Educational Administration: Theory and Practice
2024, 30(6), 3070-3083
ISSN: 2148-2403
https://kuey.net/

Research Article

Scientific Attitudes, Scientific Knowledge, And Academic Engagement: A Mediator Analysis

Mark Mauris E. Cabahug[1*], Ariel O. Tinapay[2], Claudine S. Tul-id[3], Ronald H. Nacion[4], Analie B. Asingua[5], Jerald C Moneva[6]

[1*,2,3,4,5,6]University of the Visayas, Colon St., Cebu City, Cebu, Philippines 6000, markmauris.cabahug@bisu.edu.ph, claudine16tulidme@gmail.com, ronaldncn1923@gmail.com, ariel_tinapay@uv.edu.ph, analieasingua@gmail.com, monevajerald5@gmail.com
[2,3,5]Cebu Roosevelt Memorial Colleges, Bogo City, Cebu, Philippines 6010

Citation: Mark Mauris E. Cabahug et al. (2024) Scientific Attitudes, Scientific Knowledge, And Academic Engagement: A Mediator Analysis, *Educational Administration: Theory and Practice*, *30*(6), 3070-3083
Doi: 10.53555/kuey.v30i6.5960

ARTICLE INFO

ABSTRACT

This study implied particularly significant for educators and policymakers in the Visayas region of the Philippines, where 483 senior high school students participated. The findings revealed that scientific attitudes, including rationality, open-mindedness, inquisitiveness, and curiosity, significantly influence participants' scientific knowledge and academic engagement, demonstrating strong statistical significance and interrelatedness. While Common Scientific Knowledge and Academic Engagement consistently related within the model, the minimal indirect effect of Common Scientific Knowledge on Academic Engagement suggests other factors may have a more direct impact on student engagement. Through structural equation modeling (SEM) with mediation analysis conducted via Amos software, the study underscored the importance of fostering scientific attitudes within educational settings to enhance academic engagement and scientific literacy, addressing a critical gap in current literature.

Keywords: scientific attitudes, scientific knowledge, academic engagement, mediator analysis and Visayas

I.INTRODUCTION

Inquisitiveness, curiosity, scientific rationality, and scientific open-mindedness are scientific attitudes that are important in forming academic engagement and scientific understanding. Their direct and indirect effects on scientific knowledge can be investigated through mediation analysis, with academic engagement acting as a possible mediator. These mindsets encourage a culture of investigation, critical thinking, and inquiry, which has a direct impact on students' motivation, engagement, and enthusiasm in academic pursuits (Tinapay & Tirol, 2021). This involvement highlights the significance of fostering these attitudes in educational contexts to enhance scientific literacy and engagement. In turn, this engagement supports deeper learning and skill development, ultimately boosting students' knowledge and memory of scientific topics (Tirol et al., 2022).

According to Martínez et al. (2024), academic engagement is emphasized as a critical component for attaining academic success and lowering school dropout rates. Research highlights the significance of student involvement in enhancing performance, perseverance, and retention (Bond et al., 2020). Research has focused on understanding the relationship between students' engagement and their academic performance. Scholars argue that student engagement positively predicts academic achievement, although some challenges to this view exist (Lei, 2018).

Curiosity is a complex phenomenon that plays a role in various aspects of human development and behavior. It has been found to enhance learning and memory (Rueterbories et al., 2023). Scientific literacy is a crucial aspect of education, enabling students to understand and engage with the world around them (Smith & Johnson, 2022). Research has shown that students often possess a mix of accurate and inaccurate scientific knowledge, influenced by various factors such as prior experiences, cultural beliefs, and educational background. Inquisitiveness plays a crucial role in promoting active learning and critical thinking skills among students (Tinapay et al., 2023). Students who exhibit high levels of curiosity are more likely to seek out new information, ask questions, and engage deeply with the subject matter (Tinapay & Tirol, 2022). This curiosity-

driven approach to learning can lead to enhanced academic achievement and a deeper understanding of complex concepts (Watson, 2015).

Research indicates that academic engagement can significantly develop students' curiosity, open-mindedness, and cooperation with others, which are key components of scientific attitude. Additionally, there is a documented aim in secondary science teaching to enhance rationality, objectivity, and open-mindedness among students to cultivate scientific attitudes (Siddiqui, M. A., & Khan, M., 2018).

The purpose of this research is to investigate the complex interactions among senior high school students' scientific attitude which encompasses curiosity, inquisitiveness, rationality, open-mindedness, scientific knowledge and academic engagement. This study aims to add to the growing body of knowledge on student motivation and engagement by synthesizing previous research and providing fresh perspectives, thereby influencing instructional strategies that promote holistic student development.

Literature Review

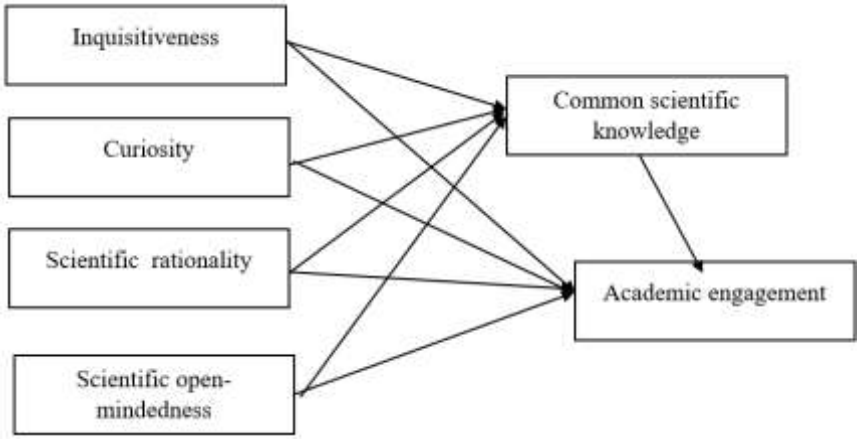
The concept of student engagement remains under-theorized and often fragmented in research. Definitions of student engagement often revolve around active participation and involvement in educational activities. Integrating various facets of student engagement into a larger framework is essential for a comprehensive understanding (Bond et. al , 2020). The influence of academic self-efficacy on student outcomes is a critical aspect explored in research. Academic self-efficacy significantly affects students' motivation levels, learning engagement, and ultimately their academic performance (Honicke, & Broadbent, 2016).

Inquisitiveness, defined as the propensity to delve into unknown realms through learning and discovery, embodies both internal curiosity about one's inner workings and external fascination with the surrounding world (Tirol, 2023). Numerous scholarly endeavors have illuminated essential characteristics inherent within this trait. For instance, inquisitive individuals consistently achieve better educational outcomes and display enhanced motivation when they possess strong student control over their education (Bai et al., 2019).

Moreover, research has indicated that those demonstrating elevated levels of inquisitiveness often manifest prosocial behaviors, such as actively participating in community projects and promoting the welfare of future generations (Kim et al., 2022). This finding underscores the positive impact of inquisitiveness on societal development and progression. Concurrently, numerous studies suggest that inquisitiveness contributes significantly to improved subjective well-being, enhancing overall life satisfaction and joyfulness (Kim et al., 2022). Effective science education strategies aim to address these misconceptions by promoting inquiry-based learning, hands-on experiments, and critical thinking skills (Smith & Johnson, 2022). By actively engaging students in the scientific process, educators can help correct misconceptions and foster a deeper understanding of scientific concepts (Tirol, 2021). Scientific knowledge is a collection of reliable information about the physical world obtained through data collection, experimentation, and analysis (National Science Foundation, 2019).

The interplay between curiosity, common scientific knowledge, motivational beliefs, and academic engagement of students has been explored in the literature. Several studies have found that curiosity is associated with students' inquiry abilities and academic performance (Flemmings et al., 2019). Motivational beliefs, such as self-efficacy and intrinsic goal orientation, have been found to positively predict deep learning strategies and resource management (Inuusah Mahama et al., 2023).

Conceptual model of the study



Statement of Purpose

This study aims to examine the interplay among curiosity, inquisitiveness, common scientific knowledge, community engagement, motivational beliefs, and academic engagement among senior high school students,

with a specific focus on common scientific knowledge as the mediator variable in the Cebu Roosevelt Memorial Colleges, Inc. S.Y. 2023-2024.

This study aims to address the following research questions:
1.What is the inquisitiveness level of the senior high school students?
2.What is the curiosity level of the senior high school students?
3.What is the rationality level of the senior high school students?
4.What is the open-mindedness of the senior high school students?
5.What is the common scientific knowledge level of the senior high school students?
6.What is the academic engagement of the senior high school students?
7.What is mediating effect of common knowledge to the scientific attitude of senior high school students in terms of:
7.1. curiosity,
7.2. inquisitiveness,
7.3. rationality, and
7.4. open-mindedness?
8. Is there an interrelationship between and among variables of the study?

II.METHODOLOGY

The design of this particular study is a Cross-Sectional Mediator Analysis. Mediator analysis is particularly well-suited for investigating the interplay of multiple variables by examining the indirect effects of one or more variables on the relationship between an independent variable and a dependent variable. In this case, the independent variables, the scientific attitudes which include curiosity, inquisitiveness, community engagement, and motivational beliefs, while academic engagement serves as the dependent variable.

Common scientific knowledge is the mediator variable in this analysis. In a study focusing on senior high school students, the participants would typically consist of individuals who are enrolled in senior high school programs. Total enumeration will be used by the researcher. The criteria of the participants of the study are as follows: The age of participants would typically be in the age range of 15 to 18 years old, representing the senior high school stage of their education. Participants may belong to different grade levels within the senior high school program, such as Grade 11 or Grade 12. The sample would ideally include both male and female participants to ensure gender diversity and representativeness. Participants should be currently enrolled in senior high school programs offered. These programs may include general academic tracks, vocational tracks, or specialized programs depending on the educational system.

The instruments of the said study will utilize a mixed of standardized and modified questionnaire. The modified questionnaires will be subjected to pilot testing and validity testing. To measure the academic engagement of the Senior High School students the researchers will utilize and modify the tool of (Handelsman et. al, 2005). A measure of College Student Course Engagement. Motivational and self-regulated learning components classroom academic performance of (Pintrich, 1990) will be used to measure students' Motivational Belief. The Community Engagement Assessment Tool of the Department of Health Services in the State of Wisconsin in 2020 will be utilized to measure the community engagement of the senior high school students. Curiosity Assessment Tool of Herwin, & Riana Nurhayati in 2021 will be utilized to measure the students' curiosity. The Inquisitiveness questionnaire is a modified one, which is anchored on the studies of (Bai et. al 2019), Watson et al 2015, Kim et al 2022 and Utami & Mustadi 2019). And lastly, the common scientific knowledge is the studies of (Chatzikyriandou et al , 2022, Hansen & Birol, 2014, Semsar et al, 2011 , Aghekyan , 2019 & Wu et al 2019).

In this study, structural equation modeling (SEM) was utilized to explore the relationships between scientific attitudes, scientific knowledge, and academic engagement. Through path analysis within the SEM framework, both direct and indirect effects of scientific attitudes on academic engagement were examined, with scientific knowledge serving as a mediator. The mediation model was constructed and estimated using Amos software, facilitating hypothesis testing and result interpretation with comprehensive statistical analyses.

Ethical Considerations

Ethical issues play a crucial role in research projects involving senior high school students. The study considered potential harm or discomfort, maintaining confidentiality, and getting informed consent from students and their guardians.

III.RESULTS AND DISCUSSIONS

Table 1
Profile of the respondents

Profile	Frequency	Percent
Strand		
ABM	35	7.20
GAS	65	13.50
HUMSS	44	9.10
STEM	256	53.00
TVL	83	17.20
Sex		
Female	292	60.50
Male	191	39.50
Type of School		
Government	256	53.00
Private (Non-Sectarian)	122	25.30
Private (Sectarian)	105	21.70
Province		
Bogo	27	5.59
Bohol	123	25.47
Cebu	128	26.50
Leyte	205	42.44
	n=483	

Table 1 illustrated the total respondents were 483 senior high school students. There were 35 (7.20%) from ABM strand, 65 (13.50%) GAS, 44 (9.10%) HUMSS, 256 (53.00%) STEM, and 83 (17.20%) from TVL. The respondents were female 292 (60.50%) and male 191 (39.50%). From government school 256 (53.00%), 122 (25.30%) from private non-sectarian school, and 105 (21.70%) from private sectarian school. The provinces included 27 (5.29%) students from Bogo city, 123 (25.47%) from the province of Bohol, 128 (26.50%) from the province of Cebu, and 205 (42.44%) from the province of Leyte.

Reliability measures

Table 2 presented the reliability statistics of the scientific attitudes: inquisitiveness, curiosity, scientific rationality, and scientific open-mindedness as well as the common scientific knowledge and the academic engagement.

Table 2
Reliability statistics

	N of items	Cronbach's Alpha	McDonald's omega	Reliability of Scale	Reliability of Scale
Inquisitiveness	9	0.956	0.956	0.956	0.956
Curiosity	25	0.912	0.909	0.912	0.912
Scientific Rationality	8	0.874	0.877	0.874	0.875
Scientific Open-mindedness	11	0.845	0.820	0.845	0.846
Common Scientific Knowledge	40	0.976	0.975	0.976	0.976
Academic engagement	13	0.957	0.957	0.957	0.957

Table 2 revealed that a 0.956 Cronbach's alpha and 0.956 McDonald's omega for inquisitiveness with 9 items which means that the instrument was very reliable. For the curiosity tool contained 25 items with 0.912 Cronbach's alpha and 0.909 McDonald's omega determines the reliability was excellent. In the assessment tool for scientific rationality, showed 25 items with 0.874 Cronbach's alpha and 0.877 McDonald's omega shows the reliability was high. Another, the scientific open-mindedness showed a 0.845 Cronbach's alpha and 0.820 McDonald's omega indicates a good reliability. Moreover, the common scientific knowledge contained 40 items showed a very reliable tool with 0.976 Cronbach's alpha and 0.975 McDonald's omega. Furthermore, the reliability of academic engagement with 13 items revealed an excellent reliability with 0.957 Cronbach's alpha and 0.957 McDonald's omega.

Table 3 presents the communalities, convergent and internal consistency to scale of all items of scientific attitudes: inquisitiveness, curiosity, scientific rationality, and scientific common-mindedness as well as common scientific knowledge, and academic engagement.

Table 3
Communalities, convergent and internal consistency to scale

Item	Initial	Extraction	Average Variance Extracted	Composite reliability
INQ1	1.000	0.671	0.4963	0.9563
INQ2	1.000	0.688		
INQ3	1.000	0.713		
INQ4	1.000	0.646		
INQ5	1.000	0.654		
INQ6	1.000	0.699		
INQ7	1.000	0.644		
INQ8	1.000	0.670		
INQ9	1.000	0.649		
INQ10	1.000	0.663		
INQ11	1.000	0.732		
INQ12	1.000	0.731		
INQ13	1.000	0.734		
INQ14	1.000	0.713		
INQ15	1.000	0.710		
INQ16	1.000	0.718		
INQ17	1.000	0.750		
CU1	1.000	0.748	0.4123	0.9667
CU2	1.000	0.672		
CU3	1.000	0.693		
CU4	1.000	0.653		
CU5	1.000	0.634		
CU6	1.000	0.605		
CU7	1.000	0.591		
CU8	1.000	0.636		
CU9	1.000	0.632		
CU10	1.000	0.681		
CU11	1.000	0.622		
CU12	1.000	0.550		
CU13	1.000	0.610		
CU14	1.000	0.656		
CU15	1.000	0.611		
CU16	1.000	0.625		
CU17	1.000	0.661		
CU18	1.000	0.736		
CU19	1.000	0.672		
CU20	1.000	0.588		
CU21	1.000	0.545		
CU22	1.000	0.696		
CU23	1.000	0.704		
CU24	1.000	0.650		
CU25	1.000	0.603		
SR1	1.000	0.615	0.4482	0.9552
SR2	1.000	0.758		
SR3	1.000	0.686		
SR4	1.000	0.730		
SR5	1.000	0.587		
SR6	1.000	0.714		
SR7	1.000	0.642		
SR8	1.000	0.626		
SOM1	1.000	0.822	0.4931	0.9405
SOM2	1.000	0.822		
SOM3	1.000	0.623		
SOM4	1.000	0.679		

SOM5	1.000	0.653		
SOM6	1.000	0.578		
SOM7	1.000	0.730		
SOM8	1.000	0.617		
SOM9	1.000	0.674		
SOM10	1.000	0.640		
SOM11	1.000	0.651		
CSK1	1.000	0.659	0.5073	0.9787
CSK2	1.000	0.711		
CSK3	1.000	0.670		
CSK4	1.000	0.703		
CSK5	1.000	0.668		
CSK6	1.000	0.725		
CSK7	1.000	0.680		
CSK8	1.000	0.694		
CSK9	1.000	0.671		
CSK10	1.000	0.586		
CSK11	1.000	0.720		
CSK12	1.000	0.726		
CSK13	1.000	0.709		
CSK14	1.000	0.722		
CSK15	1.000	0.716		
CSK16	1.000	0.695		
CSK17	1.000	0.695		
CSK18	1.000	0.690		
CSK19	1.000	0.719		
CSK20	1.000	0.701		
CSK21	1.000	0.670		
CSK22	1.000	0.695		
CSK23	1.000	0.755		
CSK24	1.000	0.781		
CSK25	1.000	0.730		
CSK26	1.000	0.720		
CSK27	1.000	0.743		
CSK28	1.000	0.622		
CSK29	1.000	0.600		
CSK30	1.000	0.679		
CSK31	1.000	0.665		
CSK32	1.000	0.796		
CSK33	1.000	0.805		
CSK34	1.000	0.808		
CSK35	1.000	0.765		
CSK36	1.000	0.777		
CSK37	1.000	0.774		
CSK38	1.000	0.740		
CSK39	1.000	0.764		
CSK40	1.000	0.749		
ACE1	1.000	0.741	0.4912	0.9665
ACE2	1.000	0.658		
ACE3	1.000	0.664		
ACE4	1.000	0.623		
ACE5	1.000	0.579		
ACE6	1.000	0.633		
ACE7	1.000	0.673		
ACE8	1.000	0.732		
ACE9	1.000	0.732		
ACE10	1.000	0.704		

ACE11	1.000	0.700
ACE12	1.000	0.663
ACE13	1.000	0.731
ACE14	1.000	0.696
ACE15	1.000	0.764
ACE16	1.000	0.708
ACE17	1.000	0.696
ACE18	1.000	0.674
ACE19	1.000	0.720
ACE20	1.000	0.712
ACE21	1.000	0.778
ACE22	1.000	0.727

Extraction Method: Principal Component Analysis.

As shown in table 3, the senior high school students have no interest in the rules and regulations in school is 54.5% by CU21 *(I don't question rules and regulations.)* indicating 45.5% has an interest. The students are resourceful to understand the subject matter better is 55.0% by CU12 *(I use various sources (books etc.) to understand the subject matter.)* whereas 45.0% were not interested to look for another sources. Then, 57.8% perceived that they are offended if a person has different views from them by SOM6 *(One may feel offended from a person who has different thinking from him/her.)* 42.2% would accept the views of others. Also, 57.9% of the students active in joining the class everyday by ACE5 *(Coming to class every day.)* yet 42.1%. Nonetheless, 58.6% are knowledgeable on the laboratory safety procedures and practices during chemistry experiments by CSK10 *(I am familiar with laboratory safety procedures and practices in chemistry experiments.)* although 41.4% of them do not know. Moreover, 58.7% don't consider studying science by SR5 (Studying science is not everybody's cup of tea.) indicating 41.3% consider science is their favorite to study. Furthermore, they inquire to deepen their knowledge by looking new materials is 64.4 % by INQ7 *(I seek additional materials to deepen your understanding of discussed topics.)* which means 35.6% were stagnant.
The perceived inquisitiveness level was measured with 17 items and the AVE for these items is 0.4963, which means 49.63% of the variations in senior high school students perceived inquisitiveness level was explained by these 17 items. There were 25 items measured in perceived curiosity level with AVE of 0.4123 (41.23%) variations of perceived curiosity level were explained by these 25 items. The scientific rationality variable with 8 items and an average variation extraction value of 0.4482 (44.82%) indicates the extent of variability or dispersion in responses to these items, suggesting that there is a moderate level of diversity in how individuals perceive scientific rationality. The scientific open-mindedness perceived level with 11 items and an average variation extraction value of 0.4931 (49.31%) indicates a moderate level of variability in how individuals perceive and practice open-mindedness in a scientific context, showing both consistency and some diversity in responses. The perceived level of common scientific knowledge with 40 items and an average variation extraction value of 0.5073 (50.73%) suggests a moderate degree of variation in how individuals understand and interact with basic scientific information, demonstrating a mix of consistency and diversity in responses. The academic engagement with 22 items and an average variation extraction value of 0.4912 shows a moderate level of variability in how individuals engage academically across a broader range of items, reflecting diverse levels of involvement, commitment, and behaviors within the evaluated context.
The composite reliability for the constructs ranges from 0.9405 to 0.9787 which exceeds 0.70 were very high. A value close to 1 indicates that the items measuring the construct are highly consistent and reliable in capturing the underlying concept. In this case, we can have a high level of confidence in the accuracy and consistency of the measurement of variable using all items. Table 4 presented the total variance of all components with initial eigen values and extraction sum of squared loadings.

Table 4
Total Variance Explained for the Construct

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	29.491	23.976	23.976	29.491	23.976	23.976
2	13.391	10.887	34.864	13.391	10.887	34.864
3	8.562	6.961	41.824	8.562	6.961	41.824
4	5.83	4.74	46.564	5.83	4.74	46.564
5	4.893	3.978	50.542	4.893	3.978	50.542
6	3.723	3.027	53.569	3.723	3.027	53.569
7	2.249	1.829	55.398	2.249	1.829	55.398
8	2.162	1.757	57.155	2.162	1.757	57.155

9	1.908	1.551	58.706	1.908	1.551	58.706
10	1.654	1.345	60.051	1.654	1.345	60.051
11	1.541	1.253	61.304	1.541	1.253	61.304
12	1.383	1.125	62.429	1.383	1.125	62.429
13	1.272	1.034	63.463	1.272	1.034	63.463
14	1.171	0.952	64.416	1.171	0.952	64.416
15	1.117	0.908	65.324	1.117	0.908	65.324
16	1.08	0.878	66.202	1.08	0.878	66.202
17	1.055	0.857	67.059	1.055	0.857	67.059
18	1.024	0.833	67.892	1.024	0.833	67.892
19	1.01	0.821	68.713	1.01	0.821	68.713
20	0.958	0.779	69.492			
21	0.907	0.738	70.229			
22	0.88	0.715	70.944			
23	0.858	0.697	71.642			
24	0.838	0.681	72.323			
25	0.82	0.667	72.99			
26	0.815	0.662	73.652			
27	0.796	0.647	74.3			
28	0.776	0.631	74.931			
29	0.748	0.608	75.539			
30	0.732	0.595	76.135			
31	0.712	0.579	76.713			
32	0.705	0.573	77.287			
33	0.682	0.554	77.841			
34	0.667	0.543	78.383			
35	0.653	0.531	78.914			
36	0.646	0.525	79.439			
37	0.617	0.501	79.941			
38	0.612	0.497	80.438			
39	0.599	0.487	80.925			
40	0.586	0.476	81.401			
41	0.579	0.471	81.872			
42	0.56	0.455	82.327			
43	0.548	0.446	82.773			
44	0.547	0.445	83.217			
45	0.542	0.44	83.658			
46	0.518	0.421	84.079			
47	0.511	0.416	84.494			
48	0.494	0.401	84.896			
49	0.477	0.388	85.283			
50	0.467	0.38	85.664			
51	0.461	0.375	86.039			
52	0.461	0.375	86.414			
53	0.447	0.363	86.777			
54	0.44	0.358	87.135			
55	0.435	0.354	87.489			
56	0.434	0.353	87.842			
57	0.416	0.338	88.179			
58	0.407	0.331	88.51			
59	0.395	0.321	88.831			
60	0.393	0.32	89.151			
61	0.388	0.315	89.466			
62	0.378	0.307	89.774			
63	0.37	0.301	90.074			
64	0.368	0.299	90.374			

65	0.359	0.292	90.665
66	0.355	0.289	90.954
67	0.347	0.282	91.236
68	0.334	0.271	91.507
69	0.323	0.263	91.77
70	0.319	0.26	92.03
71	0.312	0.254	92.284
72	0.31	0.252	92.536
73	0.299	0.243	92.778
74	0.289	0.235	93.013
75	0.285	0.232	93.245
76	0.283	0.23	93.475
77	0.279	0.227	93.702
78	0.271	0.22	93.922
79	0.267	0.217	94.139
80	0.264	0.215	94.354
81	0.258	0.21	94.564
82	0.253	0.206	94.77
83	0.248	0.201	94.971
84	0.241	0.196	95.167
85	0.236	0.192	95.359
86	0.231	0.188	95.547
87	0.228	0.185	95.732
88	0.226	0.184	95.916
89	0.22	0.179	96.095
90	0.213	0.173	96.268
91	0.207	0.168	96.436
92	0.201	0.164	96.599
93	0.199	0.162	96.761
94	0.195	0.158	96.919
95	0.191	0.156	97.075
96	0.183	0.149	97.224
97	0.18	0.147	97.371
98	0.177	0.144	97.514
99	0.175	0.142	97.657
100	0.171	0.139	97.796
101	0.159	0.129	97.925
102	0.155	0.126	98.051
103	0.155	0.126	98.177
104	0.152	0.123	98.3
105	0.147	0.119	98.419
106	0.141	0.114	98.534
107	0.139	0.113	98.647
108	0.136	0.11	98.757
109	0.133	0.108	98.865
110	0.129	0.105	98.97
111	0.125	0.101	99.072
112	0.122	0.099	99.171
113	0.113	0.092	99.263
114	0.112	0.091	99.353
115	0.104	0.085	99.438
116	0.103	0.084	99.522
117	0.098	0.08	99.601
118	0.091	0.074	99.676
119	0.089	0.073	99.748
120	0.084	0.068	99.817

121	0.079	0.064	99.881
122	0.077	0.063	99.944
123	0.069	0.056	100

Extraction Method: Principal Component Analysis.

Table 4 showed that out of 123 components there were nineteen components that are greater than 1.0 that emerged from computing eigen value. The values extended between 1.01 and 29.491. Meanwhile, the explained variance for the first component was 23.976%, 34.864% for the second, ..., 67.8925% for the eighteenth, and 68.713% for the nineteenth. The total explained variance upon measuring this construct was 68.713% that exceeds 60% indicating that it is acceptable (Awang, 2010, 2012; Hoque et al., 2017, 2018; Yahaya et al., 2018; Bahkia et al., 2019 and Awang et al., 2020).

Table 5
Means: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Inquisitiveness	52.657	0.653	80.673	***	significant
Curiosity	72.233	0.538	134.383	***	significant
Rationality	28.26	0.255	110.621	***	significant
Open-mindedness	35.545	0.3	118.478	***	significant

The mean estimates for inquisitiveness, curiosity, rationality, and open-mindedness are 52.657, 72.233, 28.26, and 35.545, respectively, all of which are significantly different from zero at the 0.001 level (two tailed), as indicated by critical ratios exceeding 80.673, 134.383, 110.621, and 118.478, respectively. These findings suggest strong statistical significance for the observed differences, indicating robust support for the presence of these scientific attitudes.

Scientific attitudes encompass fundamental values and practices inherent in the scientific community, such as adherence to empirical evidence, logical reasoning, inquiry, and skepticism (Osborne, Simon & Collins (2003) These attitudes encompass a range of qualities including curiosity, rationality, skepticism, open-mindedness, critical thinking, objectivity, intellectual honesty, humility, and reverence for life (Aydeniz , & Kotowski, 2014).

Table 6
Intercepts: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Common Scientific Knowledge	36.59	6.859	5.334	***	significant
Academic Engagement	68.663	4.947	13.879	***	significant

The intercepts for predicting Common Scientific Knowledge and Academic Engagement are estimated at 36.590 and 68.663, respectively, both significantly different from zero at a high level of confidence ($p < 0.001$). These values represent the baseline levels of Common Scientific Knowledge and Academic Engagement when all predictor variables are held constant, providing essential reference points for understanding their relationships within group.

Understanding how students engage in learning and its impact on academic achievement is crucial for fostering student engagement and knowledge acquisition, as highlighted in a study by Collie, Holliman, & Martin (2017). Additionally, Dong, Jong, & King (2020) examined the influence of prior knowledge on learning engagement, finding that prior knowledge interacts with cognitive load and self-regulated learning to predict engagement and learning outcomes.

Table 7
Covariances: (Group number 1 - Default model)

Pairwise comparison			Estimate	S.E.	C.R.	P	Label
Inquisitiveness	<-->	Curiosity	85.198	8.63	9.872	***	Significant
Curiosity	<-->	Rationality	34.113	3.394	10.052	***	Significant
Rationality	<-->	Open-mindedness	23.87	2.004	11.91	***	Significant
Inquisitiveness	<-->	Rationality	33.29	3.965	8.395	***	Significant
Inquisitiveness	<-->	Open-mindedness	32.54	4.551	7.15	***	Significant
Curiosity	<-->	Open-mindedness	32.052	3.833	8.363	***	Significant

The covariances between Inquisitiveness and Curiosity, Curiosity and Rationality, Rationality and Open-mindedness, Inquisitiveness and Rationality, Inquisitiveness and Open-mindedness, and Curiosity and Open-mindedness are all significantly different from zero at the 0.001 level (two-tailed), with estimates ranging from

23.87 to 85.198. These findings indicate strong relationships between these pairs of variables within group, suggesting interrelatedness in the observed scientific attitudes (Tirol, 2022).

Table 8
Variances: (Group number 1 - Default model)

Variables	Estimate	S.E.	C.R.	P	Label
Inquisitiveness	205.779	13.242	15.54	***	significant
Curiosity	139.551	8.98	15.54	***	significant
Rationality	31.523	2.028	15.54	***	significant
Open-mindedness	43.475	2.798	15.54	***	significant
e1	467.209	30.064	15.54	***	significant
e2	229.538	14.771	15.54	***	significant

Curiosity, identified as a fundamental human motivation, drives learning and fulfillment by prompting individuals to seek new experiences and knowledge. Open-mindedness, crucial in scientific attitudes, entails tolerance for uncertainty and a commitment to logical, critical thinking, as emphasized by Kashdan, Sherman, Yarbro, & Funder (2013). Rationality, integral to scientific inquiry, involves intellectual honesty and critical thinking, fostering a logical and analytical approach to problem-solving and inquiry (Punia & Bala, 2009).

Table 6 reveals significant variance estimates for Inquisitiveness, Curiosity, Rationality, Open-mindedness, e1, and e2, with all variables demonstrating substantial variability from zero at the 0.001 level (two-tailed), indicating diverse responses and behaviors within Group number 1. These findings underscore the importance of considering individual differences and measurement error when interpreting the relationships between scientific attitudes and outcomes (Tinapay et al., 2021).

Two studies examining scientific attitudes in elementary school students found that while gender and parental education level did not significantly impact attitudes, attitudes became more negative with age, possibly due to increased competition and focus on individual success. Furthermore, teacher scientific attitudes were found to significantly influence students' attitudes at the elementary level (Küçükaydin, 2021). Additionally, a study highlighted the importance of considering individual differences and measurement error in understanding scientific attitudes, while emphasizing curiosity as a key factor, with a revised scale capturing its multidimensional nature (Nugraha, Putri, & Sholihin, 2020).

Table 9
Total Effects (Group number 1 - Default model)

	Open-mindedness	Rationality	Curiosity	Inquisitiveness	Common Scientific Knowledge
Common Scientific Knowledge	0.664	1.161	0.342	0.233	0.000
Academic Engagement	-0.518	-0.068	0.356	0.162	0.005

The total effect of Common Scientific Knowledge on itself is observed to be 0, indicating that both direct and indirect effects combined do not lead to a change in Common Scientific Knowledge when it increases by 1 unit. This suggests a stable relationship within the model, where factors influencing Common Scientific Knowledge do not significantly contribute to its variation.

Lucas, Hunter, & Gompert (2020) investigated the impact of classroom research experiences on students' science attitudes, finding that responses aligned with scientifically mature students' expectations, though variations existed compared to nationwide data, particularly regarding attitudes about creativity in science and the reliability of scientific results. Nugraha, Putri, & Sholihin (2020) explored the relationship between students' scientific attitudes, measuring aspects like rationality, curiosity, open-mindedness, and aversion to superstition, emphasizing the importance of understanding these attitudes for educational purposes.

The sources discuss academic engagement, defined as knowledge-related interactions between academic scientists and external organizations, such as industry, politics, and the news media (Son et al., 2022). These interactions encompass contract research, consulting, informal advice provision, and networking, studied across various countries and disciplines, with individual characteristics like communication skills and attitudes influencing engagement, along with social norms (Rauchfleisch, Schäfer,& Siegen,2021)

Figure 2 Diagram of the path estimates of the mediator analysis.

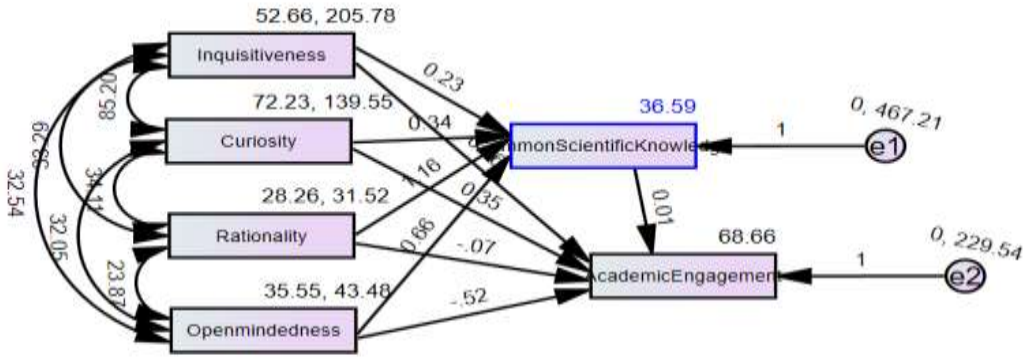


Table 10
Total, direct and indirect effects

	Open-mindedness	Rationality	Curiosity	Inquisitiveness	Common Scientific Knowledge
Total Effects (Group number 1 - Default model)					
Common Scientific Knowledge	0.664	1.161	0.342	0.233	0.000
Academic Engagement	-0.518	-0.068	0.356	0.162	0.005
Direct Effects (Group number 1 - Default model)					
Common Scientific Knowledge	0.664	1.161	0.342	0.233	0.000
Academic Engagement	-0.522	-0.074	0.354	0.161	0.005
Indirect Effects (Group number 1 - Default model)					
Common Scientific Knowledge	0.000	0.000	0.000	0.000	0.000
Academic Engagement	0.004	0.006	0.002	0.001	0.000

In science education, academic engagement is influenced by the science learning environment, particularly enjoyment of science lessons, highlighting the importance of positive, hands-on learning experiences. Additionally, while Common Scientific Knowledge has a direct effect on Academic Engagement, there is no mediation effect, indicating a stable relationship within the model (Perkmann et al, 2013).

IV.CONCLUSION

Based on the study's findings, participants' scientific knowledge and academic engagement are significantly influenced by their scientific attitudes, such as rationality, open-mindedness, inquisitiveness, and curiosity, demonstrating strong statistical significance and interrelatedness. Although Common Scientific Knowledge and Academic Engagement exhibit consistent relationships within the model, the minimal indirect effect of Common Scientific Knowledge on Academic Engagement suggests that other factors may have a more direct impact on students' engagement. These findings underscore the complex relationship between scientific attitudes, knowledge, and engagement, emphasizing the need for further research to elucidate underlying processes and inform effective educational interventions.

V. RECOMMENDATIONS

In order to improve students' scientific understanding and academic engagement, educational curricula should incorporate the development of scientific attitudes like curiosity and inquisitiveness. Additionally, in order to enhance current efforts to raise educational standards, customized treatments should be created to address variables that directly affect academic engagement.

In addition, encouraging interdisciplinary techniques in instruction can help kids develop holistically and better prepare them for a range of academic challenges.

VI.REFERENCES

1. Aydeniz, M., & Kotowski, M. R. (2014). Conceptual and methodological issues in the measurement of attitudes towards science. *The Electronic Journal for Research in Science & Mathematics Education*, *18*(3).
2. Bond, M., Buntins, K., Bedenlier, S. *et al.* Mapping research in student engagement and educational technology in higher education: a systematic evidence map. *Int J Educ Technol High Educ* **17**, 2 (2020). https://doi.org/10.1186/s41239-019-0176-8
3. Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and Educational Technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education*, *17*(1). https://doi.org/10.1186/s41239-019-0176-8
4. Bowen, G. (2015). Book review: University engagement for community economic development: The role of anchor institutions. *Journal of Community Engagement and Scholarship*, *8*(2). https://doi.org/10.54656/mfbj9657
5. Collie, R. J., Holliman, A. J., & Martin, A. J. (2017). Adaptability, engagement and academic achievement at university. Educational Psychology, 37(5), 632-647.
6. Dong, A., Jong, M. S. Y., & King, R. B. (2020). How does prior knowledge influence learning engagement? The mediating roles of cognitive load and help-seeking. Frontiers in psychology, 11, 591203.
7. Education, 25:9, 1049-1079, DOI: 10.1080/0950069032000032199
8. Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review*, *17*, 63–84. https://doi.org/10.1016/j.edurev.2015.11.002
9. Judson, M. (2017) Why Family and Community Involvement Is Important. https://bit.ly/40aQHjD
10. Kashdan, T. B., Sherman, R. A., Yarbro, J., & Funder, D. C. (2013). How are curious people viewed and how do they behave in social situations? From the perspectives of self, friends, parents, and unacquainted observers. Journal of personality, 81(2), 142-154.
11. Kline, R. B. (2016). Principles and practice of structural equation modeling (4th ed.). Guilford Press.
12. Küçükaydin, M. A. (2021). Examination of Elementary School Students' Scientific Attitudes and Intellectual Risk Taking Behaviours. Science Education International, 32(2), 149-158.
13. Lei, H., Cui, Y., & Zhou, W. (2018). Relationships between student engagement and academic achievement: A meta-analysis. *Social Behavior and Personality: An International Journal*, *46*(3), 517–528. https://doi.org/10.2224/sbp.7054
14. Lucas, L. K., Hunter, F. K., & Gompert, Z. (2020). Effect of Three Classroom Research Experiences on Science Attitudes. Journal on Empowering Teaching Excellence, 4(2), 8.
15. Nagengast, B., Marsh, H. W., Scalas, L. F., Xu, M. K., Hau, K.-T., & Trautwein, U. (2011).
16. Who Took the "×" out of Expectancy-Value Theory? A Psychological Mystery, a Substantive-Methodological Synergy, and a Cross-National Generalization. *Psychological Science*, *22*(8), 1058-1066. https://doi.org/10.1177/0956797611415540
17. Nugraha, I., Putri, N. K., & Sholihin, H. (2020). An Analysis of the Relationship between Students' Scientific Attitude and Students' Learning Style in Junior High School. Journal of science learning, 3(3), 185-195.
18. Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'este, P., ... & Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. Research policy, 42(2), 423-442.
19. Punia, V., & Bala, R. (2009). Scientific attitude amongst the Science and Non-science Pupil Teachers: A Comparative Analysis. SRDE's Higher Education Journal, 1, 9-16.
20. Rauchfleisch, A., Schäfer, M. S., & Siegen, D. (2021). Beyond the ivory tower: Measuring and explaining academic engagement with journalists, politicians and industry representatives among Swiss professorss. Plos one, 16(5), e0251051.
21. Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *APA educational psychology handbook, Vol. 1. Theories, constructs, and critical issues* (pp. 101–123). American Psychological Association. https://doi.org/10.1037/13273-005science: A review of the literature and its implications, International Journal of Science
22. Siddiqui, M. A., & Khan, M. (2018). A study of scientific attitude, teaching effectiveness and physics achievement among physics senior secondary students. International Journal of Research in Humanities, Arts and Literature, 6(8), 71-78.
23. Son, Adelaida P.; Tinapay, Ariel O.; Tirol, Shiela L.; Samillano, James H.; and Cortes, Jan Axel L. (2022) "Reading Proficiency Level of Grade 2 Learners in the Case of Modular Distance Learning: A Literature Review," International Journal of Multidisciplinary Research and Publications (IJMRAP), Volume 5, Issue 3, pp. 66-73.
24. Sunita, & Anchal, A. (2022). Academic achievement of senior secondary school students in relation to intelligence and types of school. *SDES-International Journal of Interdisciplinary Research*, *3*(4), 450–455. https://doi.org/10.47997/sdes-ijir/3.4.2022.450-455

25. Tinapay, A. O., & Tirol, S. L. (2021). Social Learning Perspectives in School Policies in a Higher Education Institution. Nat. Volatiles & Essent. Oils, 8(5), 9666-9686.
26. Tinapay, A. O., & Tirol, S. L. (2021). Teachers' Primary Roles in the New Normal: Through the E-Learning Perspective. International Journal of Innovative Science and Research Technology, 6(10), 90-91.
27. Tinapay, A., Tirol, S., Cortes, J. A., & Punay, M. (2021). Attitude of learners towards science and their science process skills in the case of the spiral curriculum: A. International Journal of Research, 10(15), 13-24.
28. Tinapay, A. O., & Tirol, S. L. (2022). Social Cognitive Development on the Implementation of Student Manual in a Higher Education Institution: A Literature. *International Journal of Science and Management Studies (IJSMS)*, *5*, 54-63.
29. Tinapay, A.O., Desabille, I.N., Tirol, S.L., Samillano, J.H. (2023). Practical Research Teachers' Technological, Pedagogical, and Content Knowledge (Tpack) and Competencies: A Literature Review. Eur. Chem. Bull. 12(4), 3140-3160
30. Tirol, S. L. (2021). Spiral Progression of Biology Content in the Philippine K to 12 Science Curriculum. International Journal of Multidisciplinary Research and Publications (IJMRAP), 4, 20-27.
31. Tirol, S. L. (2022). Spiral Progression Approach in the K to 12 Science Curriculum: A Literature Review. International Journal of Education (IJE), 10, 29-44. https://doi.org/10.5121/ije.2022.10403
32. Tirol, S.L. (2023). Science Teachers' Competence on Model-Based Inquiry: A Review of Related Literature. Eur. Chem. Bull. 2023,12(5), 2886-2902Tortosa Martínez, B. M., & Pérez-Fuentes, M. del. (2024). Design and validation of the general scale of academic engagement for Spanish adolescents (CAADE). *Heliyon*, *10*(1). https://doi.org/10.1016/j.heliyon.2023.e23732
33. Tirol, S., Cortes, S. T., Tinapay, A., & Samillano, J. (2022). A teacher training program on designing participatory educational action research proposal. Ho Chi Minh City Open University Journal of Science-Social Sciences, 12(1), 23-39.
34. Van den Broeck, A., Ferris, D. L., Chang, C.-H., & Rosen, C. C. (2016). A Review of Self-Determination Theory's Basic Psychological Needs at Work. *Journal of Management*, *42*(5), 1195-1229. https://doi.org/10.1177/0149206316632058
35. VandeWalle, D., Cron, W. L., & Slocum Jr, J. W. (2001). The role of goal orientation following performance feedback. *Journal of applied psychology*, *86*(4), 629.