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Why do students decide to stop studying physics?

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Abstract

Each year, many students opt to study physics at higher education level in the UK – at the University of Glasgow, this number is around 180. A small number of these students, though, choose to leave this area after only one year. Over two academic years (2018-2019 and 2019-2020), there were 16 students such students. The work presented here explores the reasons why they left. Whilst the structure of degrees at UofG allows for students to make such a change, it was important to understand why students would choose to make such a significant change in case it pointed to negative factors in the way the course was being delivered. A study of literature found five main broad factors that influenced the decisions of students to change degree topic: content of course (including how it was delivered), gender stereotypes, peers and the wider university community, salary and job opportunities, and staff. These areas were explored in interviews and emails. It was found that course content and job prospects played a stronger role in influencing the students' decisions than the other factors. Positives in other disciplines, and poor communication of the positives within physics, contributed to the students' decisions. Similar issues may exist in any discipline; therefore, a better understanding of these motivating factors will allow us to improve our teaching and advising provisions to ensure that no-one is unnecessarily lost from a particular path.

Keywords

higher education, physics, motivation

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Introduction

At the University of Glasgow (UofG), students on science-based degrees (including physics) typically study three subjects in year 1 and have the option (subject to performance) of moving away from their original degree subject if they so wish. Whilst the majority of students who enter on physics degrees do not typically move away from the subject, a small number do. It was decided to explore the reasons behind this decision to leave physics.

Initially, a review was carried out to identify the main influences that result in students opting to change their mind about their preferred degree choice. The literature studied identified five main areas of influence (listed in alphabetical order): content of course (including how it was delivered), gender stereotypes, peers and the wider university community, salary and job opportunities, and staff. These factors are explored in more detail in the next section.

This investigation explored how these broad areas affected physics students specifically. The goal was to gain an insight into which of these influences most affected physics students, and if (specifically) how UofG's School of Physics and Astronomy's approaches impacted those students and their choices.

Another factor that can cause a student to choose to leave a subject is poor academic performance in that subject, which prevents them from continuing. This was outwith the scope of this investigation – the goal was to find out why students who had the option to continue in physics opted not to do so. The focus did not cover those who did not have that choice.

Factors that commonly influence students to change their degree course in higher education

There are many factors that influence the decisions people make; literature was considered see if there were common themes when it came to factors that resulted in students choosing to change their discipline of study.

Course content

A study by Thomson and Pyper (2006) – which looked at students who changed their degree away from physics – found that course content was a big factor for students to leave their degree. Pace of delivery, and the feeling of being overwhelmed due to the curriculum, was the biggest source of concern for students who chose a degree in physics. More generally, Baker et al (2018) found that the primary reasons that students choose their degree is course enjoyment and the grades they achieve. Interest in what was taught on a student's course was also found to be an important factor (Liu et al., 2020).

Traditional gender stereotypes

Students in gender imbalanced subjects, especially female students who enter male-dominated subjects, are at greater risk of lower academic and social integration, which can result in them being more likely to drop out of their degree (Meyer & Strauß, 2019). This may be because female students who are in a male-dominated course can be faced with a more difficult atmosphere on the campus. Furthermore, female students' male peers and lecturers may have doubt about the students' abilities and talents for the

courses on the Science, Technology, Engineering and Mathematics (STEM) subjects (Murray et al., 1999).

Kronberger and Horwath (2013) found that, in one European university, when female students dropped out of their STEM subject degree, it was attributed to self-doubt and a lack of social integration as opposed to their grades, whilst for male students, grades were more dominant.

Steele et al. (2002) analysed the perceptions of undergraduate female students in male-dominated STEM subjects. These female students reported increased levels of stereotyping and sexist discrimination than female students in a female-dominated field. These female students were more likely to want to change their degree course.

Peers and wider community

The impact of a student's peers, and their position in the wider community of their subject and the university, can be overlooked. Jacobs and Archie (2008) found that first year students who felt they belonged within their course and within the wider university community were more likely to remain in university and continue with their degree. Pu et al. (2020) showed that there was a large influence from peers on a student's decision to switch degree. If a student has a number of peers remain in their course, they will be less likely to change degree. If a student's peer changes degree, it encourages the student to also change degree.

Salary and job opportunities

Projected salaries and job opportunities after graduation can influence a student's choice of degree. Arcidiacono et al. (2012) found that students would change degree if they felt they would obtain a similar outcome from a degree they perceive to be more advantageous in comparison to the previous degree, in terms of salary and job options. Baker et al. (2018) further found that expectant outcomes on the labour market make an impact in choice; students will choose degrees with a higher expected salary and employment probability.

This factor does not often play a role initially in a student's choices. Eegdeman et al. (2020) found that students do not have specific salary/job expectations about the course they are studying as they begin their course, due to the fact they do not have enough experience in that field. As they gain more exposure to the field of study and subsequent job options, this can cause students to drop out of their course. Zafar (2011) found that students assume salaries will be lower for degrees they do not want to pursue.

Liu et al. (2020) found a difference between men and women in regard to this area. For men, they found that the most influential factor in choice of degree was the potential for job advancement, salary and career opportunities in the field. For women, though, their attainment and grades within the course was more important. Overall, it has been found that job advancement opportunities, student interest, and career opportunities have a strong influence on students' choice of degree (Jaradat, 2017).

Staff

Interaction with staff can have a strong influence on students. Jaradat et al. (2017) found that when students receive guidance through their first and second year of study, the likelihood of them changing degree is greatly decreased. In fact, staff interaction was found to reduce the likelihood of students leaving university entirely. Simões and Soares

(2010) also found that staff advice was a key influencing factor for students when choosing a degree.

Investigation design

A qualitative approach was taken to gather the information for the investigation, focussing on a series of interviews. Interview participants were all UofG undergraduate students who had taken Physics 1 in first year (2018-2019 or 2019-2020), and subsequently changed over to another degree course at the end of first year. A total of 16 such students were identified and approached. Of these 16 students, five agreed to be interviewed. In the discussion that follows, the participants are referred to as A, B, C, D and E. The first four identified as female, the last as male. Participant C was a first-year student in 2019-20, the others in 2018-19. The participants had dropped physics in favour of degrees in other science disciplines – chemistry, computing, or statistics.

Typically, 170-180 students begin physics-based degrees at the university each year. Of these, on average approximately 10 opt to move away. This is obviously a small fraction of the class, and those that agreed to take part in the study represent a subset of that small fraction. Care is therefore needed to not over-generalise the results and data presented and discussed below.

The interviews were conducted over Zoom and approved by the College of Science and Engineering Ethics Committee. Each interview participant was told that the project has this approval. The interviews were around 40 minutes long and accompanied by a follow up email. The questions used – detailed in the Appendix – were designed to explore the main themes that had been identified as influencing students to change their degree. Those questions were designed to be open-ended to help encourage the participants to speak for as long as they wished.

The interviews were recorded using Zoom, which generated an automatic transcription. The interviews and transcript were then reviewed. A general inductive approach was taken to analyse the data, following the method described by Thomas (2006). This allowed the large amount of text to be condensed and summarised, and then any common themes identified.

In the following section, each potentially influencing factor is tackled in turn, and the extent to which they did, or did not, influence the participants.

The views of students on what influenced them to change their degree

Course content

Students on physics degrees study courses from three disciplines in year 1 – physics, mathematics, and one more which for the participants covered computing science, chemistry, or statistics. Zafar (2011) highlighted that students update their beliefs about their degree as they interact with the subject matter. The fact that the students were doing multiple courses allowed them to understand the depth of each field more clearly, which in turn allowed them to consider which course was better suited to their interests and their skills.

All participants identified positives and negatives about course content; it was the latter than influenced their decision to drop the subject.

The content of the course lectures was raised repeatedly. Participant A explained that she felt the lecture modules changed too much, with different topics being tackled from one day to the next:

> [...] even if I enjoyed like one lecture a week they would switch to like a different topic, quite a few times and it just made it harder to actually get into what we're doing [...]

Physics 1 consists of five modules per semester, each taught by a different lecturer; these modules are taught in parallel, with each advancing roughly in step through the semester. This is done deliberately so that students are encouraged to see connections between the different topics. The pattern becomes more complex at times, though, due to external limiting factors, such as lecturer availability, and clearly this was an issue for this student.

Participant C found the same problem, and also found the time available to take in the content was not sufficient:

> A lot of it was really difficult to get at first. But I think if I had time to sit with it, I would have actually managed that. I just never had time to try it.

Participant E also did not enjoy the lecture content, but his complaint was about the level of the material, rather than the changing modules. He explained that he felt the difficulty of the lecture content got exponentially harder as time went on; he struggled to understand and grasp the concepts presented to him due to this.

> I thought the lectures ramped up disproportionately towards the end. That was what I was finding. I can't remember exactly what it was but I thought it was just getting harder disproportionately and I was struggling to take that all in.

Contrasting to this, Participant D felt the content was very repetitive of what students learn in Advanced Higher Physics when in secondary school. She felt that as a Scottish university, the school should take into account that most people in Scotland will already have done a lot of the material they give in first year.

> Probably quite a bit, because about half of the stuff was stuff I'd done in high school. A lot of dynamics and all the electricity stuff I'd done in high school. About half in first and a third in second semester.

This is an issue with the Scottish university system – admission is based on the Higher qualifications, but many students attempt Advanced Higher. There is a resulting overlap in the curricula, although this is viewed by the school as a positive as it allows students to adapt to university life (both academic and social) whilst not having to handle brand new academic material from day one.

Laboratory classes were also criticised when discussing the course content. Participant B criticised both the format of the labs, and the way the students were marked, which at the time they were in the class, used an interview-based system:

> Being completely honest I hated the labs with a passion, and it was the interviews and we felt (me and my lab partner who also dropped Physics) really felt rushed, we felt like we were given a three-hour lab but two hours to do it because we had to have the interview.

Participant D felt that the labs were not given enough time as the interview cut into the lab work:

> The first two hours were for the experiment then the last hour was for the interview, so if you were first up in the interview, you wouldn't have time to write up your results and stuff.

These issues of students feeling a lack of time, of being under pressure or overwhelmed agree with Thompson and Pyper (2006). Whether in labs or lectures, these themes carry through for multiple students. The interview-based assessment method was being trialled the year this student took the course; ultimately, whilst there were many benefits to this system, an evaluation showed that it was both unpopular and inappropriate and has been dropped.

Lastly, Participant A found that the labs were not that connected to the lecture content compared to other courses:

> [...] I'd say it wasn't completely disconnected, but it was definitely less connected compared to other courses.

Here we see evidence of the student making a comparison between physics and other subjects; in this case, physics came off poorer.

Traditional gender stereotypes

Physics is seen traditionally as a male-dominated subject. Studies suggest that female students may feel external pressure on them due to this fact (e.g., Kronberger & Horwath, 2013). They may also face discrimination from their male peers (Steele et al., 2002). The School of Physics and Astronomy has done a lot to combat such issues, and for the most part it did not play a role in the decisions of the female students who took part in this study.

Participant A felt the course had a good gender balance in first year but was unsure how that ended up for students further into their degree:

> I thought the physics was like pretty good in terms of like Gender and stuff and first year I don't know how it ends up later on.

Participant B also felt there was a good gender balance in first year and did not feel it influenced her decision:

> I definitely didn't think it had any influence on my decision to leave the subject, I still think women are really under-represented in the field of physics and most sciences. But all the girls I met in physics were absolutely lovely. I actually was kind of surprised about how many girls

> were in physics and I honestly looked at the room and my eyes went well that's pretty 50/50.

Participant B did, unfortunately, feel discriminated against by a fellow student, however this did not dissuade her from physics. Rather, it drove her to do better than him.

> I had one moment of like a guy student in first year being quite sexist towards me. I don't think that influenced my decision. More than just make made me feel more like confident that I can just like be better than him.

Participant C did not feel gender affected her decision and she instead felt having a physics degree would be advantageous as a woman:

> I would say that doesn't affect me at all, actually, I think it would be kind of the opposite. I kind of thought to have a physics degree already, if you can find the job for it you can get paid quite well for it. Because there's not a lot of women in STEM subjects, especially physics and a lot of companies, like, look out for female people who can do physics to hire. So I was kind of thinking it's good to have especially because there's not as many women there.

Finally, Participant D also agreed that gender stereotyping did not play a major role in her decision:

> No, not really, I didn't find that affected me. Most of the people in my year were girls anyway so it didn't impact me at all. You could say the same about maths, like there's a lot of boys in maths.

Peers and wider community

It has been shown before that students who do not have friends within their course are more likely to leave the course, and this was borne out in the interviews (e.g., Jacobs & Archie, 2008). Participant B was the only one who reported having strong relationships within physics. She did not feel her friends had an impact on her leaving physics but took reassurance from them that her opinions were not just her own:

> I don't think my friends made a massive impact to my decision. And I'm not the type of person to let people sway me and when I spoke to my friends about it. They agreed with me about the issues I was having with physics, especially with the labs and so like I felt like it wasn't only me and it was okay to be feeling like that.

Participants A and C did not have close physics friends, so did not discuss their decision with anyone. Participant D, meanwhile, felt that her friends did influence her decision to change course as her course friends actually introduced her to statistics, which she ended up leaving astronomy, and then physics for.

> Probably a lot. I knew a boy from school who was on my maths course and he introduced me to another few boys. I told them I wasn't enjoying astronomy and it was them who told me I should try stats.

Participant E felt that his peers may have been a minor factor as he had friends from school in his computing course and not in his physics course. This meant it was easier for him to integrate into the course:

> Maybe I found computing easier not only because I was better but also because I had friends and stuff from school. I think it might be a factor but wasn't a major factor.

When asked about their participation in the wider physics community, none of the participants had taken any significant part. They had attended the odd general lecture, but nothing more.

Salary and job opportunities

This topic was explored via email after the interviews had been carried out. Career prospects upon graduation, projected earnings, career advancement and job lifestyle are all factors that can influence a student's degree choice. Students tend to pick the course with higher employability, higher earnings, and more advancement opportunities.

Participant A believed that internships would be easier to find in computing science rather than physics:

> I am of the opinion that it was most definitely easier to find internships in computer science than in Physics. The intern who I worked with was actually doing Physics at Cambridge too, but he said he couldn't imagine what kind of job in Physics he would get after graduating, and that he'd most likely prefer a computer science job. I must also say that there has definitely been a popular opinion that CS leads to a desirable and stable job, alongside a pretty good pay.

Participant D felt that salary and career opportunities influenced her decision a bit because, again, she believed there weren't many careers in physics aside from lecturing, teaching or research, none of which she was interested in. She also believed that there were higher salaries within maths and statistic positions over physics jobs, a view Participant E shared, though in this case comparing computing to physics.

> The main factor at play here which is that I understood computing much more intuitively than Physics - I am better at computing than Physics so I will be able to do a more advanced job in the CS field than in Physics.

Participant B did not believe salary was a factor, but career opportunities were due to her skill set:

> I would say salary didn't play any role in my decision but the career opportunities did. I found myself better suited to the Chemistry lab environment compared to a Physics lab.

Participant C felt she would rather be in a career her talents were more suited to:

> I'm a lot better at Chemistry than I am at Physics, so I'd rather go into a profession I'm good at and possibly get paid slightly less.

Staff

Participants reported that staff presented a very positive view of the subject and school. This was not enough to offset the decision to leave the area, however it was enough to prevent the students from leaving university entirely. Each student has a personal Adviser of Studies, responsible for guiding students through their degree and answering any questions they might have. The participants all reported positive experiences of theirs, with the Advisers helping them talk through their concerns about degree choice and navigating the administrative issues surrounding changing their degrees. Without having Adviser meetings, more students may have felt overwhelmed and dropped out of university entirely instead of just changing degree. This is in keeping with the literature, as having regular meetings with Advisers discourages students from leaving the university entirely (Jaradat et al., 2017).

Discussion and conclusions

This investigation explored the reasons why five students, who had initially come to university to study physics, opted to move away from the discipline. Consideration of the literature had identified five broad areas that researchers had found could influence a student to make such a decision. In the case of the students here, it was found that two of these played a strong role: course content, and future salary and job prospects. Gender stereotypes, peers, and staff were found to play a less significant role.

Four of the participants cited the lecture content as a main factor behind why they changed degree, either due to the material being too hard, uninteresting (because they had seen it before) or delivered in a manner they found confusing. This caused the students to feel overwhelmed, which the literature states leave students wanting to change degree course (Thompson & Pyper, 2006). Two of those who took part cited the laboratory content as a main factor behind why they changed degree; here, the issue was timing – either the material did not match up to the lectures they were attending, or they were being asked to do too much in the time given. Whilst these issues could be considered course-specific, there is an underlying issue that applies more broadly: communication. One student did not like the way lecture modules were delivered; if it was made clear to the class why the lectures were delivered as they were, this could have helped address this. Similarly, the overlap with Advanced Higher courses should be addressed directly, so that students understand the value in the repetition of material.

All participants felt salary and/or job opportunities played a role in why they changed degree course, an area noted before (Baker et al., 2018); however, the focus varied. Some felt that their talents would be more suited to another field rather than physics, whilst others were not aware of the jobs available to physics graduates. One felt physics jobs were restricted to teaching/lecturing or research, whilst another felt that her new degree had better paid jobs and more available career paths. This clearly highlights, once again, the importance of communication. In any discipline, we cannot assume that students will realise what options are open to them unless we explicitly detail those opportunities. This was an example where other subjects were clearly doing a better job here, and as a result appear more appealing.

Whilst only these two areas played an active role in influencing the participants in this study, the other less-influential areas provided useful insights. Traditional gender stereotypes – traditionally a negative influence on female students – did not play a major

role here. All four of the female participants stated this did not influence their decision to leave physics. This result should not be taken to mean that gender pressures do not exist in the subject; rather, they highlight the successes that the school these students studied in has taken to tackle this issue directly. This is an area that cannot be ignored, and the examples here show that suitable initiatives can work to make sure they do not contribute to decisions to leave the discipline.

In terms of the effects of peers and the wider university community, four of the participants had peers, or a lack of, which influenced their decision. Only one student had close peers on the physics course; however, she explicitly stated that this did not influence her decision. However, the others did not have peers (or close peers) on the physics course. The literature states that students want to feel they belong within their course (Pu et al., 2020). In this case, the participants had a lack of peers; so, whilst peers did not drive them away, a lack of peers gave them less reason to stay. Indeed, one student stated specifically that her peers in the degree course she changed to influenced her decision to leave physics because they "sold her" on the new degree. A factor which influences belonging within the course is being involved in the wider course community (Jacobs & Archie, 2008). For the cohort considered here, though, this played little direct role as they did not report having any strong connections to this wider community; indirectly, this could have caused an influence as there was no-one to discourage them from moving away. This is in keeping with the literature, that students who are not involved in the wider course community are more likely to leave the course.

Finally, staff influence here was found to be purely positive. Interactions with staff were viewed in a positive light – whilst they could not dissuade them from leaving the discipline, they did help them to remain at university. The fact that students who had grown disillusioned with physics still viewed the staff in this area positively is nice to see.

Overall, then, this study found that the broad factors that the literature indicated influenced a student's decision to move away from their initial discipline did apply to these physics students, but there was a wide variation in the extent of the effects. Course content and future prospects dominated; clear, more detailed communication on these issues could perhaps have prevented these students from losing their affection for this subject. All disciplines, then, should take care to never assume students recognise and understand the full value of the degree they are undertaking as they begin their academic journey.

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