Universal Journal of Educational Research 6(11): 2492-2497, 2018 http://www.hrpub.org
DOI: 10.13189/ujer.2018.061113

Examining Reasons behind High School Students' Decisions to Enroll in Physics Courses

Hui-Yiing Chang[1,*], Jessica Nicole Kohler[2], Jordan Elizabeth Ard[3], Clausell Mathis[4]

[1]Division of Science, Mathematics and Engineering, University of South Carolina Sumter, United States
[2]Department of Biochemistry and Molecular Biology, University of South Carolina Columbia, United States
[3]Department of Biological Sciences, University of South Carolina Columbia, United States
[4]School of Teacher Education, Florida State University, Tallahassee, United States

Abstract High school physics enrollment in the United States of America is low compared to other science disciplines. Since physics is a requirement for most STEM related degrees, not having experience in this discipline in high school can affect how well a student adjusts to science related majors during college. Taking physics during high school benefits students because it gives them the fundamental conceptual knowledge for science and engineering. However, data obtained from a study by Heitin shows that two out of five high schools in the U.S [1] do not offer physics. This is of great concern, because with the recent push for a more scientifically literate population through many STEM initiatives around the country, increasing the number of students who enroll in high school physics courses is of paramount importance. This study aimed to explore factors related to high school students' decisions regarding enrolling in physics courses. Data for this study were gathered by an electronic survey of high school seniors in a select district in the Southeastern U.S. The findings were explored to identify ways to increase enrollment in physics courses within the district. Results suggest that external factors such as family structure, employment outside school, peer support, future plans for after high school, and academic influences such as guidance counseling influenced students' decision to take physics during high school. The findings of the study implicates there needs to be more effort from personnel in school districts such as school administrators and guidance counselors to encourage more students to enroll in physics courses while in high school.

Keywords Physics, Enrollment, High School

1. Introduction

Physics has always been a discipline that is least enrolled compared to other science disciplines. With a national push for more science, technology, engineering, and mathematics (STEM) involvement, the importance of high school physics enrollment has also increased.

Data from the American Institute of Physics shows that there is a general upward trend in physics enrollment [2]. However, compared to other science disciplines, physics has the lowest enrollment. According to the National Center for Education Statistics, only 36% of high school students take physics, in comparison to 70% and 96% for chemistry and biology, respectively [3]. Currently around 39% of high school students enroll in physics [2], which is far below the other major STEM disciplines such as chemistry and biology. Given the importance of physics, there remains a need to further increase enrollment, particularly in low socioeconomic areas. Students are less likely to have access to and/or enroll in physics courses in these areas compared to higher income areas [2].

As described by Woolnough [4], physics is commonly the last high school science course taken, which can impact enrollment numbers. High school graduation requirements in the majority of states only require students to enroll in biology and chemistry, resulting in many students viewing physics as an elective and not needed. Others may be unwilling to take physics because they believe that it is difficult, too math-intensive, and not taught by a qualified teacher. A common perception of physics is that it is "too hard" and only for "smart" students. Many high school students are not aware of the importance of physics toward pursuing STEM professions.

There are likely a variety of factors for reasons behind low physics enrollment, ranging from school to home and peer influences. Examining the relationship between physics enrollment and these factors can provide needed insight to develop strategies to increase enrollment in physics courses. This study is an attempt to examine factors influencing students' physics course taking through a survey conducted among high school seniors.

Review of Literature

The state of high school physics enrollment has been a topic researched for decades [5-9]. Past studies of physics enrollment had primarily been based on gender [10,11] and equity [12-14]. These studies revealed there are lower percentages of women and minorities compared to other populations within the areas of high school physics enrollment, college physics enrollment, and physics related careers. For high school enrollment, female students take physics at a lower rate than male students [15], a pattern seen also in their more urban peers [16]. Studies have shown that gender equity issues could be due to the lack of identification in physics among females [10], something that may also be true for students who are in urban areas [16]. Even though female high school physics enrollment has increased, the rate of increase is smaller compared to that in other major science disciplines [17,18]. The slow rate of increase highlights the importance of examining approaches to increase physics enrollment. Physics education researchers have primarily focused on instruction [19,20], learning [21,22], and curriculum [23], but neglect other factors that may influence enrollment.

Enrollment in physics courses is generally lower in the poorer regions of the country [24]. According to a study by the American Institute of Physics, 47% of seniors in wealthier school districts were enrolled in physics courses, compared to 24% in less wealthy districts [18]. Even if a student shows interest, there may be barriers that prevent him or her from taking physics. These barriers may range from lack of pre-requisite courses such algebra, geometry, and pre-calculus [25]. Additionally, school counselors may deter students from taking physics due to their perception of students and/or opinions of the importance of physics [26,27]. These trends speak to the need for more research investigating the causal factors for low participation in physics among schools serving students who are underrepresented in the field.

The goal of this study is to shed light on the reasons behind low enrollment in physics courses by closely examining students' reasoning within one school district. The research question that guided this study is: *What are student-based and school-based factors that influence high school students' decision making regarding their enrollment in a physics course?*

Background

The Sumter School District (SSD) in Sumter, South Carolina was studied because it has a large percentage of students underrepresented in physics. The physics courses offered in SSD in Fall 2014 were:
Physics, 11^{th} or 12^{th} grade
Physics Honors, 9^{th} or 10^{th} grade
Physics Honors, 11^{th} or 12^{th} grade
Physics for the Technologies, 11^{th} or 12^{th} grade

The last course in the list was not offered in Spring 2015. The first course is a college preparatory course. The next two courses are pathways toward Advanced Placement and International Baccalaureate courses. All courses are algebra based. Students who choose to enroll in one of these physics courses will not be taking any other physics courses through their time in high school. Out of a total high school student population of 4740 in the district, 167 were enrolled in a physics course in the Fall 2014 semester. That constituted 3.52% of that population. Enrollment in physics courses during Spring 2015 was 75, which constituted 1.63% of the total high school student population of 4593. The percentages are far below the national average of 39% [2]. The age range for the students was 16-20 years old.

Participants

190 seniors from the school district voluntarily participated in the survey on April 23, 2015. Table 1 describes the demographic characteristics of the participants. Out of the 190, 187 were from two of the three high schools in the district. The remaining 3 students did not state their schools. 79 of the participants had enrolled in a physics course during high school while 101 had not (Table 2). The remaining 10 participants did not state an answer. The largest demographic of participants was African American (61.1%), followed by Caucasian (21.6%).

Table 1. Demographic Characteristic of Students who Participated in the Survey

Ethnicity	n	%
African-American	118	61.1
Caucasian	41	21.6
Hispanic/Latino	2	1.1
Asian/Pacific Islander	2	1.1
Other	13	6.8
Total	190	100.0

Table 2. Answer to question, "Have you ever enrolled in a physics class during high school?"

	n	%
Yes	79	41.6
No	101	52.3
No Answer	10	5.2
Total	190	100.0

2. Methods

Data Collection

The survey (Appendix A) consisted of 29

multiple-choice and short-answer questions. It was produced by the first three authors and designed to assess how personal factors, school factors, and support from peers impacted students' enrollment in physics. Questions asked included familial background topics, employment outside school, future career goals, encouragement to take physics, peer support, and opinions of physics class. Data were analyzed using a statistical analysis software SPSS, which is commonly used among most educational researchers. Descriptive statistics such as percentages and frequencies were calculated and presented.

Data Analysis

Personal factors

Family background

A higher percentage of students who had enrolled in a physics course lived with both parents (42%) compared to students who had not enrolled (30%). For students who were living with a non-parent guardian, the percentage of students who had not enrolled in physics (12%) was more than triple the percentage of students who had enrolled (4%). The percentage of students who enrolled in physics, whose fathers' highest educational attainment was a bachelors' degree (15%), was more than twice as high as the percentage of students who had not enrolled, whose fathers had the same level of educational attainment (7%). In addition, a higher percentage of students who enrolled in physics had mothers whose highest educational attainment was a bachelors' degree (24%) in comparison to the percentage of students who had not enrolled (15%).

Employment outside school

A larger percentage who had not enrolled in physics (40%) compared to students who enrolled (32%) held a job outside school. For students who worked an average of more than 0 to 10 hours per week at their jobs, the percentage of students who had not enrolled in physics was more than triple the percentage of students who had enrolled. However, for each of these categories, more than 10 to 20 hours, more than 20 to 30 hours, and more than 30 to 40 hours, the percentage that enrolled is less than 2% higher than the percentage that had not enrolled.

Plans after high school

A higher percentage of students who had enrolled in physics (69%) compared to students who had not enrolled (49%) stated that they were most likely to attend college after finishing high school. There is similar occurrence for the category of joining the military after finishing high school. A higher percentage of students who had not enrolled in a physics course (27%) compared to students who enrolled (14%) stated that they were most likely to attend technical college after finishing high school. There is similar occurrence for the category of entering the work force.

Parental expectations

A higher percentage of students who had enrolled in physics (71%) compared to students who had not (61%) had parents who expected them to attend college after finishing high school. There is similar occurrence for each of these categories: enter the work force and join the military after finishing high school. A higher percentage of students who had not enrolled in physics (16%) compared to students who enrolled (8%) had parents who expected them to attend technical college after finishing high school. There is similar occurrence for the category of being involved in other matters.

School factors

Extracurricular activities

A higher percentage of students who had not enrolled in a physics course (47%) compared to students who had enrolled (29%) spent an average of 0 to 5 hours per week on extra-curricular activities (ECA), such as school clubs, sports, and organizations outside of school. However, a higher percentage of students who had enrolled in a physics course compared to students who had not enrolled spent an average of more than 5 to 10 hours per week on ECA. There is similar occurrence for each of the remaining categories: more than 10 to 15 hours, more than 15 to 20 hours, more than 20 to 25 hours, more than 25 to 30 hours, and more than 30 hours per week spent on ECA.

Support from school personnel and peers

For students who were offered a physics class during counseling, the percentage of students who had enrolled in physics (62 %) was more than twice as high as the percentage of students who had not enrolled (25%). For students who were encouraged to study physics, the percentage of students who had enrolled in physics (35%) was almost twice as high as the percentage of students who had not enrolled (18%). For students who had the importance of physics explained to, the percentage of students who had enrolled in physics (29%) was more than triple the percentage of students who had not enrolled (9%). A higher percentage of students who had enrolled in physics (75%) compared to students who had not (46%) would be supported by their friends or social groups if they enrolled in a physics class.

Short-answer responses

For the short-answer question, "What was your reason for not enrolling in a physics class?" the most common answer was they did not need it to graduate. High school graduation requirements for the Sumter School District do not mandate enrollment in physics. For the short-answer question, "What was your reason for enrolling in a physics class?" majority of the participants who had enrolled

responded that they were made or required to. Finally, for the short-answer question, "How do you think your physics class could/can be improved?" the most common answer was for physics classes to be taught better.

Chi-Square Analysis

Chi-Square (χ^2) analysis was performed to understand the relationships between students' enrollment in physics courses and several categorical variables. The larger the difference between the Chi-Square value and the degrees of freedom (df), the stronger the relationship between deciding to take physics and the categorical variable. Results are displayed in Table 3 in the order of the strength of this relationship, beginning with the strongest.

Table 3. Chi-Squared Analysis on factors influencing students' decisions to enroll in physics courses

Categorical Variable	χ^2	df
Plans for after high school	168.122	10
Has importance of physics explained to	159.318	4
Would/Will be supported by friends or social group if enroll(ed) in physics	151.51	4
Has been encouraged to study physics	128.89	4
Has been offered a physics class during counseling	125.297	4
Parental expectations for after high school	128.23	10
Hold a job outside school	99.98	4
Number of hours per week worked at job	45.395	84
Mother's highest educational attainment	142.01	116
Number of hours per week spent on extracurricular activities	111.39	134
Father's highest educational attainment	119.93	120

Chi-Square values show that the largest indicator for a student enrolling in physics during high school was plans for after high school, and the lowest indicator was father's highest educational attainment. The Chi-Square analysis also shows significant relationships between enrolling in a physics class and having the importance of physics explained to, peer support, having been encouraged to study physics, having been offered physics during counseling, parents' expectations, and holding a job. There are less significant relationships between enrolling in a physics course and parents' highest educational attainment, and hours spent on extracurricular activities. Overall the Chi-Square analysis suggests that external influences from people such as parents, academic personnel and peers play a major role in a student's decision to take physics.

3. Conclusion/Discussion

The results of the study showed a relationship between students' decisions on enrolling in a physics course and their family situation, parents' educational background, extra-curricular activities, employment outside school, future plans after high school, and academic influence. The data suggest that living with both parents will impact his or her taking upper level courses including physics, a finding also supported by Lareuv and Horvat [28]. Participants who had both parents at home were more likely to take physics than those who did not. This could be due to more attention being placed on the students' courses along with the ability to provide assistance, such as tutoring, and extra instruction. Additionally, parents' educational history, such as the father's, impacted students' enrollment. A possible cause is that since physics is a male dominated field, children with more highly educated fathers are more likely to receive influence to take physics. It could also be linked to economics. For example, if a student's father has a college degree, he is more likely to have a greater income, allowing his children to focus more on their studies. These findings are supported by many others that show that parents' education levels were related to STEM degree attainment [29]

Results suggest that students who held a job outside school were more likely not to enroll in physics. This may be primarily due to less time in focusing on studies. Most students who enrolled in physics had goals of attending college after high school. Depending on intended major, there are colleges that recommend students to have experience in physics prior to matriculation.

There could be alternative reasons for the findings. For example, the community and culture of the school may not promote participation in physics. Additionally, recommendations from guidance counselors impacted students' choice to enroll in physics courses. Finally, graduation requirements in this district did not include physics, which may have resulted in low enrollment.

Limitations

There are some limitations to this study. One may be the smallness of the sample size. Only two out of the three high schools of the district participated in the study, and many seniors from the two schools did not participate. Additionally, students' motivation, which may have impacted students' choice to enroll in physics, was not factored in.

Implications

There is little research that investigates personal and school factors that influence physics enrollment. Primarily, researchers have investigated instructional and curriculum factors [23,30]. The findings from this study may be useful in investigating strategies that can be used to promote participation in physics both within and without the school. The study reported here examined factors related to high school students' decision to enroll in physics courses. A variety of issues were investigated that may have factored into students' choices.

Although many of the possible factors are beyond the control of educators, some are within their control, such as offering a physics class during counseling, encouraging students to study physics, and explaining the importance of physics to students, particularly to groups of students whose family lives suggest they are unlikely to consider physics. The survey suggests that students who were influenced by each of these factors were about twice to thrice as likely to enroll in a physics course during high school compared to other students. School districts may increase their enrollment in physics classes by taking action according to these three factors. To help solve the problem of friends or social groups of students not supporting them if they enroll in physics classes, a physics society could be started to provide social support to these students.

Physics is an essential subject and is needed to train future generations in science and technology, as well as to maintain our role as leaders in scientific and technological development. It is well recognized that understanding physics is the key towards excelling in a STEM related career. Inadequate enrollment in physics courses has important implications not only for the continuity of students' scientific endeavor, but also for the scientific literacy of future generations, and health of the STEM pipeline. Seen in this light, high schools that diminish physics are restricting opportunities for their students and preparedness for STEM disciplines.

Finally, it may benefit school districts, especially those with lower than optimal enrollment in physics courses, to administer such surveys to discover the reasons behind their students' decisions to enroll or not enroll in physics courses, so that ideas for changing this situation can be implemented appropriately. Even though the sample size of students is small compared to the national population of physics students, this study gave a solid perspective on factors that inhibit physics enrollment.

Appendix A

1. Have you ever enrolled in a physics class during high school?
2. If you answered "No", what was your reason for not enrolling in a physics class?
3. Which parents and/or guardians do you live with?
4. What is your father's highest educational attainment?
5. What is your mother's highest educational attainment?
6. Which extra-curricular activities are you involved in?
7. On average, approximately how many hours do you spend on extra-curricular activities per week?
8. Do you have a job outside school? If you answered "Yes", what kind of job do you have?
9. On average, approximately how many hours do you work per week?
10. Which of the following are you most likely to do after high school?; If you selected "Other", please indicate:
11. What vocation/career/profession would you like to settle in ultimately?
12. What do your parents expect you to do after high school?; If you selected "Other", please indicate:
13. Have you ever been offered a physics class during counseling?
14. Has anyone ever encouraged you to study physics?
15. If you answered "Yes", who encouraged you to study physics?
16. If you selected "Other", please indicate:
17. Has the importance of physics ever been explained to you?
18. If you answered "Yes", who explained the importance of physics to you?
19. Which of these statements best supports your understanding of physics?
20. Would/Will your friends or social group support you if you enroll(ed) in a physics class?
21. If you answered "Yes", which year(s) of high school did you enroll in a physics class?
22. Which semester(s) of each year stated above did you enroll in a physics class?
23. What grade did you receive? (If you repeated the class, give both grades.)
24. What was your reason for enrolling in a physics class?
25. On average, approximately how many hours did/do you spend per week doing homework for physics class?
26. Do you think you were/are given too much homework in your physics class?
27. Outside of class, other than time spent on homework, on average, approximately how many hours did/do you spend per week studying physics?
28. Do you think you spent/spend too much time studying physics?
29. How do you think your physics class(es) could/can be improved?
30. Would you agree to a follow-up interview in person?

The survey can be accessed at https://docs.google.com/forms/d/e/1FAIpQLSdMb_3el40RhNNs5fh28suL0-rp8ZlAAp0Fjv_qaKNWfpuflw/viewform?c=0&w=1.

REFERENCES

[1] L. Heitin, Education Week, (2016), p. 6.

[2] S. White and C. L. Tesfaye, Statistical Research Center of the American Institute of Physics (2014).

[3] C. Nord, S. Roey, R. Perkins, M. Lyons, N. Lemanski, J. Brown, and J. Schuknecht, National Center for Education Statistics. Washington, DC: US Government Printing

Office (2011).

[4] B. E. Woolnough, Physics Education 29, 368 (1994).

[5] A. Johansson, 2015.

[6] A. L. King, The Physics Teacher 3, 119 (1965).

[7] S. S. Masood, arXiv preprint physics/0702089 (2007).

[8] S. S. Masood, arXiv preprint arXiv:1405.6442 (2014).

[9] S. S. Masood, arXiv preprint arXiv:1403.550 (2014).

[10] Z. Hazari, E. Brewe, R. M. Goertzen, and T. Hodapp, The Physics Teacher 55, 96 (2017).

[11] C. Riegle‐Crumb and C. Moore, Social Science Quarterly 95, 253 (2014).

[12] A. Kelly, American Association of Research Education, San Diego, CA (2004).

[13] E. Brewe, V. Sawtelle, L. H. Kramer, G. E. O'Brien, I. Rodriguez, and P. Pamelá, Physical Review Special Topics-Physics Education Research 6, 010106 (2010).

[14] A. Traxler and E. Brewe, Physical Review Special Topics-Physics Education Research 11, 020132 (2015).

[15] C. Riegle-Crumb, G. Farkas, and C. Muller, Sociology of Education 79, 206 (2006).

[16] A. M. Kelly, Physical Review Special Topics- Physics Education Research 9, 010122 (2013).

[17] N. S. Board, Science & engineering indicators (National Science Board, 2002), Vol. 1.

[18] S. White and C. L. Tesfaye, Statistical Research Center of the American Institute of Physics (2011).

[19] E. Brewe, L. Kramer, and G. O'Brien, Physical Review Special Topics-Physics Education Research 5, 013102 (2009).

[20] E. Etkina, A. Warren, and M. Gentile, The Physics Teacher 44, 34 (2006).

[21] L. Deslauriers, E. Schelew, and C. Wieman, Science 332, 862 (2011).

[22] D. E. Meltzer and R. K. Thornton, American Journal of Physics 80, 478 (2012).

[23] L. L. Liang, G. W. Fulmer, D. M. Majerich, R. Clevenstine, and R. Howanski, Journal of Science Education and Technology 21, 114 (2012).

[24] A. M. Kelly and K. Sheppard, American Journal of Physics 77, 902 (2009).

[25] Z. Hazari, G. Sonnert, P. M. Sadler, and M. C. Shanahan, Journal of Research in Science Teaching 47, 978 (2010).

[26] F. E. Crawley and C. B. Black, Journal of Research in Science Teaching 29, 585 (1992).

[27] L. E. Klopfer and M. G. Ignatz, Science Education 59, 571 (1975).

[28] A. Lareau and E. M. Horvat, Sociology of Education, 37 (1999).

[29] X. Chen, National Center for Education Statistics (2009).

[30] E. Etkina, Physical Review Special Topics- Physics Education Research 6, 020110 (2010).