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Understanding the Pedagogical Drivers of Students' Career Interests in Astronomy in Public Universities

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Abstract

Grooming future astronomers is significant to the sustainable development of an emerging economy like Nigeria but this will require proper understanding of the drivers of students' interest in astronomy as a career path. This study examined the pedagogical drivers of students' career interest in astronomy in public Universities in Nigeria. Three research questions were answered in the study which adopted mixed method design. There were 162 respondents (154 students and eight lecturers) who were sampled for the study. The instrument used for data collection was a structured questionnaire. The research questions raised were analyzed using percentage, Ordinary Least Square (OLS) regression and thematic analysis. The result of the study indicated that technology, perception, welfare, incentives, and curiosity were among the factors that influenced students' interest in astronomy as perceived by the lecturers. The study equally showed that student's interest to choose astronomy as a career path is influenced by students' level of awareness about astronomy, conceptual understanding and membership of professional bodies significantly while the gender of the student, year of study and academic performance were not significant. The challenges to taking up astronomy as a career included lack of institutional collaboration, teacher competence and inadequate facilities among others. The study recommended that students pursuing a course in astronomy should be enrolled into available professional bodies from their first year in school.

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Introduction

Science across all fields have continued to influence development in various ways and the Bureau of Labor Statistics as cited in Bergstrom et al., (2016) pointed out that the demand for more science and engineering experts continues to soar in order to meet the needs of humanity. Therefore, sustaining interest in Science, Technology, Engineering and Mathematics (STEM) is important to meet this growing demand. One of the branches of science that has continued to draw public interest both consciously and unconsciously for several centuries is astronomy (Ozkan & Akcay, 2016) due to its importance to humanity and the immediate environment. Despite the importance of astronomy as a means of understanding the immediate and celestial environment, the planned inclusion of astronomy in the curriculum of schools is only about two decades ago (Cardinot & Fairfield, 2021) especially in most developing countries. This has delayed the level of participation in astronomical activities in these places. Uludag et al., (2014) asserted that it is only when students have prior knowledge about astronomy that they can start to consider it as an area of interest and this has not fully happened due to slow planning, policies, programs and projects in this field.

So far, the interest of students in astronomy has seen more males practicing the profession than females. This is however not surprising as scholars such as Sjoberg and Schreiner (2010) pointed out that there are more males than females who show interest in science generally and the statistics are in most cases disproportional. Related evidence was provided by Ivie et al., (2016) as they asserted that despite the fact that some female students choose science related disciplines at the undergraduate level, the statistics becomes slimmer as they progress to masters and even doctorate level and attrition also exists even among female science practitioners including experts in astronomy and astrophysics. The low involvement and participation of female in astronomy exists both in developed and developing countries with several governments and organizations seeking for ways to change the narrative. Kewley (2021) noted that even in Australia, available data shows that women who participate in astronomy at the senior levels remains historically low and these women are two to three times more likely to leave the profession than their male counterparts. This leaves the participation of women in astronomy as an issue of concern given the fact that entry into the profession especially at tertiary education level is low while the exit to other professions is very high.

Studies such as that of Kugler *et al.,* (2021) have shown that women have the potentials to study science like their male counterpart only if an enabling environment is provided. Achieving this objective starts with increasing the knowledge of intending and prospective students about astronomy. Furnham and Hughes (2014) stated that students are more likely to identify with simpler astronomical concepts and phenomena than complex ones which are often met with confusion. This experience often results to misconceptions which may be higher among female students due to their unconscious bias and stereotypes. Aloisi and Reid (2019) stated that these biases are not only in terms of entering the astronomy profession but also exists in the areas of collaboration, allocations, review processes and speaking in conferences. Generally, there is a high level of misconception among students about astronomy especially on issues related to celestial bodies (Shaafi et al., 2023) and female students will require more than just verbal conviction to study the course. This has its implication on women's intention and willingness to study astronomy.

According to Farooque (2020), when students develop interest in astronomy, it drives their intrinsic motivation, attention, focus, understanding and is also instrumental to retaining them in the profession. However, achieving this starts with making basic concepts and phenomena understandable. Common terms in astronomy such as the solar system, black hole, galaxies and so on need to be simplified for students from basic to higher levels of education so, Nilsen and Angell (2014) pointed out that this is equally important and not just knowing or memorizing the logical facts.

It has been revealed by scholars such as Mills et al., (2016) that even after some students have passed through formal instruction on astronomical concepts even at higher levels of education, they still perform poorly in tests of conceptual understanding. However, Ivie et al., (2016) stated that there may not be sufficient information on astronomy which has made some students to resort to studying physics why some other studies are disturbed about their job prospects after studying astronomy. Benitez-Herrera et al., (2019) added that there are also social and psychological factors which make women to be excluded from studying science including astronomy. There is therefore the need for a joint approach to deal with these complexities in order to promote women's interest and performance in astronomy.

Empirically, Shaafi et al., (2023) conducted a study on interest in astronomy among university students in Malaysia. Undergraduate students from four different faculties provided data via a structured questionnaire. A descriptive analysis of the responses revealed a substantial difference in the interest that male and female students had in astronomy. The students' primary subject and their degree of astronomy knowledge differed significantly as well. There was no significant correlation found between the respondents' parents' educational background and their misconception in astronomy, nor between the students' faculties and misconceptions in the subject. On the other hand, Zulkipli et al. (2022) investigated student's conceptions of astronomy in Universiti. Teknologi Mara in Malaysia. The study included 120 university students who were enrolled in various courses and had varying educational backgrounds. The data collected from the students through a questionnaire was descriptively analyzed, and the results showed that the most common misconceptions were that the moon revolves around the sun annually (69.2%), that the earth is shaped like a geoid (77.5%), that December is Australia's longest day (75.0%), that the earth is closer to the sun during summer (79.2%), that the sun is red (82.5%), that the sun is at the center of the universe (77.5%), that stars shine due to reflected light from the sun (78.3), and that there is no gravity on the moon (75.0%). According to the survey, pupils' comprehension of astronomical concepts was lacking.

Tezer (2022) carried out another study on middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy. The Misconceptions Test About Astronomy Concepts (MTAC), the Attitude Astronomy Scale (AAS), and a demographic questionnaire were completed by 348 and 360 sixth-grade pupils, respectively, who made up the study's sample. The data collected from the students was analyzed using MANOVA and correlational analysis, and the findings showed that there was positive correlation between their attitudes toward astronomy and their misconceptions about astronomy ideas. The attitudes of students in the sixth and seventh grades about astronomy did not significantly differ from one another. According to the MANOVA analysis, there was a significant difference in students' levels of interest between male and female students.

Additionally, interest in astronomy had a big impact on future careers.

Ozkan and Akcay (2016) conducted another study on preservice science teachers' beliefs about astronomy concepts. In this study, the qualitative research method was employed. 118 preservice science instructors (40 freshmen, 31 sophomores, and 47 juniors) made up the sample. Semi-structured interviews and the Astronomy Conceptual Questionnaire (ACQ) were used to gather data. The findings showed that preservice science instructors had a number of astronomy-related misunderstandings. Every mistake is typically founded on a widely held false belief about astronomy. Additionally, they struggle to understand simple definitions and comprehend astronomy idea illustrations. Additionally, there is no variation in the pupils' comprehension of astronomy ideas across different levels.

Furthermore, Cardinot and Fairfield (2021) investigated alternative conceptions of astronomy and how Irish secondary students understand gravity, seasons, and the big bang. In order to gather student opinions regarding gravity, seasons, and the Big Bang from 498 secondary school pupils in Ireland, a quasi-experimental method was used. The findings revealed that students of all years held 15 different beliefs, and even senior students had the same alternative thoughts as first-year students. Sedeno et al., (2018) conducted a sociological study of gender and astronomy in Spain. To investigate such tendencies, in-depth interviews were done with post-doctoral and PhD applicants as well as teaching staff members. One of the study's findings was that both men and women thought that women had the primary duty for raising children, and that males held the highest positions of authority in organizations.

Anjos and Doran (2024) also conducted a study on innovations in teaching astronomy and space exploration for improved learning experiences using methodologies, case studies and best practices. The study showed that conducting experiments, through hands-on activities or using astronomy software and telescopes enable students gain first-hand experience and facilitates a deeper understanding of astronomical concepts, thereby allowing students to actively participate in experiments, observations, and simulations related to light pollution and climate change. In a similar manner, Bergstrom et al., (2016) conducted a gender study on evolution and persistence of students' astronomy career interests. The study's targeted respondents comprised 15,847 female STEM professionals. Research indicates that students who participate in extracurricular activities such as stargazing, tinkering with electrical or mechanical devices, or reading science or science fiction have a significantly higher likelihood of being interested in pursuing a career in astronomy when they graduate from high school. Furthermore, the authors discover that girls who spend extracurricular time stargazing have a higher improvement in their chances of becoming astronomers than do boys. It was also demonstrated that these extracurricular activities are a stronger indicator of astronomy interest than academic predictions that are frequently researched. These studies establish a gender dimension to astronomy which calls for further research.

Therefore, the main objective of the study was to investigate the gender differentials in the study of astronomy among students in Nigerian Universities. The specific objectives of the study were to:

- determine the factors influencing students' interest in astronomy as a career path in Nigerian Universities.
- examine the effect of students' attributes on their interest in astronomy as a career path in Nigerian

Universities.

- determine the innovative pedagogical strategies that mostly fosters students' interest in astronomy in Nigerian Universities.
- ascertain how innovative pedagogical strategies influence students' interest in astronomy in Nigerian Universities.
- ascertain the challenges to studying astronomy as a career path among students in Nigerian Universities.

Research Questions

The following research questions were raised to guide the study:

- What are the factors influencing students' interest in astronomy as a career path in Nigerian Universities?
- What is the effect of students' attributes on their interest in astronomy as a career path in Nigerian Universities?
- What are the innovative pedagogical strategies that mostly fosters students' interest in astronomy in Nigerian Universities?
- How do innovative pedagogical strategies influence students' interest in astronomy in Nigerian Universities?
- What are the challenges to studying astronomy as a career path among students in Nigerian Universities?

Methodology

The study relied on the use of mixed method design in order to gather insight on the issue under investigation. The population of the study was staff and students of Astronomy related Departments in public Universities in Nigeria. There were a total of 162 respondents who were sampled for the study which consisted of 154 students and eight lecturers. The respondents of the study were drawn using multistage sampling technique. Firstly, purposive sampling technique was used to select one University that offers Astronomy as a full programme (discipline) and one University that offers it as a subject among the first-generation Universities in Nigeria in the order of their year of establishment. On this basis, University of Nigeria Nsukka, Enugu State, Nigeria and University of Ibadan, Oyo State, Nigeria were selected in that order. Secondly, the Department where astronomy was domiciled in these Universities was also purposively selected. The third level of sampling involved the stratification of the department into the different years of study in the University. The final sampling process was the random selection of 20 students in the various years of study in these Universities. According to the National Universities Commission (NUC), there is an approved student-teacher ratio of 1:20 for science-based courses in Nigeria. This benchmark was used to select 10 students (50% of the required benchmark) in the various years of study totaling 80 in each institution and 160 students from both Universities. Furthermore, four lecturers in the same department from each of the selected Universities were also randomly selected from lecturers in each year of study to respond to a structure interview question that supported the responses from the students in the quantitative instrument which totaled eight participants. The instrument used for data gathering from the students was a 23-item questionnaire. The research questions were analyzed using percentage, mean scores, rank order, Ordinary Least Square (OLS) regression and thematic analysis.

Results

Figure 1 revealed the opinion of the lecturers who participated in the study on the factors that influence students' interest in astronomy as a career path. It was revealed that the major themes that summarized the opinion of the lecturers on the factors that influence students' interest in choosing astronomy as a career path include access to technology, perception or belief of the students, welfare related factors, curiosity and availability of incentives.

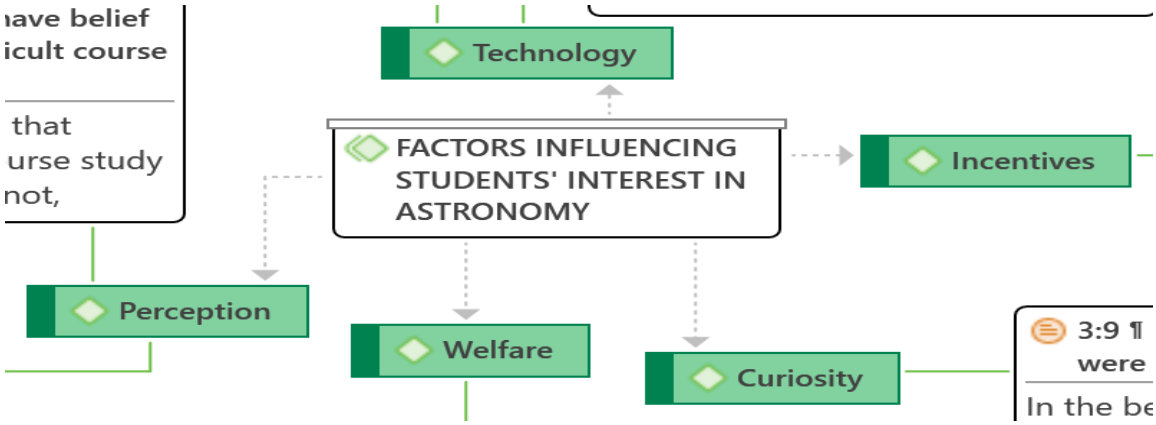

Figure 1. Factors Influencing Interest in Astronomy

Table 1 showed the effects of different student related factors on their interest in choosing astronomy as a career path.

Table 1. Effect of Students' Attributes on their Interest in Astronomy as a Career Path

Coefficients [a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	20.604	2.384		8.644	.000
	Gender	.008	.510	.001	.015	.988
	Year of Study	.169	.540	.013	.313	.754
	Type of Programme (full time or part time)	5.076	.581	.401	8.735	.000
	Awareness	.197	.055	.174	3.609	.000
	Academic Performance	.424	.379	.047	1.118	.265
	Conceptual_Understanding	.465	.097	.238	4.784	.000
	Membership_of_Professional_Body	5.324	.663	.373	8.029	.000

a. Dependent Variable: Astronomy Career Interest

In the table, the significance value was compared with a p-value of 0.05. The value derived is significant when the significant value is less than the p-value of 0.05 while it is not significant when it is otherwise. Similarly, the value of beta shows the proportion of contribution of each of the indicators to students' career in astronomy. This

is particularly so for the standardized coefficients which gives the actual effect of each of the indicators. It was shown that type of programme, awareness, conceptual understanding and enrollment as member of the professional astronomy association were significant determinants of the students' interest in choosing astronomy as a career path. However, the gender, year of study of the students and academic performance were not significant determinants. Of these significant student variables, the type of programme (full time or part time) as well as membership of professional bodies had the highest effect on interest in choosing astronomy as a career path for the students.

Table 2 indicated that there are innovative pedagogical strategies that students believe are relevant to fostering their career interest in astronomy.

Table 2. Innovative Pedagogical Strategies That Mostly Fosters Students' Interest in Astronomy

S/No	Items	Mean	Decision	Rank
1	Practice of experimentation is good way to spur students' interest in astronomy	2.88	Agree	1st
2	Use of virtual and augmented reality makes astronomy appealing to students	2.73	Agree	5th
3	Simulation of real-world events fascinates students to become astronomers	2.71	Agree	6th
4	Problem based learning method is good for building students' passion for astronomy	2.82	Agree	2nd
5	Organizing discussion forums promote interest in astronomy for students	2.75	Agree	4th
6	Field trips to observatories and planetarium is a way to enhance students desire to become astronomers	2.79	Agree	3rd
Average		**2.78**	**Agree**	

While the students agreed with all the strategies identified based on the fact that the mean values of each strategy was above the criterion mean value of 2.50 used for decision making, the ranking showed that some strategies are preferred than others. Basically, the students preferred experimentation, problem-based learning and field trips as the major or most essential strategies and this suggests that the students preferred hand-on or practical approaches as a route to building interest in astronomy and this suggests the need for more practical approaches to teaching the subject while other strategies which were also identified can be supportive strategies.

Table 3 showed the influence of the innovative strategies of teaching astronomy on students' interest and it was shown that the major influence was that these strategies enhanced students' engagement. This aligns with the earlier findings from the preferred strategies which showed that students appreciate hands-on strategies than other non-pragmatic approaches of learning the subject. Similarly, it was shown that the strategies help to simplify complex astronomical concepts and also fosters deeper understanding of the field. While the students agreed to the various items as ways these strategies influenced their interest, they pointed out that promoting real world

experience was least realized and this may be due to the fact that practical approaches to the teaching of the subject may be under-realized and this calls for more practical approaches of teaching the subject so as to foster students' interest in astronomy as a career.

Table 3. Influence of Innovative Pedagogical Strategies on Students' Interest in Astronomy

S/No	Items	Mean	Decision	Rank
1	Increased students' engagement	2.98	Agree	1st
2	Simplification of complex astronomical concepts	2.94	Agree	2nd
3	Promotes relevance to real world situation	2.82	Agree	7th
4	Inspires students to pursue a career in astronomy	2.89	Agree	4th
5	Fosters deeper understanding of the field of astronomy	2.92	Agree	3rd
6	Makes students to be more informed about astronomical innovations	2.85	Agree	6th
7	Enables students to build resilience in their astronomical career pursuit	2.86	Agree	5th
Average		**2.89**	**Agree**	

Table 4 established that over 50% of the male and female students sampled for the study agreed with the items raised as challenges to studying astronomy except for large class size.

Table 4. Challenges to Studying Astronomy as a Career Path Among Students

S/No	Items	Male Students (n= 90)		Female Students (n= 64)	
		Agree	Disagree	Agree	Disagree
1	Incompetent Teachers	60.9	39.1	58.8	41.2
2	Inadequate Facilities	95.7	4.3	70.6	29.4
3	Large Class Size	17.4	82.6	29.4	70.6
4	Insufficient Funding	91.3	8.7	76.5	23.5
5	Inadequate Political Will	87.0	13	88.2	11.8
6	Parental Interference	69.6	30.4	52.9	47.1
7	Fear of Unemployment	91.3	8.7	82.4	17.6
8	Inappropriate Curriculum	56.5	43.5	52.9	47.1
9	Students Attitude	82.6	17.4	82.4	17.6
10	Inadequate Institutional Collaboration	91.3	8.7	88.2	11.8
Average		**74.36**	**25.64**	**68.23**	**31.77**

This means that the students mainly disagreed that large class size was a challenge in studying astronomy but agreed that other factors such as incompetence of the teacher, inadequate facilities, insufficient funding, inadequate political will, parental interference, fear of unemployment, inappropriate curriculum, student attitude and inadequate institutional collaboration. However, more male students agreed that fear of unemployment and inadequate collaboration was the main challenge they faced in studying astronomy as a career path while majority of the female students identified inadequate political will and inadequate institutional collaboration as the major challenge. Generally, inadequate institutional collaboration stood out as the major challenge to studying

astronomy as a career path among the students. The male students with an average of 74.36% agreed with the challenges identified than the females with an average of 68.23% as challenges to their study of astronomy as a career path.

Discussion

The study showed that the factors influencing students' interest in astronomy, as expressed through various participant quotations were technology, perception, welfare, incentives, and curiosity. Study by Zulkipli et al., (2022) alluded to the fact that students often showed misconceptions about astronomy and this shapes their belief, perception and even curiosity about studying a course in this area. Perception of the students was described as significant as one of the participants stated that "*most of the students have belief that physics is a very difficult course study in the university and it is not*" while another participant said "*most of the students look at that area as being dry*". This means that some of the students think that a career in astronomy is a dry field with limited employment prospect. Alluding to this finding, Ozkan and Akcay (2016) indicated from their research that those who are new to astronomy often hold a different perception about a career in this field. Similarly, welfare concerns were raised by other participants among the factors influencing a career in astronomy. It was said that "*the welfare package of those that are in higher institution*" was a way to increase interest. Incentives are also crucial, with one of the participants advocating for "*an incentive that can motivate them to teach*" as this is essential to groom future astronomers. Summarily, the study of the viewpoints of the participants uncovers factors that influence a stronger interest and proficiency in astronomy among Nigerian students.

The result of the data collected and analyzed from the students showed that student's interest to choose astronomy as a career path is influenced by several students related factors but at different proportions. Despite the fact that the type of programme (full time or part time) that the student is enrolled in determines their interest to adopt astronomy as a career path, other factors such as their level of awareness, conceptual understanding and membership of professional bodies were also significant. The contribution of membership of professional bodies was more pronounced among the student factors that spur them to take astronomy as a career. Studies including that of Shaafi et al., (2023) also alluded to the fact that those who had prior knowledge about astronomy differ in their approach to the course significantly explaining the role that membership can play in choosing astronomy as a career. This implies that students who are enrolled as member of astronomy related professional bodies are more inclined to practice astronomy in the future than those who are not. This is equally followed by whether or not the students are studying this course as a full or part time programme. This means that students who study astronomy in an institution that offer the course as a full-time programme are more likely to become astronomers in the future. Other factors such as level of awareness about astronomy and understanding of concepts in astronomy were also contributors to the prospect of building a career in their regard. However, other factors such as gender of the student, year of study and academic performance were not significant. This finding however differ from the outcome of the study by Bergstrom et al., (2016) which indicated that girls who star gaze are more likely to become astronomers than the boys. However, the implication of this substantiates the early finding of this study that engaging in astronomy related activities increases the chances of students become future astronomers. In the same manner, the outcome of the study by Cardinot and Fairfield (2021) also indicated that students whether in

their first of final year held the same belief about astronomy which may explain why this result was not significant in terms of the effect of year of study on students' choice of astronomy as a career. This study therefore substantiates the fact that being male or female does not necessarily determine the student's interest to pursue a career in astronomy and this also applies to the year of study and the academic performance of the students.

The position of the students from the findings of the study was that the preferred innovative pedagogical strategies that fosters their interest in astronomy was experimentation, problem-based learning and field trips. While other strategies such as discussion, use of virtual reality and simulation were also highly rated, the students seem to derive more interest in strategies that gives them a more practical and learner-involved learning method. This suggests that the teaching of astronomy must be fully pragmatic and put the students at the center of this learning in order to build their career interest in astronomy. The students alluded that when this is done, it will improve their engagement, understanding and enable them build resilience to any challenge encountered on this career path. This finding aligns with the result from the study by Anjos and Doran (2024) which found that engaging students in experiments, through hands-on activities or using astronomy software and telescopes helps them gain first-hand experience and facilitates a deeper understanding of astronomy. It is therefore safe to say that the way astronomy is taught in the University also influences the possibility of choosing the subject as a career path for the students.

The response from the students further indicated that inadequate institutional collaboration was the major factor that hinder the students from pursuing a career in astronomy. The outcome of this study varies from that of Tezer (2022) which indicated that student's interest in astronomy differs but this has not been explained by the challenges that they face as discovered from this study. Collaboration as indicated from the findings of this study can take several form whether academic or professional and this was identified as challenges that can hinder their interest in pursuing a career in astronomy. The students also pointed out that other factors such as teacher competence, facilities, funding, political will, parental interference, fear of unemployment, inappropriate curriculum and student attitude were also challenges to choosing astronomy as a career path. This result agrees with that of Sedeno et al., (2018) which indicated that parents have some perception about gender role of their children which may affect the level of support they give to such children to become astronomers. Majority of the students agreed to these challenges but with some more pronounced than others. However, the male and female students mainly disagreed with large class size as a challenge to studying astronomy. This may be because the NUC has set a classroom benchmark which most of these institutions comply with and this may account for why this is not a challenge.

Conclusion

The study concluded that pursuing a career in astronomy is determined by several factors which included the students' level of awareness about astronomy, conceptual understanding and membership of professional bodies which were significant determinants while the gender of the student, year of study and academic performance were not significant. The lecturers sampled for the study equally agree with this outcome as their interview responses also revealed that perception, curiosity, welfare and access to technology were factors that influences

the students' interest in astronomy. The use of practical approaches to teaching astronomy such as experimentation, problem-based learning and field trips aroused the curiosity and interest of the students to become astronomers more than the other mentioned strategies and this suggests the need for more pragmatic approaches of teaching the subject to students. The challenges to studying astronomy as identified from the study included lack of institutional collaboration, teacher competence and inadequate facilities which are among the barriers that need to be addressed for grooming future astronomers from Nigerian Universities.

Recommendations

The following recommendations were made based on the findings of the study:

- Students pursuing a course in astronomy should join available professional associations within and outside the University so as to boost their knowledge, skill and interest in this field of study.
- There is need for university administrators to establish multi stakeholders' collaboration with the government, private sector and practitioners on how to promote the interest and participation in astronomy in the country.
- Government at all lecturers should increase allocation to tertiary education as this is instrumental to creating an enabling environment for the practice of astronomy in the country through the acquisition of the needed facilities, expertise and reforms that are needed to promote the profession and increase students' interest in it.
- Available astronomical professional associations in the country should regularly organize job fair where students can acquire the needed information for securing their choice of employment after graduation.
- Teaching of astronomy must be made as practical and pragmatic as possible and this may require some curriculum review in order to make the subject as real as possible using the best pedagogical strategies. This will also require the provision of the right quantity and quality of resources to foster students' interest in astronomy
- Mentorship programmes should also be provided by the Universities as this will provide students with the opportunity to interact with successful astronomers who can share some real-life experiences as well as provide developmental training for the students to succeed in this career path.

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