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RESEARCH

Pharmacy Students' Perceptions of Natural Science and Mathematics Subjects

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Objective. To determine the level of importance pharmacy students placed on science and mathematics subjects for pursuing a career in pharmacy.
Method. Two hundred fifty-four students completed a survey instrument developed to investigate students' perceptions of the relevance of science and mathematics subjects to a career in pharmacy. Pharmacy students in all 4 years of a master of pharmacy (MPharm) degree program were invited to complete the survey instrument.
Results. Students viewed chemistry-based and biology-based subjects as relevant to a pharmacy career, whereas mathematics subjects such as physics, logarithms, statistics, and algebra were not viewed important to a career in pharmacy.
Conclusion. Students' experience in pharmacy and year of study influenced their perceptions of subjects relevant to a pharmacy career. Pharmacy educators need to consider how they can help students recognize the importance of scientific knowledge earlier in the pharmacy curriculum.
Keywords: science, mathematics, pharmacy students, career

INTRODUCTION

To be progressive and competitive, countries need a high level of scientific literacy within their general population and, more specifically, in their supply of science, technology, engineering, and mathematics (STEM) professionals.[1] There is a general lack of interest in science subjects by students, especially in secondary education, in the United Kingdom [2,3] and the United States.[4] Children as young as 10 are not interested in pursuing careers in science despite enjoying science at this age.[5] This lack of interest in science subjects increases as students progress through the educational system.[6,7] This has led to a STEM skills shortage in the United Kingdom [1] and is of equal concern in the United States.[8,9]

A major problem with this apathy toward science and mathematics subjects is that many students are unaware of the job prospects that require this knowledge.[10] For instance, many medical students in the United States do not perceive the relevance of science education to clinical practice.[11] This is also an issue within pharmacy and the MPharm curriculum in the United Kingdom, specifically with regard to chemistry.[12]

A study by Langridge and colleagues that investigated the impact of a career explorers program on US high school students' perceptions of pharmacy as a profession found that students entered the program with misconceptions about the roles, duties, and responsibilities of a pharmacist, as well as a lack of understanding of the different career options available.[13] This study provides some evidence of the potential value of understanding students' perceptions of the pharmacy profession. Seventy percent of pharmacy graduates in the United Kingdom are likely to work in community pharmacy, while a relatively smaller cohort (22%) entered the hospital sector and less than 5% worked in industry.[14] Regardless of their career plans, pharmacy students in the United Kingdom are required to complete the MPharm degree and spend 12 months in practice as a preregistration trainee before taking the national registration examination to become a qualified pharmacist. While educational contexts differ, along with the end destination of pharmacy graduates, there is a common emphasis on the importance of maintaining the scientific expertise of pharmacy graduates. This is evident in the guidelines and standards of the accreditation organizations of both the United States and United Kingdom,

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with the Accreditation Council for Pharmacy Education[15] in the United States highlighting the importance of "the thorough scientific foundation necessary for achievement of the professional competencies," and the UK regulator, the General Pharmaceutical Council,[16] emphasising that "sound science is the basis of effective pharmacy." This is also recognized at an international level, with the International Pharmaceutical Federation making scientific expertise a core element in its statement of policy on good pharmacy education practice: "Basic (first degree) education programmes should provide pharmacy students and graduates with a sound and balanced grounding in the natural, pharmaceutical and healthcare sciences that provide the essential foundation for pharmacy practice in a multi-professional healthcare delivery environment."[17] While there are obvious differences in pharmacy education, science remains a core subject area within pharmacy education.

There is a need to understand students' perceptions of the role of the pharmacy profession,[18] particularly given discussions in the United Kingdom to change the structure of the MPharm degree program to include an integrated preregistration year similar to other healthcare courses, such as medicine and nursing.[19] Students' views of the profession are likely to affect their engagement with different aspects of their studies. If subjects are considered irrelevant, students will be less motivated to engage in those parts of the curriculum. Motivation to do schoolwork that is based on interest or value is associated with various types of school engagement, including active behavioral participation, interest, and self-regulated learning.[20,21] The MPharm degree has undergone extensive changes in the United Kingdom in the last decade, where emphasis has been placed on clinical and practice-based subjects, while the science-based subjects have been integrated and contextualized wherever possible into clinical practice. Nonetheless, a thorough understanding of these subjects is vital to ensure safe and effective pharmacy practice.[22] A better understanding of students' perceptions of science and mathematics subjects, and how these are viewed with respect to their future careers as pharmacists would help colleges and schools of pharmacy develop appropriate educational interventions to maximize student engagement. This study intended to determine the relevance and importance pharmacy students place on science and mathematics subjects related to their future pharmacy career.

METHODS

Ethical approval for this study was granted by the Research Ethics Committee of the University of Central Lancashire. Pharmacy students in all 4 years of the MPharm degree program were invited to take part in the study during one of their break periods between lectures. The study was explained to students before the survey instrument was disseminated. Students were also told that taking part in the study was voluntary and that not taking part would have no impact on their studies. As an incentive to participate, students who completed the survey instrument were entered in a prize drawing to win a £50 shop voucher (1 voucher per cohort). Students were also informed that the survey instrument was anonymous and no identifiable information would be collected. A research associate within the institution who normally had no direct contact with students administered the survey instrument. The second- (P2), third- (P3), and fourth-year (P4) students completed the survey instrument in November and December 2012. The first-year (P1) students completed the survey instrument in January 2013 (the UK academic year begins in September).

Demographic information on gender, age, and ethnic origin was collected. Students were asked if they currently worked in pharmacy and if any of their family or close friends worked in pharmacy. To capture students' views on the relevance of science subjects to a pharmacy career, they were asked to indicate the importance of the following subjects when pursuing a career in pharmacy on a 4-point Likert scale ranging from not important to very important: chemistry, organic chemistry, inorganic chemistry, physical chemistry, biology, molecular biology, biochemistry, microbiology, physics, mathematics, advanced mathematics, algebra, statistics, and logarithms. Descriptive and inferential analysis was conducted using SPSS, version 20 (IBM, Armonk, NY). Descriptive and inferential statistics (1-way analyses of variance) were conducted.

RESULTS

Of 353 students in all 4 years of study, 254 students (72%) participated in the survey. Of the participants, 103 (86%) P1 students completed the survey instrument, while 33 (36%) P2 students, 59 (82%) P3 students, and 59 (86%) P4 students completed the survey instrument.

One hundred sixty-nine (66.5%) participants were female and 85 (33.5%) were male, which was similar to the gender ratio of the students within the school (57.7% female and 42.3% male). Most students were between the ages of 18 to 20 years (45%) or 21 to 24 years (42%). With regard to ethnic origin, most students were in 1 of 3 ethnic groups: white British (27%), Asian British: Indian (26%) and Asian British: Pakistani (25%). There were 103 (41%) P1 students, 33 (13%) P2 students, 59 (23%) P3 students, and 59 (23%) P4 students. More students (55%) knew a family member or a close friend who worked in pharmacy. Most students (68%) did not work in pharmacy at the time of the study.

Table 1. Pharmacy Student Perceptions of the Importance of Science and Mathematics Subjects to a Career in Pharmacy

Subject	Not Important, No. (%)	Not Very Important, No. (%)	Quite Important, No. (%)	Very Important, No. (%)
Biology	3 (1.2)	11 (4.3)	67 (26.4)	173 (68.1)
Biochemistry	2 (0.8)	15 (5.9)	93 (36.6)	144 (56.7)
Molecular biology	2 (0.8)	19 (7.5)	97 (38.2)	136 (53.5)
Chemistry	9 (3.5)	16 (6.3)	109 (42.9)	120 (47.2)
Organic chemistry	4 (1.6)	25 (9.8)	110 (43.3)	115 (45.3)
Microbiology	8 (3.1)	30 (11.8)	110 (43.3)	106 (41.7)
Mathematics	12 (4.7)	21 (8.3)	118 (46.5)	103 (40.6)
Inorganic chemistry	10 (3.9)	42 (16.5)	112 (44.1)	90 (35.4)
Physical chemistry	7 (2.8)	37 (14.6)	122 (48.0)	88 (34.6)
Algebra	60 (23.6)	68 (26.8)	71 (28.0)	55 (21.7)
Logarithm	48 (18.9)	71 (28.0)	81 (31.9)	54 (21.3)
Statistics	38 (15.0)	75 (29.5)	91 (35.8)	50 (19.7)
Advanced mathematics	51 (20.1)	96 (37.8)	62 (24.4)	45 (17.7)
Physics	70 (27.6)	92 (36.2)	60 (23.6)	32 (12.6)

Not all of the science and mathematics subjects were viewed as relevant to a career in pharmacy (Table 1). In particular, a higher percentage of students (63.8%) viewed physics as either not very important or not important. Similarly, 147 (57.9%) students viewed advanced mathematics as not important or not very important to a career in pharmacy, whereas mathematics was viewed as quite important or very important by 221 (87.1%) students. Nearly half of the study participants viewed algebra as a subject not important or not very important for a career in pharmacy. One hundred nineteen students viewed logarithms as not important for a career in pharmacy, and 133 students viewed statistics as not important for a career in pharmacy.

There was no significant difference between each gender or between the ethnic origin groups studied. First-year students viewed the following 6 subjects as significantly more relevant when pursuing a career in pharmacy than did P3 and P4 students: organic chemistry, mathematics, advanced mathematics, algebra, statistics, and logarithm (Table 2). First-year students also viewed inorganic chemistry and physics as more relevant than did P3 students. However, P3 students viewed biology as significantly more relevant than did P1 students (Table 3).

The following 6 subjects were viewed as significantly more important when pursuing a career in pharmacy for students aged 18 to 20 years ($p=0.05$) than those aged 21 to 24 years: organic chemistry, physics, mathematics, advanced mathematics, algebra, and logarithm. Biology and statistics were viewed as more important by students aged 21 to 24 years compared to those aged 18 to 20 years ($p<0.05$).

Organic chemistry, inorganic chemistry, statistics, and logarithms were viewed more important ($p<0.05$) to pursuing a career in pharmacy by students who did not know anyone working in pharmacy than students who had a family member or close friend working in pharmacy. Similarly, inorganic chemistry, physical chemistry, algebra, and logarithms were viewed as important subjects ($p<0.05$) when pursuing a career in pharmacy by students who did not currently work in pharmacy compared to students who did.

DISCUSSION

Pharmacy students in our study did not view all science and mathematics subjects taught within the MPharm curriculum in the same way. Chemistry and biology were viewed as important to pursuing a career in pharmacy. Incidentally, these are the 2 commonly studied subjects at post 16-education, A-level (General Certificate of Education Advanced Level) for entry into the MPharm degree program throughout the United Kingdom. Conversely, some science and mathematics subjects included as part of the MPharm curriculum in the United Kingdom were not viewed as important to a career in pharmacy. Both physics and advanced mathematics had a high percentage of students who did not view these subjects as important to a career in pharmacy, which coincides with the lower number of students having studied physics or mathematics beyond the General Certificate of Secondary Education.[23] Neither physics nor mathematics at A-level are compulsory subjects for entry into the MPharm degree program, which may also affect students' perceptions of their relevance. There was no difference between any of the test variables and the subjects of chemistry, molecular biology, biochemistry, and microbiology. Students generally viewed these subjects as important and relevant to pursuing a career in pharmacy. There were, however, significant differences related to the different test variables for the other subjects.

Table 2. Comparison of Master of Pharmacy Degree Students' Ratings of the Relevance of Completing Certain Subjects When Pursuing a Career in Pharmacy

Subject	*P*	First-Year, Mean (SD)	Third-Year, Mean (SD)	Fourth-Year, Mean (SD)
Organic chemistry	<0.05	3.5 (0.7)	3.1 (0.7)	3.3 (0.7)
Mathematics	<0.05	3.4 (0.7)	3.0 (0.8)	3.1 (0.8)
Advanced mathematics	<0.001	2.8 (1.0)	2.1 (0.9)	2.1 (1.0)
Algebra	<0.001	3.0 (1.0)	2.2 (0.9)	2.0 (1.0)
Statistics	<0.001	2.9 (0.9)	2.6 (0.9)	2.2 (0.9)
Logarithm	<0.001	3.1 (0.9)	2.5 (1.0)	1.9 (0.9)

This was particularly true for logarithms, with significant differences related to 4 of the test variables. Algebra, statistics, organic chemistry, and inorganic chemistry had 3 significant differences.

The difference between students' views of science and mathematics subjects in the 4 years of study was interesting. First-year students perceived many more subjects as relevant to a career in pharmacy than did P3 and P4 students. This may be because of the increasing contextualization of science to pharmacy practice throughout the course, so that science subjects are not easily identified as such by students in the later years. This may be enhanced by the stronger emphasis on pharmacy practice in later years of study at our school. It may also be an effect of P1 students having more recently left secondary education, where subjects are more clearly defined.

The perceived lack of relevance of some subjects to a career in pharmacy may be linked to students' exposure to family or friends who worked in pharmacy. The positive evaluation of a subject was more likely to be associated with students in their first year of study who were in the younger age group, did not have a friend or family member working in pharmacy, and who were not currently working in pharmacy themselves. Students who have had more experience in pharmacy may see many of the subjects as having less relevance. One explanation for this may be that, on superficial observation of the role of the pharmacist, the application of scientific and mathematical knowledge is not immediately obvious. This may result in a narrow view of what pharmacists do in their day-to-day role and duties. Students may not have witnessed certain roles within the pharmacy profession that require the use of these subjects. They also may not have envisioned the application of the scientific and mathematical knowledge in daily pharmacy practice, particularly in community pharmacy. Given that 70% of pharmacists practice in the community, this is not surprising.[14] In community pharmacies, students may perceive that clinical knowledge is restricted to advanced services such as medicine use reviews, while dispensing is sometimes seen as procedural and prescriptive. Our study suggested that more exposure to pharmacy practice results in the view that science and math subjects are less, rather than more, relevant to the profession. The lack of awareness of the wider role of pharmacists and the different careers within pharmacy open to graduates[13] may have had an impact on their perceptions.

While STEM careers are still predominantly undertaken by white males,[24] we did not find any significant differences between gender or students from different ethnic backgrounds with regard to their views towards the science and mathematics subjects within the MPharm degree program. However, the other differences tend to suggest that more needs to be done to enable students to understand why these subjects are relevant.

The overall response rate for the study was good, with 3 of the 4 classes of students having a response rate more than 80%. However, the response rate for P2 students was low (36%), which may explain why no significant difference was shown. This was a result of unforeseen difficulties in obtaining access to the P2 students rather than students deliberately declining to take part in the study.

There were several limitations to our study. It was based on only 1 UK school of pharmacy. Also, the study was based on a self-rated survey instrument and, therefore, some students may have given the answers they thought were required, resulting in social desirability bias. Qualitative interviews or focus groups may have established a deeper understanding of students' views of these subjects and why they did or did not view them as important to a career in pharmacy.

Future research may also consider the views of science and math subjects from the perspective of qualified

Table 3. Comparison of Master of Pharmacy Degree Students' Ratings of the Relevance of Completing Certain Subjects When Pursuing a Career in Pharmacy

Subject	*P*	First-Year, Mean (SD)	Third-Year, Mean (SD)
Inorganic chemistry	<0.01	3.3 (0.7)	2.9 (0.7)
Physics	<0.001	2.7 (0.9)	1.8 (0.8)
Biology	<0.01	3.0 (0.7)	3.6 (0.6)

pharmacists. With the expanding roles of pharmacists in recent years, greater responsibilities and opportunities are available and pharmacists play a key role in the healthcare process. A strong scientific knowledge that underpins clinical practice is essential to safeguard patients.

CONCLUSION

With more integration and contextualization into the MPharm degree program, there is a sense of "thinning out" or "diluting" the science in the curriculum among current academics, which may be attributed to the emphasis on more clinically relevant teaching within the core science subjects. With more emphasis on clinical practice and patient care, students must understand and appreciate the underpinning science embedded within the pharmacy curriculum to help achieve safe practice. Our study highlighted the differences in students' perceptions among various science and mathematics subjects based on students' year of study and pharmacy experience. Pharmacy educators should consider how they can help students recognize the importance of the underpinning scientific knowledge while continuing to convey science and math subjects as relevant in an applied pharmacy context.

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