WHY SOME STAY: A STUDY OF FACTORS CONTRIBUTING TO PERSISTENCE IN UNDERGRADUATE PHYSICS[1]

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ABSTRACT. Concern about the dropout rate in the Physics Department at Université de Montréal led to a four-step research study to provide department decision-makers with information about factors influencing student persistence. A cross-section of students (dropouts and continuing) were interviewed, followed by interviews with a number of faculty and staff. A questionnaire was then developed which was administered to two cohorts of students. Responses were obtained from 82 students. Results from students from different years and the two administrations showed no significant differences, indicating that student opinions are consistent over time. Students who later dropped out and those who stayed differed in their perception of their skills and knowledge in physics and their confidence that they would finish the program. Other factors identified that may contribute to the low perseverance rate include low class attendance, students' lack of knowledge of career opportunities other than teaching, their unrealistic view of physics and the work of a physicist, and a significant discrepancy in study time between that expected by faculty and that considered reasonable by students. Preliminary recommendations and questions for further research are presented.

RÉSUMÉ. L'inquiétude suscitée par le taux élevé d'abandon au département de physique de l'Université de Montréal a mené à cette étude en quatre volets qui vise à fournir aux décideurs des informations sur les facteurs qui influent sur la persévérance des étudiants. Nous avons interviewé un échantillon d'étudiants (ayant abandonné et poursuivant leurs études) et un certain nombre de professeurs et membres du personnel. Nous avons conçu un questionnaire qui a été soumis à deux cohortes d'étudiants. 82 étudiants y ont répondu. Les opinions des étudiants sont cohérentes puisqu'aucune différence significative n'a été observée entre les étudiants des deux groupes. Les étudiants qui ont finalement abandonné et ceux qui ont persévéré avaient une perception différente de leurs habiletés, de leur connaissance de la physique et de leur confiance de pouvoir mener leur programme à terme. Nous avons noté d'autres facteurs qui contribuent à un faible taux de persévérance: les absences en classe, le manque d'informations sur les débouchés qui s'offrent aux diplômés, une vision idéaliste de la physique et du rôle du physicien et finalement une différence importante entre le temps consacré aux études et ce que l'on attend des professeurs. Nous présentons des recommandations préliminaires et quelques axes de recherche à poursuivre.

Dropout among students enrolled in the physics programs[2] at the Université de Montréal has hovered around 60% for a number of years. Of the approximately 100 students who enter each year, only about 35 will graduate. This situation, while comparable to science programs in other universities (La Haye & Lespérance, 1992; Tobias, 1990), nevertheless raised concerns among department administrators. This paper reports on research undertaken to provide information about the factors influencing student persistence in their programs. The research involved four steps: student interviews, faculty and staff interviews, and two separate questionnaires completed by students enrolled in the physics programs. We present a brief discussion of the background of the study, followed by the results of each step.

Previous studies on dropout can be divided into two major types. The most common are those studies that look at dropout from a systemic point of view (i.e., students who drop out of the school system entirely, at either the primary, secondary, or tertiary level). These studies generally include a variety of factors other than academic competence (Drew, 1990; Eisenberg & Dowsett, 1990; Finn, 1991; Halpin, 1990; Johnson, 1994; Mallette & Cabrera, 1991; Nisbet & Welsh, 1976; Poole, 1978; Tinto, 1975; Zahrly, 1990). As Corman, Barr, and Caputo (1992) mention, however, most published research on attrition is American, and generalizing from these studies may lead to inappropriate conclusions. The Université de Montréal recently conducted a study on student perseverance among undergraduate students across all departments, results of which led to the establishment of general policies to enhance retention of students by the institution (Crespo & Houle, 1995). However, studies such as that do not provide specific enough information to pinpoint difficulties that may lead to students abandoning a specific program, nor do they consider factors leading to switching programs within a university, a case of program dropout but institutional perseverance.

A smaller number of studies have focused on or specifically discussed dropout from specific programs; for example, science programs (Donaldson & Dixon, 1995; Hudson & Rottmann, 1981; La Haye & Lespérance, 1992; Rigden & Tobias, 1991; Ste-Marie & Winsberg, 1981; Seymour, 1992; Tobias, 1990; Wollman & Lawrenz, 1984). Interestingly, these studies do not consistently support the popular belief that academic performance, more specifically past performance in mathematics and science, is a significant factor in student dropout from science programs. Several studies have found significant gender effects;

for example, Donaldson and Dixon (1995) found that many more females than males withdraw from introductory chemistry courses.

Tobias' (1990) study highlighted the importance of a number of factors affecting learning, performance, and attitudes in undergraduates taking science courses – notably social (the culture of student life), organizational (the culture of the program, the department, and the institution), and pedagogical (the culture of the class, program philosophy, teaching methods, and study skills). All of these factors can be expected to contribute to a student's decision to persist in a given science program. We therefore decided to focus on these factors in this study.

To complement information available from student files and the university study cited above, we conducted interviews to gather data from a sample of students and professors. We used this information to develop a questionnaire that was administered to physics students of two cohorts; the data were analyzed to profile these students in general and to identify differences between students who persevered and those who dropped out. It should be borne in mind that the main objective of this activity was to provide the Physics Department with decision-making data; thus recommendations for actions contributing to reducing the number of students leaving the department were developed and are presented as well. Therefore, the research questions of this study were explicitly guided by the desire of the Physics Department to effect a change in the current situation.

STUDENT INTERVIEWS

In order to obtain a better understanding of the factors contributing to the low persistence rate at the Université de Montréal, a first step was to examine the students' perspective. As McKeown, MacDonell, and Bowman (1993) discuss, the importance of obtaining a clear understanding of the student perspective, rather than simply making assumptions about what is important to students, has often been overlooked. An initial interview guide was constructed, based on factors identified in the literature (Hudson & Rottmann, 1981; La Haye & Lespérance, 1992; Rigden & Tobias, 1991; Ste-Marie & Winsberg, 1981; Seymour, 1992; Tobias, 1990; Wollman & Lawrenz, 1984). The questions were organized in seven themes: descriptive data on the student; the university environment; the physics programs; pre-university preparation; difficulties encountered, either with organizational factors or with specific mathematics and physics content areas; teaching competence of lab demonstrators and teaching assistants; and teaching competence of professors. Interviewees were also asked to speculate on the reasons for the high dropout rate and make recommendations for improving the program.

Method

A list of 16 students who had taken the first physics course[3] was drawn up, eight of whom had continued in the program and eight of whom had dropped out. Within each subgroup, four had higher than average grades and four had lower than average grades. A total of eight students were interviewed individually (two from each subgroup). The interviews lasted between 75 and 130 minutes each. The interview cycle was stopped after eight students as saturation was reached; in other words, when no new information was being contributed by the interviewees.

Results

The results of the interviews were analyzed and grouped under nine categories. A summary of each category is presented below.

DESCRIPTIVE DATA. The students interviewed formed a homogeneous group with respect to age, other family members having done university studies, absence of financial difficulties, and their housing and employment situations. Physics was the first choice for all students. This choice was often made in high school, although some were not sure until they were finishing the science program in CEGEP. The majority of the interviewees saw the employment potential for physics graduates as being almost exclusively teaching-related: the level at which one could teach (high school, CEGEP, university) was determined by how far one went in university studies (B.Sc., M.Sc., or Ph.D.). The one difference found was that students who persevered claimed to spend on average approximately 30% more time studying than did those who had dropped out.

UNIVERSITY ENVIRONMENT. The students complained that they did not receive adequate – in terms of both time and quality of – guidance from the department. Students reported that important information was not received upon entry into the program, and they were not followed closely enough during their course of studies. Students were allowed to begin in the winter term, but those who did found themselves extremely limited in their choice of courses. Individual course outlines often did not agree with the course descriptions provided in the university calendar. Students were rarely required to consult books or journals in the library for their course work. Instead, they viewed the library as a place for group work, but found it wanting for this purpose. Computers were also not seen as essential to success in the program, although one student felt that the appropriate use of computers was very important for successful lab work. Perceptions about the quality of student life varied considerably. Some students felt that they did not have time to be involved while others felt that there was no student life to speak of or that it was reserved for a small clique. Still others felt that the social aspects of their university experience were both enjoyable and beneficial. Perceptions about the relationships between first-year and older students varied similarly.

PHYSICS PROGRAMS. The absence of labs in the first year was cited as a factor that may contribute to some students' lack of motivation. Labs were also seen as a way to encourage group work and better relations among the students. Students felt that the links between courses were rarely explained by the professors. Coordination (or lack thereof) between courses in mathematics and courses in physics was mentioned as a cause of problems; this was seen in schedule conflicts, the physical distance between buildings (and therefore classrooms and professors' offices), and out-of-sync curricula (mathematical concepts are often required in the physics courses before they are studied in the math courses). In general, student-faculty relations were seen positively. The program requirements and workload were seen as demanding, but not unreasonably so. The courses and exams were perceived as difficult, but this was somewhat compensated for by "generous" grading. The students were all aware that all students with the necessary prerequisites are accepted and that the majority do not finish in physics.

PRE-UNIVERSITY PREPARATION. The students were largely satisfied with their preparation in terms of linguistic competence (both French and English[4]). They were less satisfied with their preparation in mathematics and physics, and were largely unsatisfied with their training in study skills. Most of the students perceived themselves as strong students in CEGEP, and were now readjusting that perception, as the level of students in university is higher.

DIFFICULTIES ENCOUNTERED. Difficulties were specifically mentioned with respect to three courses in physics and three in mathematics. However, the difficulties mentioned were not consistently attributed to general underlying causes such as incoherence in the curriculum, inherent difficulty of the content, or students lacking prerequisite skills or knowledge.

TEACHING ABILITY OF FULL-TIME FACULTY. Many of the students' comments concerned the teaching abilities of their professors. A number of qualities were commented upon and a wide range of abilities was observed among the teaching staff. However, the factor mentioned most often was the ability of the professor to keep students interested and motivated in the subject matter in particular and physics in general. Also mentioned was the ability to make links between mathematics and physics, between theory and applications, and between the subject matter and research topics. Students also commented on professors' use of teaching materials, and their ability to encourage group work and involve students in problem-solving activities.

TEACHING ABILITY OF DEMONSTRATORS AND PART-TIME LECTURERS. There was a wide range of teaching competence among the demonstrators and part-time teaching staff. Specific criticisms were leveled at demonstrators who limited themselves to solving assigned problems at the board with no interaction with the students as well as at those who used a too-advanced mathematical language. The mathematics courses given by the math department were often taught by people without the interest or competence necessary to make any links with applications in physics.

HYPOTHESES ABOUT DROPOUT. The interviewees felt that most students who dropped out of physics did so because of individual inadequacies: lack of motivation, lack of real interest in physics, inadequate academic preparation, poor study habits. Also seen as contributing to some students' decision to leave the program were the large number of students in first-year courses as well as the impression given in first-year courses that physics is simply a branch of mathematics and that there is really nothing new to be learned. Interestingly, half of the interviewees thought that a large percentage of students who drop out do so to transfer to engineering studies, an opinion not confirmed by university data.

SUGGESTIONS FOR IMPROVEMENT. The interviewees made numerous suggestions to increase the number of students completing degrees in physics. These concerns ranged from providing more support and follow-up to students, to restructuring the program and specific courses to project a more dynamic image of physics.

FACULTY INTERVIEWS

Armed with the results of the student interview process, six professors (covering a range of domains of teaching and research areas as well as years of teaching experience), the Chair of the department, and the academic administrative assistant were interviewed, following the same interview guide and referring (anonymously) to student comments, where appropriate.

These faculty interviews provided a fairly coherent perspective on why such a high percentage of students did not persist in their studies in physics.

DESCRIPTIVE DATA. There was a shared perception that the students did not devote enough time to their studies and did not approach their studies as the equivalent of a full-time job. Faculty concurred that students saw teaching as the only career path and confessed that there was no concerted effort to change this view. In at least one case, the professor concurred that students with a degree in physics could only expect to teach.

UNIVERSITY ENVIRONMENT. Faculty agreed that the library served mainly as a place for students to meet, as they were rarely required to consult journals or books.

PHYSICS PROGRAMS. The professors were, by and large, sympathetic to the students' desire to have labs in the first year, and agreed that such labs could contribute to increasing or maintaining students' motivation. One professor, however, recounted that in the past there had been first-year labs which had been canceled after student pressure because of the difficulties encountered with learning the necessary theory at the same time as attending the labs. This supported concerns addressed by several faculty members about the challenge of designing labs that would go beyond recipe-following and require some thought but not too much advanced theoretical knowledge. The concerns expressed about coordination between math and physics courses were supported, but seen as endemic to any physics program.

PRE-UNIVERSITY PREPARATION. There was a general consensus that many of the students did not have adequate preparation, especially in mathematics and study skills.

TEACHING ABILITY OF FULL-TIME FACULTY. Encouraging group work by the students was not a concern, and in one case the professor raised the question of how to evaluate fairly the performance of individual students in group situations.

HYPOTHESES ABOUT DROP-OUT. The faculty felt that many students become disillusioned when they realize that by studying physics they would not solve the "great mysteries of the universe." Many students enter the program with an overly romantic view of what physics is and what physicists do.

STUDENT QUESTIONNAIRE

Based on the results of both sets of interviews, we developed, piloted, and revised a student questionnaire, which was then administered by the researchers to all students enrolled in the physics programs (see Appendix A). The items included in the questionnaire were intended to address a number of issues related to the academic environment. The majority of the items asked students to rate their opinion on a four-point Likert scale – a middle point was deliberately excluded and four points were deemed to provide an adequate level of discrimination. For administrative purposes, items were organized so as to prevent "clustered" responses (e.g., when items are grouped by the relation to the same topic), but nonetheless respecting the need for a sequence, when appropriate. Items were developed with the following categories in mind: disciplinary interests, curriculum, physics program, university environment, teaching (both style and quality), student support, and competence and individual characteristics.

The questionnaire was developed from a program perspective rather than to gather information that related solely to student characteristics. In other words, the intent was to examine which elements of the students' experience in the physics programs contributed to their decision to stay in the program or to drop out. For this reason, the questionnaire could not be administered upon entry, but had to wait until students had had sufficient experience with the program, courses, the teaching staff, etc., to be competent to answer the questions. The researchers therefore visited six compulsory courses (two from each year) in April 1994, the week before the final exams (Admin 1), and received almost 100% return from the students in class. An interesting point is that less than half of students still registered for the classes were in attendance, a not uncommon situation according to the professors.

The questionnaire was administered again in November 1994 only to students enrolled in the compulsory first-year course in Mechanics. This time, researchers visited shortly after the mid-term (Admin 2). The same response rate was obtained: almost 100% from the less than 50% of students in attendance. Admin 1 results therefore reflect the students' perspective at almost the end of the academic year; Admin 2 results are from much earlier in the year (halfway through the first term). The second administration was intended to determine if by gathering first-year students' opinions earlier in the academic year, a larger pool of potential dropouts could be identified.

In all, completed questionnaires were received from 82 students at the first administration (Year 1: 38/90 enrolled; Year 2: 26/53 enrolled; Year 3: 18/25 enrolled[5]) and 52 students at the second administration.

Information was obtained from the Registrar's Office as to whether students had graduated or re-enrolled the semester after the administration of the questionnaire, as well as the students' GPA. These data were used in the analysis.

Data analysis

Information was obtained as to which students who had completed the questionnaire at the first administration were still registered in the program the following academic year. Of the 82 students, 10 had graduated, 62 were still registered, and 10 had dropped out. (It is impossible to know from the data available if these ten students switched programs within the university, transferred to another university, or terminated their university studies.) Since the percentage of dropouts was significantly below that for the physics student population as a whole, it must be assumed that the group that completed the questionnaire was to some extent a self-selected group. As mentioned earlier, it was striking to note that at both administration times, only 50% of the students registered for the classes were in attendance. As Etcheverry, Clifton, and Roberts (1993) report, non-attendance in class is correlated with low achievement. The low attendance may be an indicator that a student is sufficiently disconnected from his or her studies to be at risk for dropping out, and this fact may, in and of itself, be of use in identifying students "at risk" in order to try contacting them.

Cluster analyses were performed to see if any groupings of variables distinguished those who dropped out from those who persisted. No meaningful clusters were discerned. Because of the small number of responses related to the number of variables, factor analysis was not conducted.

RESULTS. The overall results from the first administration, which included students from the three years of the program, are presented in Appendix B. Analyses were completed to look for difference by year of studies (1, 2, or 3) and by program (B.Sc. or Major in Physics vs. Math-Physics). The few statistically significant differences found do not appear to be particularly meaningful. Therefore, for purposes of subsequent analyses, the first administration is treated as one group. The results of the second administration, which was completed by 52 first-year students, are also presented in Table 1. The fact that the comparison of results from students from different years and from the two administrations resulted in no meaningful differences allows us to assert that students' experiences, attitudes, and opinions are fairly consistent over time (both within an academic year and across the three years of the program). This means that the concerns raised by the students are ones which must be taken seriously, as they are not "a passing phase."

STUDENT COMMENTS. There was space on the questionnaire for students to write in comments; 79 of the 134 students who completed the questionnaire did so. The comments were all examined, and clearly supported both the results of the preliminary interviews as well as the quantitative results from the questionnaire. The supporting comments concerned the quality of teaching, the amount of work in the program, the quality of the students' preparation in physics and mathematics, the physical environment, and the opportunities for someone with a physics degree. An interesting suggestion, offered by six students from the second administration, was the explicit request for a diagnostic test to be given upon admission to the program that would allow the students to identify their weak areas and undertake remedial work over the summer before they began their first year of studies.

THOSE WHO STAYED VS. THOSE WHO LEFT. We then obtained data on whether the first-year students who had completed the questionnaire at the first or second administration were still in the program in January 1996. Of the 90 first-year students who had completed the questionnaire, 57 were still enrolled and 28 had dropped out (5 missing data); none had graduated. The withdrawal rate was proportionate by gender to the enrolment rate, indicating no differential effects. Analysis of the responses of the two groups resulted in only two statistically significant differences, both of which relate to the student's self-perception. The statements "I am confident that I will finish the program I am enrolled in" and "In comparison with the other students in the program, I think that my skills and knowledge in physics are. . ." were answered more positively by students who had continued their studies than by those who had dropped out of the physics program (see Table 1). These results suggest that students who are more likely to drop out are initially less confident that they will finish and less confident of their skills and knowledge in physics than their peers. It should be noted that there was no significant difference between the two groups on academic performance as indicated by GPA, which underscores the fact that it is the student's own perception that is important to assess. This is consistent with results reported by Smith (1991) that there was significant attrition among students with satisfactory grades.

TABLE 1. Significant differences between students who stayed in the physics program and those who dropped out in terms of *M* and *SD*

Statement	Confidence in finishing the program (4 strongly agree; 1 strongly disagree)	Skills and knowledge in physics (5 very strong; 1 very weak)
Stayed		
M / SD	3.4 / 0.75	3.3 / 0.79
Left		
M / SD	3.0 / 1.19	3.0 / 0.58
	F=6.559, p<.012, df(1,83)	F=11.954, p<.001, df(1,82)

DISCUSSION

The most striking result of the study is not the answer to any specific question, but simply the fact that approximately 50% of students registered for courses do not attend classes, either the week before final exams in the second term or shortly after the mid-term exams in the first term. This "non-result" indicates that early on, half of the students do not feel that going to class is a worthwhile activity. Simple arithmetic leads to the conclusion that many of these students do not return the following term to continue their studies in physics. As mentioned above, Etcheverry et al. (1993) found that while time spent on different activities, such as paid work, had little effect on educational achievement and expectations, non-attendance in class is an important cause for concern. The absentee students have apparently already made up their minds to withdraw, or are certainly in the process of disengaging themselves. Any interventions intended to attract these students to stay must therefore occur early in the year; even waiting for the results of mid-terms to identify students "at risk" may be leaving it until too late. Year 3 students showed a slightly higher attendance rate than Years 1 and 2, which is not surprising. Not attending classes can be expected to have a more negative impact on first-year students, as their absence from class reduces their potential to network with other students as well as to create a sense of belonging to the program. Also, since study skills were identified in the interviews and the questionnaire as relatively weak, the ability of these students to study effectively on their own must be questioned. While we are not saying that all students must attend all classes, it is to be hoped that the great majority of students would find attending classes worth the effort. Students suggested that reducing class size and encouraging group work and involving students in problem-solving as well as using innovative instructional materials in class would contribute to this end by making classes more effective.

Several findings relate to the physics student body as a whole. Students did not know of career opportunities other than teaching. This lack of knowledge may help explain why it was that even third-year students did not have a clear sense of what they were going to do when they finished their degree. This finding confirmed a perception on the part of the Chair of the department that many students had a very limited appreciation of what they could actually do with a degree in physics. The confirmation was enough to lead to the creation of a department newsletter which, among other things, highlights graduates who are currently employed in a variety of fields (e.g., medicine, engineering).

The re-introduction of labs into the first-year curriculum was another action that was being contemplated by the Department. The generally favorable response to this idea by the students supported the decision to create first-year labs, and these are now in place. A related concern, expressed by the faculty and supported by the questionnaire results, is that the students on the whole have an overly romantic view of physics and what physicists do, to wit, they solve the great mysteries of Nature. By having more hands-on experiences in first-year, it is hoped to provide students with a more realistic understanding of the research process. This, combined with helping students see the practical applications of research in physics and a degree in physics, will contribute to students developing a more realistic view of physics and physicists.

A concern for both faculty and students was to increase guidance and follow-up for students by drawing on both faculty and more advanced students. The department has set up this year a system whereby each new student is assigned a professor to be his or her tutor. The role of the tutor is to help the students feel part of the physics "community" and create a connection from the beginning of a student's course of study. There are approximately two students assigned to each professor, with a minimum of two formal meetings scheduled per session, one at the beginning of term and the second near the midterms.

A final general result of note concerns the amount of time students spend studying. The faculty members all complained during their interviews that the students simply did not work hard enough; they felt that students should be putting in a 60-hour week – 20 in class and another 40 studying. The overall average that students claimed to be studying a week is 19, and their "ideal" amount of time studying is 24 hours per week, a far cry from 40. Whether the faculty members are right and the students are lazy or the students are right to expect a 40-hour week is a topic that should be debated elsewhere; the implications of the discrepancy are significant. If the faculty is counting on students doing twice the work outside class that they are, clearly many students will have significant difficulties in keeping up with the content covered.

When analyzing the differences between the students who continued in their physics studies and those who did not, it is noteworthy that the only significant difference comes from students' *perceptions* of their potential success and their skills and knowledge. It appears that students who are less confident are more apt to drop out, even though there is no significant difference in their mean GPA. This leads to a rather obvious but valid conclusion: if you want to know who's at risk for dropping out, ask the students. Obviously, the factors that influence different students will be different: some may think they will not finish because they don't think they can do it; others are disillusioned with the discipline; and still others may like physics but don't see the point of completing their studies in physics because they don't want to teach.

CONCLUSION

After reflecting on these data, we developed a series of preliminary recommendations, some of which have already been mentioned. These recommendations were conceived as hypotheses for action, and their feasibility was not evaluated when formulating them, although it was certainly a factor when evaluating their potential for implementation. Recommendations already mentioned concerned the re-introduction of first-year labs, the creation of a newsletter to inform students about a variety of career opportunities, and the implementation of a formal tutor relationship between students and professors. Additional recommendations are currently under consideration: increasing support for group work in terms of both physical space and course design; enhancing the image of physics as a dynamic field that is more than a subset of mathematics by emphasizing the links between and among research and courses; and improving teaching to favor group work and interaction.

Clearly, there are a number of issues raised which warrant further study to orient future actions. Two important questions regarding the students in the physics programs are: why don't they go to class, and where do they go when they leave physics. Related questions include whether those students who do not regularly attend classes have an informal peer network for studying. Knowing what happens to the students who drop out would also be useful. Do they transfer to other programs at the Université de Montréal, at other universities, or do they drop out of studies either temporarily or permanently? Another avenue of investigation pertains to how the situation in physics compares to that in other departments in the university as to class attendance and the student work week. The answers to all of these questions will help departmental decision-makers take appropriate and productive actions to improve the retention rate of students in physics.

The research reported here involved different perspectives on a complicated problem, and one for which no single action will suffice. However, by drawing on the students' and the faculty's perspectives, it is to be hoped that actions can be undertaken which will help reduce student attrition. It is naive to think that all students who enroll in a physics program will complete it; nor should they – especially if the program has no quota and no stringent selection procedure. The goal should be, however, to support those students who are both capable of completing the program of study and genuinely interested in physics.

NOTES

1. Modified versions of this paper were presented at the Annual Meeting of the National Association for Research in Science Teaching (NARST), March 31-April 3, 1996, St. Louis, MO and the Annual Meeting of the American Educational Research Association (AERA), April 8-12, 1996, New York, NY.

2. In 1994, the Department of Physics at the Université de Montréal had four undergraduate programs: a B.Sc. (honors), a Major and a Minor in Physics, as well as a bidisciplinary program in Mathematics and Physics run by the Faculty of Arts and Science.

3. At the Université de Montréal, as in other Québec universities, students enter a physics program after completing a two-year college program (at institutions called CEGEPs) in which they cover what in most North American universities corresponds to introductory physics. For this reason, their first university physics course is in Analytical Mechanics. Until 1995, students would normally take this course concurrently with one on Relativity and several courses in the Department of Mathematics.

4. Linguistic competence in English is important as most of the textbooks used are in English, even though the language of instruction is French. The university culture, however, means that students expect their professors to produce a set of extensive course notes in French that in many cases serves as an alternate text.

5. As explained in note 3, students come to their university studies after having completed a two-year post-secondary program. This means that to complete an undergraduate degree in a Québec university for these students generally requires a three-year program, as is the case with the programs in physics.

ACKNOWLEDGMENT

The authors would like to thank Prof. Manuel Crespo and Ms. Rachel Houle, Université de Montréal, for advance access to their study on institutional perseverance; Profs. Huguette Bernard and Jean-Guy Blais, Université de Montréal, for their help in the design of the questionnaire; Prof. Blais for his valuable suggestions for designing and conducting the data analysis; and Michèle Perron, LIDÉ, Université de Montréal, for her help in the data analysis.

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JEAN-ROBERT DEROME a pris sa retraite de l'Université de Montréal en juin 1997. Auparavant, il était professeur titulaire et directeur du département de physique. Il continue ses activités dans le domaine de l'éducation.

APPENDIX A. Questions in order of presentation to the students (translated from the original French)

For the following questions, circle the number which reflects your opinion.
4=strongly agree 3=agree 2=disagree 1=strongly disagree

The areas of physics which interest me are:				
- thermodynamics	4	3	2	1
- electromagnetism	4	3	2	1
- field theory	4	3	2	1
- mechanics	4	3	2	1
- biophysics	4	3	2	1
- astronomy and astrophysics	4	3	2	1
- relativity	4	3	2	1
- quantum mechanics	4	3	2	1
- electronics and measurement	4	3	2	1
- solid state	4	3	2	1
The types of activities which interest me are:				
- laboratory experiments	4	3	2	1
- theory	4	3	2	1
- computer-based numerical analysis	4	3	2	1
The program should have a survey course on modern physics in the first year	4	3	2	1
The information that I received from the department helped me to orient my studies	4	3	2	1
I understand the links between the different **physics** courses in the program	4	3	2	1
I understand the links between the **physics** and the **mathematics** courses in the program	4	3	2	1
The program should include lab work in the first year	4	3	2	1
I would like the professors to talk to us about their research interests during their courses	4	3	2	1
I would benefit from having a more advanced student as an official guide to help me with my studies	4	3	2	1
The department should intervene and suggest remedial courses, workshops, etc. to students who need them	4	3	2	1
My work habits and study methods are adequate to succeed in the program	4	3	2	1
The professors should frequently demonstrate the principles they are teaching with experiments in class	4	3	2	1
I can see the links between course content and current research in physics	4	3	2	1
It would be helpful to have access to a room in the department for group work	4	3	2	1
There should be general interest physics books available in the library	4	3	2	1
All courses should share the same evaluation scale (for conversion to letter grades)	4	3	2	1
The **mathematics** courses allow me to appreciate a different point of view than that of the physicist	4	3	2	1
I often had difficulties in my **physics** courses because of the mathematics used	4	3	2	1
The study of physics basically entails revisiting the same subjects with more and more complex mathematical tools	4	3	2	1
The professors should encourage more team work in their courses	4	3	2	1
Being taught in large groups did not hinder my learning	4	3	2	1
Students should be made to participate more actively in looking for solutions to the problems posed in class	4	3	2	1
The role of the physicist is to make significant contributions to the advancement of knowledge about Nature	4	3	2	1
I give great importance to obtaining feedback on my work within a reasonable time frame	4	3	2	1
I often ask questions in class	4	3	2	1
The homework assignments prepare me well for the exams	4	3	2	1
The work load required by the **physics** courses is reasonable	4	3	2	1
If there had been remedial courses in physics or mathematics, I would have taken them	4	3	2	1
If there were a workshop to help improve my work habits and study skills, I would take it	4	3	2	1
I had financial difficulties which hindered my performance in the program	4	3	2	1
The program should have a limited number of places available and there should be a stricter admissions policy	4	3	2	1
I am confident that I will finish the program I am enrolled in	4	3	2	1

Percentage of professors who: **(4=** all ; **3=** about three-quarters; **2=** about half; **1=** one-quarter or less)

- do not appear to be interested in the subject matter they are teaching	4	3	2	1
- know well the subject matter they are teaching	4	3	2	1
- communicate well the subject matter they are teaching	4	3	2	1
- go too quickly for me to understand everything	4	3	2	1
- do not take course evaluations into account to improve their courses in subsequent years	4	3	2	1

I took Math 303 in Cegep **1** = YES **2** = NO

What do you think are the most common career opportunities for someone with a B.Sc. in physics (in order of frequency):

1) ____________________ 2) ____________________ 3) ____________________

Number of hours per typical week I spent on the following activities during this term:

	courses (classes or labs)	studying	work	transportation
really				
ideally				

In comparison with the other students in the program, I think that my skills and knowledge in **physics** are:
1 = very weak **2** = weak **3** = average **4** = strong **5** = very strong

In comparison with the other students in the program, I think that my skills and knowledge in **mathematics** are:
1 = very weak **2** = weak **3** = average **4** = strong **5** = very strong

What do you plan to do when you finish the program you are enrolled in?

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Comments:

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APPENDIX B. Results grouped by theme (not presentation order) for all students from both administrations (The number of respondents per question ranged from 71 to 82 for the first administration, and from 46 to 52 for the second.)

	1st Admin		2nd Admin	
Scale: (4= strongly agree; 3= agree;2= disagree; 1= strongly disagree	*M*	*SD*	*M*	*SD*
Interest:				
The areas of physics which interest me are:				
- thermodynamics	2.7	.73	2.7	.79
- electromagnetism	3.0	.79	2.9	.84
- field theory	3.0	.88	2.9	.84
- mechanics	2.9	.84	3.0	.86
- biophysics	2.2	1.00	2.5	1.05
- astronomy and astrophysics	3.0	1.01	3.5	.86
- relativity	3.4	.73	3.4	.88
- quantum mechanics	3.3	.79	3.3	.75
- electronics and measurement	2.2	.91	2.6	1.02
- solid state	2.5	.90	2.4	.82
The types of activities which interest me are:				
- laboratory experiments	2.8	1.06	3.2	.79
- theory	3.6	.67	3.5	.73
- computer-based numerical analysis	2.8	.94	2.9	.84
Curriculum:				
The program should have a survey course on modern physics in the first year	2.9	.93	3.0	.93
I understand the links between the different physics courses in the program	3.1	.72	3.0	.68
I understand the links between the physics and the mathematics courses in the program	3.3	.73	3.4	.67
The program should include lab work in the first year	2.5	1.04	2.6	1.06
I can see the links between course content and current research in physics	2.6	.79	2.1	.65
The mathematics courses allow me to appreciate a different point of view than that of the physicist	3.2	.82	3.2	.81
The study of physics basically entails revisiting the same subjects with more and more complex mathematical tools	2.9	.93	2.9	.83
The role of the physicist is to make significant contributions to the advancement of knowledge about Nature	3.4	.78	3.6	.61
Program:				
All courses should share the same evaluation scale (for conversion to letter grades)	3.1	1.01	2.9	1.04
The work load required by the physics courses is reasonable	3.2	.71	2.4	.98
The program should have a limited number of places available and there should be a stricter admissions policy	1.9	1.07	1.8	.98
Environment:				
It would be helpful to have access to a room in the department for group work	3.3	.88	3.6	.70
There should be general interest physics books available in the library	3.4	.68	3.5	.61
Being taught in large groups <u>did not hinder</u> my learning	2.9	.90	2.9	.86
Teaching style:				
I would like the professors to talk to us about their research interests during their courses	3.4	.79	3.3	.76
The professors should frequently demonstrate the principles they are teaching with experiments in class	3.1	.86	3.2	.72
The professors should encourage more team work in their courses	2.8	.84	3.0	.91
Students should be made to participate more actively in looking for solutions to the problems posed in class	3.0	.80	3.1	.88

Scale: (4= strongly agree; 3= agree;2= disagree; 1= strongly disagree	1st Admin *M*	1st Admin *SD*	2nd Admin *M*	2nd Admin *SD*
Teaching style (continued):				
I give great importance to obtaining feedback on my work within a reasonable time frame	3.5	.65	3.7	.51
The homework assignments prepare me well for the exams	3.2	.64	2.7	.74
Student support:				
The information that I received from the department helped me to orient my studies	2.3	.85	2.2	.83
I would benefit from having a more advanced student as an official guide to help me with my studies	2.8	.96	3.1	1.07
The department should intervene and suggest remedial courses, workshops, etc. to students who need them	3.0	.86	3.3	.82

Scale: (4= all; 3= about three-quarters; 2= about half; 1= one-quarter or less)	1st Admin *M*	1st Admin *SD*	2nd Admin *M*	2nd Admin *SD*
Quality of teaching:				
Percentage of professors who:				
- do not appear to be interested in the subject matter they are teaching	1.5	.72	1.4	.75
- know well the subject matter they are teaching	3.3	.77	3.2	.83
- communicate well the subject matter they are teaching	2.1	.73	2.2	.76
- go too quickly for me to understand everything	1.6	.75	1.8	.84
- do not take course evaluations into account to improve their courses in subsequent years	1.6	.81	1.7	.86

Scale: (4= strongly agree; 3= agree;2= disagree; 1= strongly disagree	1st Admin *M*	1st Admin *SD*	2nd Admin *M*	2nd Admin *SD*
Competence and Individual characteristics:				
I often had difficulties in my physics courses because of the mathematics used	2.2	1.09	2.9	1.03
If there had been remedial courses in physics or mathematics, I would have taken them	2.4	1.15	2.7	1.10
I often ask questions in class	2.2	.96	2.2	.96
My work habits and study methods are adequate to succeed in the program	2.9	.81	2.7	.66
If there were a workshop to help improve my work habits and study skills, I would take it	2.5	1.10	2.8	1.15
I had financial difficulties which hindered my performance in the program	2.1	1.13	1.8	.97
I am confident that I will finish the program I am enrolled in	3.7	.57	3.0	1.06

I took Math 303 Introduction to differential equations in CEGEP
Admin 1: *Yes*: 63% No: 37% Admin 2: *Yes*: 59% No. 41%

In comparison with the other students in the program, I think that my skills and knowledge in physics are:
(1 = very weak 2 = weak 3 = average 4 = strong 5 = very strong)
Admin 1: 3.4 (.80)
Admin 2: 3.1 (.69)

In comparison with the other students in the program, I think that my skills and knowledge in mathematics are:
(1 = very weak 2 = weak 3 = average 4 = strong 5 = very strong)
Admin 1: 3.4 (.90)
Admin 2: 3.4 (.74)

Number of hours per typical week I spent on the following activities during this term:

Admin 1:	courses (classes or labs)		studying		work		transportation	
really	18.4	(4.31)	16.3	(9.47)	5.4	(7.98)	6.2	(4.68)
ideally	19.1	(3.84)	21.2	(8.68)	3.3	(5.39)	2.6	(3.26)
Admin 2:								
really	21.0	(3.98)	18.8	(10.8)	6.2	(7.31)	6.9	(4.78)
ideally	21.1	(3.93)	22.8	(10.4)	4.9	(6.48)	2.9	(3.56)

What do you think are the most common career opportunities for someone with a B.Sc. in physics (in order of frequency): Admin 1 & 2 gave the same responses

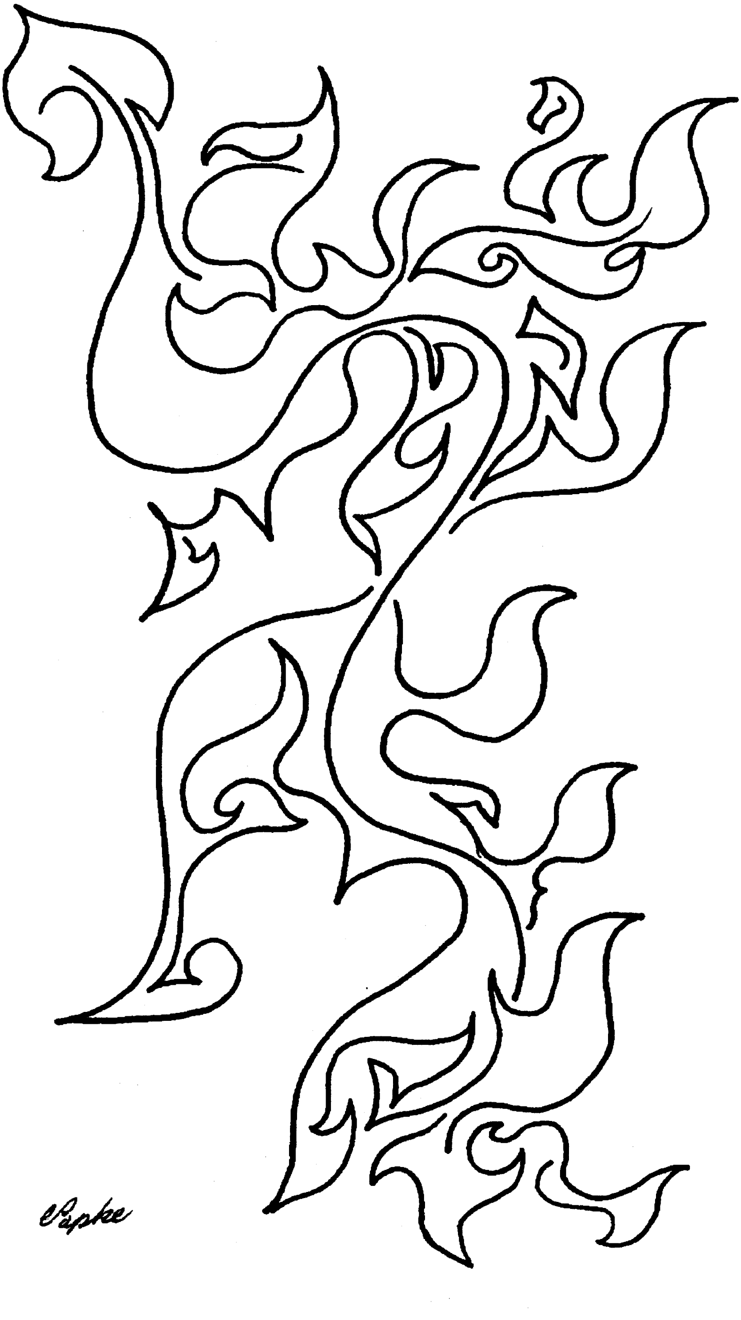
1) Teaching 2) Graduate studies in physics 3) Research

What do you plan to do when you finish the program you are enrolled in?
Admin 1 & 2 gave the same responses

1) Studies in physics or mathematics 2) Studies in non-university teaching 3) Other studies

Age of respondents: Admin 1: *M* - 21.7, *SD* 2.4 (min. 18; max. 30)
Admin 2: *M* - 20.9, *SD*. 3.8 (min. 18; max. 36)

Sex of respondents: Admin 1: *M* - 62 (77.5%) *F* - 18 (22.5%)
Admin 2: *M* - 43 (89.6%) *F* - 5 (10.4%)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