extraversion, and their relationship to gender and culture. The sample consisted of 400 eighth-grade students. He gathered data by reviewing student records and using an Eysenck-developed behavior inventory. The final results revealed a high degree of gender diversity. Kohl et al. (2000) researched the factors that influence students' families and undermine parental participation. The study found a significant correlation between parents' education and children's achievement. Naderi et al. (2010) researched gender and intellect, their association, and their ability to predict educational achievement. The cumulative grade point averages were used to measure educational attainment. The findings indicated that toy boys' and girls' educational gains were not substantially different. Similarly, the effect of school environment involving demographic variables on student motivation and achievement was examined and revealed that girls had better motivations and results than boys (Chaturvedi, 2009; Khoso, Oad & Ahmad, 2023).

Ferguson (2009) studied school-aged children to establish a connection between academic achievement and family structure. The findings indicated that female students in urban and rural areas performed better than male students. Additionally, rural students outperformed urban students. In another study, the association between student achievement and classroom motivation among third- and first-grade students was investigated by Broussard (2004), who revealed that students with better motivation toward their learning produced better academic results. Tavani et al. (2003) researched motivation as a predictor of high students' academic success. The study found a positive and significant relationship between motivation and student performance. Parental education was also favorably associated with

student learning. It was revealed that enthusiasm is a strong predictor of academic achievement.

Mishra (2015) examined the relationship between motivation and student achievement. The study revealed substantial differences in achievement and motivation between urban and rural students. In another study, Tsang (2004) examined students' motivations towards learning and their achievement by gathering data from students. The findings indicated that family interdependence was more important for migrants than native-born families. Migrants were academically motivated due to the families' attitude toward migrants. Francis (2004) researched the effectiveness of a dialogue and opposing issue-based approach for increasing students' academic performance and motivation. The rating scale on achievement motivation was employed for data collection, and school reports were used for student performance. The study found a positive relationship between both academic performance and student motivation.

Methodology

A causal-comparative design was employed in this quantitative research to compare the science motivation of secondary school science students. A cluster sampling technique was employed, and 40 schools (20 girls and 20 boys involving 20 urban and 20 rural) were selected as the study sample. All the students of the sampled schools were taken as the study's final sample. One thousand one hundred forty survey questionnaires were distributed among the 10th class science students in secondary schools of district Okara. Exactly 1000 questionnaires were returned for further data analysis.

Instrumentation

The researchers used an Urdu-translated version of The Science Motivation Questionnaire II (SMQ-II) developed by Glynn et al. (2011) after seeking permission from the author. The Science Motivation Questionnaire II (SMQ-II) meets the reliability and validity requirements as a research instrument. In the current study, the items of the science motivation questionnaire were arranged into five categories: self-efficacy, intrinsic motivation, self-determination, grade motivation, and career motivation in science subjects i.e. biology, physics, and chemistry. The instrument has 25 items to evaluate students' motivation toward science. Three versions of the Science Motivation Questionnaire (for Physics, Chemistry, and Biology) were prepared to collect the data separately. The questionnaire was pilot-tested before collecting the primary data from the students of the 10th class. Overall, the scale's reliability was 0.86, and it was found satisfactory to collect data for the main study. Moreover, students' Physics, Chemistry, and Biology marks in the BISE Sahiwal exam 2019 were also collected from the relevant schools.

Data Analysis

Data analysis was employed by using SPSS 20 software. To analyze the data, independent samples t-test, and descriptive statistics were employed to compare students' motivation for the science subjects and their academic achievement of 10th class students.

Table 1

The Research Demographic Details

Demographic with sample size n= 1000 10th class science students		Frequency (f)	Percentage (%)
Gender	Female	511	51.1
	Male	489	48.9
	Total	1000	100
Location	Urban	522	52.2
	Rural	478	47.8
	Total	1000	100

Table 1 provides demographic details of the students who participated in the study. The table indicates that amongst the total sample (n = 1000), there were 51.1% female (511) and 48.9% male (489)

students who participated in this study; further, 52.2% students belonged to an urban area (522) while 47.8% (478) students belonged to rural areas.

Table 2

Gender-Based Motivation Independent Sample T-test of Physics (N=1000)

Factors	Gender	N	M	SD	t-test	df	Sig.
Intrinsic Motivation	Female	511	15.70	3.37	2.112	998	0.035
	Male	489	16.45	3.21			
Self-Efficacy	Female	511	16.06	3.19	2.063	998	0.039
	Male	489	16.98	3.03			
Self-Determination	Female	511	16.39	3.02	1.360	998	0.021
	Male	489	16.91	3.08			
Grade Motivation	Female	511	16.03	2.74	1.223	998	0.014
	Male	489	17.65	2.72			
Career Motivation	Female	511	16.24	3.05	1.366	998	0.001
	Male	489	17.11	2.90			
Overall	Female	511	82.95	12.75	1.489	998	0.004
	Male	489	84.22	12.62			

p>0.05

Table 2 revealed that male students' motivation was better than that of all five factions of motivation: self-efficacy, intrinsic motivation, self-determination, grade motivation, and career motivation. Overall results showed that male students were significantly better (M=84.22, SD= 12.5) in Physics motivation than female students (M=82.95, SD=12.75), t(998)=1.489),p=.004.

Table 3

Gender-Based Motivation Independent Sample T-test of Chemistry (N=1000)

Factors	Gender	N	M	SD	t-test	Df	Sig.
Intrinsic Motivation	Female	511	15.01	3.23	1.43	998	0.022
	Male	489	17.69	3.55			
Self-Efficacy	Female	511	15.82	2.92	.043	998	0.001
	Male	489	16.81	3.08			
Self Determination	Female	511	15.32	3.09	.339	998	0.002
	Male	489	16.88	3.18			
Grade Motivation	Female	511	15.76	2.72	.858	998	0.002
	Male	489	17.60	2.73			
Career Motivation	Female	511	15.38	2.60	1.966	998	0.021
	Male	489	17.02	2.98			
Overall	Female	511	80.30	12.28	1.096	998	0.002
	Male	489	83.22	11.15			

p>0.05

Table 3 showed that male students were better as compared to female students on all five factors of science motivation: self-efficacy, intrinsic motivation, self-determination, career motivation, and grade motivation. The overall, results showed that the mean score of male students was higher (M=83.22, SD=11.15) than female students (M=80.30, SD= 12.28) in Chemistry motivation t(998)=-1.096, p=0.002.

Table 4

Gender-based Motivation Independent Sample T-test of Biology (N=1000)

Factors	Gender	N	M	SD	T	df	Sig.
Intrinsic Motivation	Female	511	16.86	3.29	1.723	998	.005
	Male	489	16.07	2.93			
Self-Efficacy	Female	511	16.95	3.06	2.786	998	.005
	Male	489	16.18	2.86			
Self Determination	Female	511	17.15	3.23	1.906	998	.017
	Male	489	16.53	2.91			
Grade Motivation	Female	511	17.59	2.81	1.752	998	.010
	Male	489	16.89	2.51			
Career Motivation	Female	511	17.96	2.93	3.377	998	.001
	Male	489	16.56	2.57			
Overall	Female	511	88.98	12.94	2.863	998	.003
	Male	489	85.54	11.38			

p>0.05

Table 4 revealed that perceptions related to the Biology motivation of female students were found higher as compared to perceptions of male students in all five factors: self-efficacy, intrinsic motivation, self-determination, career motivation, and grade motivation. The overall mean score of female students' motivation in Biology was revealed to be significantly higher (M=88.98, SD=12.94) than male students (M=85.54, SD=11.38) with t(998)=2.863), p=.003.

Table 5

Locality-based Independent Sample T-test for Physics (N=1000)

Factor	Locality	N	M	SD	T	Df	Sig.
Intrinsic Motivation	Urban	522	16.64	2.80	-3.492	998	.000
	Rural	478	15.59	3.48			
Self-Efficacy	Urban	522	17.42	2.49	-4.730	998	.000
	Rural	478	16.46	3.36			
Self Determination	Urban	522	16.68	2.73	-1.684	998	.000
	Rural	478	16.14	3.22			
Grade Motivation	Urban	522	17.98	2.29	-3.668	998	.000
	Rural	478	17.33	2.93			
Career Motivation	Urban	522	17.44	2.45	-3.612	998	.000
	Rural	478	16.75	3.30			
Overall	Urban	522	87.27	11.34	-4.732	998	.000
	Rural	478	81.35	14.73			

Table 5 revealed that there was a significant difference between urban and rural school students for all factors of motivation: self-efficacy, intrinsic motivation, self-determination, career motivation, and grade motivation. In overall, motivation of urban students in Physics (M=87.27, SD=11.34) was higher than rural students (M=81.35, SD=14.73), $t(998)=-4.732$, $p=0.000$.

Table 6

Locality Based Locality-independent sample t-test for Chemistry (N=1000)

Factor	Locality	N	M	SD	T	Df	Sig.
Intrinsic Motivation	Urban	522	16.06	3.32	-1.719	998	.089

Factor	Locality	N	M	SD	T	Df	Sig.
Self-Efficacy	Rural	478	15.67	3.50	-2.691	998	.002
	Urban	522	17.16	2.80			
Self Determination	Rural	478	16.61	3.12	-3.312	998	.003
	Urban	522	16.70	2.86			
Grade Motivation	Rural	478	16.03	3.28	-2.973	998	.003
	Urban	522	18.00	2.31			
Career Motivation	Rural	478	17.47	2.93	-.896	998	.284
	Urban	522	17.27	2.82			
Overall	Rural	478	17.09	3.86	-2.766	998	.006
	Urban	522	85.21	11.64			
	Rural	478	82.89	13.40			

p>0.05

Table 6 revealed that students of Chemistry subjects from urban and rural localities were not significantly better in terms of intrinsic motivation t(-1.719)=998, p=0.086), and career motivation t(-.896)=998, p=.284, but students from the urban localities were significantly better in terms of self-efficacy t(-2.691)=998, p=.002, grade motivation t(-2.973)=998, p=.003, and self-determination t(-3.312)=998, p=.003. Overall, the motivation of urban school students was better as compared to rural school students in Chemistry, *t*(998),=-2.766, p=.006.

Table 7

Locality-based Independent Sample T-test for Biology (N=1000)

Factors	Locality	N	M	SD	t-test	Df	Sig.
Intrinsic Motivation	Urban	522	17.07	2.31	-6.649	998	.000
	Rural	478	15.75	3.36			
Self-Efficacy	Urban	522	17.64	2.32	-5.517	998	.000
	Rural	478	16.58	3.20			
Self Determination	Urban	522	17.08	2.28	-5.620	998	.000
	Rural	478	15.97	3.35			
Grade Motivation	Urban	522	18.34	1.91	-5.279	998	.000
	Rural	478	17.44	2.92			
Career Motivation	Urban	522	18.07	2.10	-6.692	998	.000
	Rural	478	16.90	2.95			
Overall	Urban	522	88.20	8.390	-7.193	998	.000
	Rural	478	81.85	12.74			

p>0.05

Table 7 revealed that students studying Biology in urban and rural schools were different in all the factors of motivation: self-efficacy, intrinsic motivation, career motivation, self-determination, and grade motivation. In overall, motivation of urban students (M=88.20, SD=8.39) was higher than rural students in Biology (M=81.85, SD=12.74), *t*(998)=-7.193, *p*=.000.

Discussion

The study was designed to compare science motivation and achievement based on student gender and school location. The study's findings showed that students who were more motivated to learn science performed better than less motivated students. The study revealed that male students were significantly better than female students in motivation for physics and chemistry, while female students were better in motivation for biology. The study also revealed that urban students were more motivated towards Physics, Chemistry, and Biology than rural students. The findings were consistent with various previous research (Daschler &

Niemeyer, 1984; Glynn & Koballa, 2006); Francis, 2004; Kozochkina, 2009; Mahadi & Jafari, 2012; Stewart et al., 2010; Stoynoff, 1997; Tavani et al., 2003), provided evidence that students' motivation towards science subject is essential for their achievement in science subject. There are also various studies revealed gender-based and school-location-based differences in the students in their motivation towards science subjects and affect their achievement in science subjects (Chaturvedi, 2009; Ferguson, 2009; Joshi et al., 2012; Mishra, 2015; Muller, 1998; Imran et al., 2023) that are consistent with the present study by holding evidence that more motivated students have better achievement in science subjects rather than less motivated students. However, in a few studies, gender-based difference was not found in student achievement, but confirmed that equally motivated students performed better in their learning (Garon-Carrier et al., 2015); Naderi et al., 2010). Finally, the previous studies also revealed a positive and significant correlation between students' motivations and their academic achievement (Broussard, 2004; Francis, 2004; Haider et al., 2015; Tavani et al., 2003; Tsang, 2004) that are also consistent with the present study and provided evidence as well that if students are more motivated in the subjects, they perform better in the examination.

Conclusion and Recommendations

The study compared gender-based and school location-based differences in science motivation and students' academic achievement. The present study revealed that students motivated to learn science performed better than less motivated students. The study found that the motivation of male students was better than female students towards their science subjects. The study also revealed that urban students were more motivated towards science subjects than rural students. The study proved that students' motivation is essential to improving their academic achievement. The study recommended that teacher should play their role to enhance the motivation of their students towards science subjects, which is essential for their learning and success as well as to meet life's challenges. The current study revealed that female students are less motivated, and district authorities should see that matter and ensure that their motivation is enhanced. The current study also revealed the difference between the motivation of rural and urban students. It recommended that the district authorities arrange the training of rural school teachers on how to enhance the motivation of their students, which is the most important aspect of their learning. Overall, the study provided valuable evidence that motivated students performed better in science subjects than less motivated students. The government might make arrangements to improve the student's motivation, which is highly required for academic achievement.

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