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Research Paper

A Comparative Study on Lecture and AI-Based Methods in Teaching Science and its Effectiveness on Students' Academic Motivation, Academic Anxiety and Academic Achievement of the Adolescents in Rural Areas

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ABSTRACT

Introduction and Background: AI is increasingly recognized as a transformative tool in education. This study addresses the need for a comprehensive examination of its effects on academic outcomes, motivation, and anxiety. The significance lies in AI's potential to enhance learning experiences, critical thinking, and meta-cognitive functions. **Methods:** Sixty rural students participated, undergoing a pre-post-test design. Academic achievement was assessed through a Google Forms multiple-choice test. Ethical considerations were ensured, and students were placed into two groups at random. The pre-test conditions established baseline equivalence. In the post-test phase, one group experienced traditional lectures, while the other utilized an AI-based tool, ChatGPT. Statistical analyses, including t-tests and Pearson's correlation, were employed. **Results:** The study's pre-test conditions revealed no notable differences in Academic Motivation (AM), Academic Anxiety (AAnx), and Academic Achievement (AAch) within the Control and Experimental groups. Post-test results indicated consistent AM levels between groups, but the Control group exhibited higher AAnx, while the Experimental group showed increased AAch. Comparing pre-test to post-test conditions, no significant changes in AM were observed in either group. However, the Control group experienced heightened AAnx, while the Experimental group demonstrated enhanced AAch. Correlation analyses unveiled a non-significant negative relationship between AM and AAnx in both groups, and a non-significant positive relationship between AAnx and AAch. Noteworthy, the Control group showed a weak negative relationship between AAch and AM, whereas the Experimental group displayed a non-significant positive association between AAch and AM. These findings contribute nuanced insights into the differential impacts of teaching methods on student motivation, anxiety, and achievement, underscoring potential areas for educational refinement.

Keywords: *Method, Artificial Intelligence (AI), Academic Motivation, Academic Anxiety, Academic Achievement, Adolescents*

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With the advent of Artificial Intelligence (AI), the algorithms of our world are changing swiftly and sleeker chances of survival remain if we do not reconfigure our way of life. Artificial intelligence (AI) is a rapidly evolving branch of computer science and technology that focuses upon creating computer systems capable of performing activities that typically necessitate human intelligence. The constant and fast-evolving progress of technology has significantly influenced educational systems worldwide (Ausat, 2023; Kraugusteeliana, 2022).

"Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment." (Nilson, 2009, p.I)

Machine learning, especially deep learning as well as neural networks, has advanced, as has Natural Language Processing (NLP), resulting in applications such as chatbots and language translation. (Fuchs, 2023). From voice assistants to smart homes, AI has become integral in everyday life, shaping industries and societal landscapes rapidly (Roslan, 2023). Responsible AI development and deployment are crucial for maximizing societal benefits (Cheng, 2021).

The application of AI in education revolves around categorization and decision-making, with the aspiration for self-learning capabilities (Pedro, 2019). While the ultimate goal is a self-enhancing, adaptive instructional system, progress in this direction has been modestly initiated by educational technology (Edtech) companies.

The emergence of the latest era of AI, exemplified by Chat-GPT (Generative Pre-trained Transformer), is propelling intelligent technology into an unprecedented historical phase. GPT has a multitude of possible applications in education. These applications have the potential to alleviate the workload of educators by automating various tasks. (Whalen, 2023). Research has shown that ChatGPT, with its ability to produce responses matched to user-provided keywords, has been shown in studies to have a good impact on education and learning. (Shidiq, 2023; Biswas, 2023).

In ancient India, the traditional Gurukul system emphasized personalized education through direct student-teacher interactions (Jayalaksmi & Smrithi Rekha, 2022). The advent of technology introduced smart boards and audio-visual aids, enhancing the learning pedagogy. However, their widespread adoption faced challenges, especially in rural areas, due to infrastructural limitations. The unforeseen global crisis became a catalyst for change, compelling schools across the spectrum, from rural to urban, to transition to online platforms. This shift saw the integration of AI in classrooms, providing a more interactive and dynamic learning environment, transcending geographical barriers.

The zest and desire that leads an individual towards their goal is the drive known as motivation. Motivation has been derived from 'Movere', a Latin word that means 'to move'. Atkinson (1996), defined motivation as "The term motivation refers to the arousal of a tendency to act to produce one or more effects." The way an individual directs himself towards an object of circumstances that he does not process is known as achievement motivation. If someone values those things and situations and believes he has a

responsibility to deal with them, he may be considered to have an accomplishment motive. (Sarnoff, 1962)

In the classroom, students engaged in learning benefit from a continual stream of motivation provided by their teachers. Motivating students is an intricate endeavor, as it is highly personalized. The factors such as family, home environment, socio-economic status; individual factors like intelligence etc., driving student behavior are diverse and intricate, rather than being singular and straightforward (Ajay, 2016).

Anxiety is the body's alert system, triggered by biochemical changes in the brain and body. It heightens the attention, with increased adrenaline and decreased dopamine, preparing you for the "fight-or-flight" response. Academic anxiety refers to feelings of fear, tension, or dread that are associated with academic settings such as tests, assignments, specific courses such as math, reading, or science, social demands from parents or classmates, and discomfort with group study or classroom teamwork. (Huberty, 2012)

Academic achievement is a multi-faceted construct that represents the extent to which an individual has succeeded in an instructional environment. Parents aspire for their children to excel academically and achieve the highest level of performance. It seems that the education system predominantly revolves around the academic success of students, even though various other educational objectives are also expected. Researchers are interested in understanding the factors that influence students' academic achievement and to what extent these factors contribute to their achievements (Ramaswamy, 1990; Amrai, 2011). Anxiety is not inherently detrimental. Excessive anxiety can disrupt concentration and memory, both of which are pivotal for academic achievement (DordiNejad, 2011). However, without some level of anxiety, many of us might lack the motivation to engage in exam preparation, essay writing, or daily coursework. Numerous studies have concluded that a moderate degree of anxiety can bolster academic performance by instilling motivation. (Singh, 2015)

A complex relationship exists between academic anxiety, academic motivation, and academic achievement. Studies have revealed that heightened academic motivation correlates positively with increased academic achievement (Gupta, 2017), as motivated students tend to exhibit proactive learning behaviors and commitment to tasks. These three factors operate in a bidirectional manner (Akpur, 2017), with achievement impacting motivation and anxiety, and vice versa.

Integrating adaptive learning technologies, including AI-driven tools, offers opportunities for personalized learning experiences, potentially reducing anxiety and catering to various learning preferences (Shidiq, 2023). Educators play a crucial role in navigating these dynamics, ensuring that teaching strategies align with the varied needs of students and contribute to a positive and conducive learning environment.

REVIEW OF LITERATURE

Numerous studies have explored the intricate relationships and impact of academic anxiety on achievement. (**Attri, 2013; Dobson, 2013; Shakir, 2014**) Furthermore, gender differences on the same have also been a lens to delve into their intricacies, but, the reason behind the differences remains a mystery unsolved. (**Pomerantz, 2002).** Research has

identified a notable adverse correlation between test anxiety and academic performance, highlighting that female students tend to experience higher levels of academic anxiety compared to their male counterparts. (**Sharma, 1990; Mnicholas, 1998; Bryme, 2000; Bhansali, 2008**).

The current societal emphasis on a child's academic success has led to heightened concerns about academic anxiety in both rural and urban children, and have found significant differences among groups. (**Yagnik, 2001**). Many studies have been conducted on the correlation between academic motivation and academic achievement. Among the several dimensions of motivation, academic achievement has the highest correlation with competition and the lowest with praise. (**Amrai, 2011**). A considerable amount of variation exists in the academic motivation between high and low achievers (**Gupta, 2017**).

A study revealed that there was a negative relationship between anxiety and academic achievement. (**Nadeem, 2012**). Other studies, attempted to compare the differences in academic anxiety and academic motivation among male and female students. (**Shakir, 2014**)

In 2015, advanced AI methods were used to assess academic achievement in European public high schools, which revealed that AI strategies outperformed the traditional methods. (**Cruz-Jesus, 2020**) ChatGPT's capacity to provide responses tailored to user-supplied keywords has the potential to make a positive contribution to the field of education and learning. (**Shidiq, 2023; Biswas, 2023**). A recent study showed that within the framework of employing ChatGPT for educational purposes, it is crucial to recognize that technology serves as a tool and cannot entirely supplant the role of the educator. (**Ausat, 2023**). In an argumentative review, it was established that creating ChatGPT-driven solutions for self-directed learning in higher education demands a complex and multidisciplinary approach that incorporates input from educators, researchers, students, and various stakeholders. (**Baskara, 2023**)

This study addresses a research gap in rural areas using AI-based teaching and its effectiveness on students' academic achievement, achievement motivation, and academic anxiety in the context of different teaching methods, with a particular focus on the innovative use of ChatGPT. The study aims to contribute to our understanding of how technology, in this case, AI-based tools, can impact education and students' academic experiences.

Significance of the Study

This study undertakes a comparative analysis between traditional lecture methods and AI-based approaches in the instruction of science, evaluating their impact on students' academic performance, motivation, and anxiety levels. The study addresses a notable research gap, as the interconnected influence of academic achievement, achievement motivation, and academic anxiety has not been thoroughly explored.

In the realm of educational advancement, AI has emerged as a valuable tool, a significance underscored by the unique approach employed in this study. The utilization of AI is shown to engage students effectively, fostering improved learning outcomes, heightened critical thinking abilities, and the promotion of meta-cognitive functions. Secondly, if anxiety is

found among the students, counseling can be recommended. The research seeks to provide valuable insights for educators and policymakers in shaping the future of teaching methods.

METHODS

In this study, 60 students from a rural school were included from classes XI to XII. The study adopted a pre-post-test design to observe changes in academic achievement, achievement motivation, and academic anxiety before and after the implementation of lecture and AI-based learning methods, with ChatGPT being introduced as a teaching tool in the post-test phase.

Academic achievement can be assessed through a variety of methods. Traditional approaches include examinations, tests, and assignments, while projects and portfolios offer practical insights into understanding. Class participation, homework, and oral assessments provide additional dimensions to evaluation. In the present study, academic achievement was measured using a multiple-choice test in Google form based on the topic and sub-topics taught by the assigned teacher.

Students gave their consent to participate in this study, ensuring data privacy and confidentiality, and addressing any potential risks or concerns associated with the study. They were then randomly divided into two groups and were assessed on the basis of academic achievement, anxiety and motivation.

Pre-test conditions: In the initial phase of this study, the pre-test conditions were meticulously implemented. First, the target classes were identified, and a total of 60 students were randomly organized into two groups, each comprising 30 participants. Ensuring ethical considerations, students willingly provided consent. A dedicated teacher collaborated in this research, guiding the students through a science chapter using the traditional lecture method. Specific sub-topics within the subject were allocated for focused study, followed by the administration of a comprehensive set of multiple-choice questions for academic assessment and other one for academic anxiety and motivation through Google Forms. The collected data underwent careful scrutiny and evaluation, setting the groundwork for the subsequent phases of the study.

Post-test conditions: The two groups were taught using different methods - Group 1 through the lecture method and Group 2 using the AI-based tool ChatGpt.

Statistical tools such as mean, standard deviation, t-test, and Pearson's correlation were employed to evaluate the collected data. Data interpretation and conclusion drawing were performed based on the analyzed results, providing insights into the impact of lectures and AI-based learning methods on academic achievement, motivation, and anxiety among rural students.

Materials

Academic Anxiety Scale: This scale is a set of eleven 4-point Likert-type items. The response options utilized a scale from "1 = Not at all typical of me" to "4 = Very typical of me." The scale was developed by Cassady, 2010, and primary aim of this scale was to create a straightforward yet comprehensive contextual framework for assessing anxieties commonly encountered in academic settings.

Academic Motivation Scale (AMS): The Academic Motivation Scale (AMS), developed by Robert Vallerand in the early 1990s, is a self-report questionnaire aiming to gauge students' academic motivation. Rooted on the Self-Determination Theory (SDT), the AMS assesses individuals' motivation for academic activities. The scale comprises 28 items categorized into seven Likert rating-scales, ranging from 1 (not at all true) to 7 (very true). The scale has a satisfactory internal consistency (mean alpha- 0.81) and good test-retest reliability ranging from 0.70 to 0.90 over one week to six months.

Test Results: The achievement motivation of students was scored based on the results from the test conducted in the class on the topic taught by the teacher.

Hypotheses

HN	Hypothesis Statement
1	There is no significant difference in Academic Motivation between the Control Group and the Experimental Group in the pre-test situation.
2	There is no significant difference in Academic Anxiety between the Control Group and the Experimental Group in the pre-test situation.
3	There is no significant difference in Academic Achievement between the Control Group and the Experimental Group in the pre-test situation.
4	There is no significant difference in Academic Motivation between the Control Group and the Experimental Group in the post-test situation.
5	There is no significant difference in Academic Anxiety between the Control Group and the Experimental Group in the post-test situation.
6	There is no significant difference in Academic Achievement between the Control Group and the Experimental Group in the post-test situation.
7	There is no significant difference in Academic Motivation in the Control Group from pre-test to post-test.
8	There is no significant difference in Academic Motivation in the Experimental Group from pre-test to post-test.
9	There is no significant difference in Academic Anxiety in the Control Group from pre-test to post-test.
10	There is no significant difference in Academic Anxiety in the Experimental Group from pre-test to post-test.
11	There is no significant difference in Academic Achievement in the Control Group from pre-test to post-test.
12	There is no significant difference in Academic Achievement in the Experimental Group from pre-test to post-test.
13	There is no significant relationship between Academic Motivation and Academic Anxiety in the Control Group in post-test.
14	There is no significant relationship between Academic Anxiety and Academic Achievement in the Control Group in post-test.
15	There is no significant relationship between Academic Achievement and Academic Motivation in the Control Group in post-test.
16	There is no significant relationship between Academic Motivation and Academic Anxiety in the Experimental Group in post-test.
17	There is no significant relationship between Academic Anxiety and Academic Achievement in the Experimental Group in post-test.
18	There is no significant relationship between Academic Achievement and Academic Motivation in the Experimental Group in post-test.

RESULTS

Table 1: t-test between the variables

Variables	N	M	SD	t	*p*
V1=Pre test, aca.Motv.C Group	60	141.9	22.51		
				0.05	0.960
V2=Pre Test aca. Motv. E Group	60	141.72	22.31		
V1=Pre test, aca. Anxiety,C Group	60	18.83	5.44		
				-0.19	0.850
V2=Pre Test aca. Anxiety, E Group	60	19.02	5.28		
V1=Pre test, aca.Ach.C Group	60	13.2	3.07		
				0.32	0.750
V2=Pre Test aca. Ach. E Group	60	13.02	3.28		
V1=Post test, aca.Motv.C Group	60	134.02	21.13		
				0.05	0.960
V2=Post Test aca. Motv. E Group	60	149.35	21.4		
V1=Post test, aca. Anxiety,C Group	60	22.52	5.52		
				5.91	0.000**
V2=Post Test ,aca.Anxiety, E Group	60	16.75	5.16		
V1=Post test, aca.ach.C Group	60	11.2	2.97		
				-10.74	0.000**
V2=Post Test aca. Ach. E Group	60	16.7	2.63		
V1=Pre test, aca.Motv.C Group	60	141.9	22.51		
				1.98	0.05
V2=Post Test aca. Motv. C Group	60	134.02	21.13		
V1=Pre test, aca.Motv.E Group	60	141.9	21.31		
				-1.96	0.053
V2=Post Test aca. Motv. E Group	60	149.35	21.4		
V1=Pre test,aca. Anxiety,C Group	60	18.83	5.44		
				-3.68	0.000**
V2=Post Testaca. Anxiety,C Group	60	22.52	5.52		
V1=Pre test,aca. Anxiety,E Group	60	19.02	5.28		
				2.38	0.020*
V2=Post Test,aca.Anxiety, E Group	60	16.75	5.16		
V1=Pre test, aca.ach.C Group	60	13.2	3.07		
				3.63	0.000**
V2=Post Test aca. Ach. C Group	60	11.2	2.97		
V1=Pre test, aca.ach.E Group	60	13.02	3.28		
				-6.79	0.000**
V2=Post Test aca. Ach. E Group	60	16.7	2.63		

$^{**}p < 0.01$ $^{*}p < 0.05$

DISCUSSION

From the results of the study, it is clear that there is no significant difference between Academic Motivation (AM), Academic Anxiety (AA), and Academic Achievement (AAch)

in Control and Experimental groups. In the post-test, both groups did not differ significantly in AM, but the Control group had higher AA, while AAch was higher in the Experimental group.

When comparing pre-test to post-test conditions, neither group showed a significant change in AM. The Control group showed more anxiety in the post-test, whereas the Experimental group had higher AA in the pre-test. AAch was significantly higher in the post-test for both groups.

Regarding correlations, AM and AA are negatively related in both groups, and AA and AAch are positively related, though the relationships are not significant. In the Control group, AAch and AM are negatively related (weakly), while in the Experimental group, they are positively related (but not significantly).

The absence of a significant difference in AM and AA during the pre-test mirrors previous findings (Attri, 2013; Dobson, 2013; Shakir, 2014). Consistent with literature, the study reaffirms the negative relationship between AA and AAch (Sharma, 1990; Mnicholas, 1998; Bryme, 2000; Bhansali, 2008). The study extends the AM–AAch relationship by showing a weak positive correlation (+0.10) in the Experimental group, aligning with Berg (2014).

Studies have emphasized AI's efficacy in enhancing academic outcomes (Cruz-Jesus, 2020). This study supports that view, showing ChatGPT positively impacted students' academics and motivation (Ali, 2023; Caratiquit, 2023). While recognizing AI's benefits, some caution against viewing it as a replacement for educators (Shidiq, 2023; Biswas, 2023). An argumentative review emphasizes the need for a multidisciplinary approach (Ausat, 2023), aligning with this study's balanced perspective.

The study adds depth by focusing on rural contexts. A previous study highlighting significant differences in AA among groups resonates with these findings, stressing the importance of varied educational settings (Yagnik, 2001).

The comparison of AAch between groups aligns with Namnabati (2010), who noted the lecturing method led to higher AAch than problem-based learning, reinforcing the influence of teaching methodology on outcomes.

Discrepancies exist. For instance, Das (2014) found a negative AA–AAch correlation, contradicting this study. This highlights the importance of exploring contextual factors affecting outcomes.

While Parvaie (2023) reported increased AM and AAch in virtual learning over lectures, this study highlights the positive impact of AI-based tools like ChatGPT. Such divergent results underscore the importance of tailoring interventions to specific contexts.

In conclusion, the relationship between instructional methods, AA, AM, and AAch is intricate and context-dependent. This study, centered on ChatGPT's use in rural settings, contributes a distinctive perspective. As educational practices evolve, recognizing the interplay of instructional methods, technological interventions, and broader educational environments remains critical.

CONCLUSION AND IMPLICATIONS

The study found no significant difference in academic motivation, anxiety, or achievement between control and experimental groups in the pre-test. In the post-test, while motivation levels remained similar, the control group showed higher academic anxiety and the experimental group showed higher academic achievement. These findings highlight the potential of AI-based interventions, such as ChatGPT, to enhance academic performance and reduce anxiety. The study underscores the need for a dynamic approach to education, advocating for teacher training programs that include AI integration, the development of targeted strategies based on individual differences in motivation and anxiety, and the strategic inclusion of technology in curricula. Future research should examine the long-term impact and adaptability of AI tools across diverse educational settings to find an optimal balance between traditional and AI-enhanced learning methods.

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Conflict of Interest

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