Introduction

Issues of attrition and retention are of relevance to anyone who is concerned with developing more inclusive first year curricula. For several reasons, including socio-economic, especially science, technology, engineering, and mathematics (STEM) education has been in focus of a lot of the literature. This study concerns the students' first year experiences in a STEM programme, but we hypothesize that the results are widely applicable across university programmes.

Currently, the most thorough inquiry into why undergraduates leave STEM convincingly concludes that the most prominent difference between students who stay and students who leave is their initial interest in science [1]. Students who stay are often *intrinsically* interested in the subject and conversely, students who leave, are often *extrinsically* interested [1].

A study of attrition at a research-intensive Swedish university concludes that two types of introvert discourses dominate students' explanations for prematurely leaving physics [2]. Either students explain their choice of leaving by crafting an argument around not being 'good enough' or the argument ultimately rests on a perspective that 'things just happen the way they do'. Both discourse-models [cf. 3] are introvert. They do not concern causal references to the external educational context – like curriculum structure and teaching method.

To circumvent this issue of introspection we perceive of attrition as complementary to retention. We think of the choice of leaving *vís a vís* staying as results of different coping strategies – some obviously more successful than others.

Methodology

A longitudinal research design was chosen. The data was obtained during one particular cohort's first year in a traditional three+two year university programme. The physics programme was chosen because has a attrition rate of approximately 30%, which is typical of a STEM programme with issues of attrition.

26 students participated in individual interviews. In total, our dataset consists of approximately 100 interviews carried out during the course of one academic year. Before study-start, a semi-qualitative questionnaire about the students' self-perceived motivation for studying physics and self-expected strategies for learning physics was administered.

Results

The initial questionnaire and first interviews clearly reveals that the students are intrinsically motivated, but that their notion of the scientific field which drives the motivation is rather vague.

Relatively early in the study it was clear to us that a majority of the students who participated in our interviews felt intellectual gratification by connecting their interest in physics to their subjective idea of the general field of physics. The students generally expect of the content of their studies that it provide them with tools to discover the world on their own, not merely the knowledge already discovered by others. That is, learning is intellectually gratifying to them when it allows for them to connect to (what we choose to call here) a subjective idea of the general field of physics.

By ‘a subjective idea of the general field physics’ (‘idea of physics’ for short) we mean the student’s individual, hence subjective, picture of physics as a discipline, including the broader societal context. It encompasses the student’s intrinsic interest in the field and it constitutes that general context towards which the teaching discipline lends its purpose. An appreciation of how teaching and learning is connected to the student’s idea of physics gives a sense that learning physics serves a purpose that transcends passing the exam.

In the beginning when the assignments, labs and theoretical models are relatively simple, it is appears to be relatively easy for the students to connect their learning experiences to their idea of physics. However, as the task becomes more complex and the physics more advanced, it becomes significantly harder for them to connect to their ideas of physics. Occasionally then, students can invoke a sense of belonging to a select few, when they are able to understand complex physics phenomena or manage to follow professor’s mathematical derivations in lectures.

As they progress through the second half of their first year, they seem to be overwhelmed with the details and complexity of the theory:

> You know, its so easy to become so... lets call it fascinated by nature. […] But it’s just that it contains so much complex mathematics, you know. Often, this sense of perfect purpose, it kind of disappears in mathematical manipulations and... formalism […] but I think that maybe there were a lot who, when they started studying, had a somewhat romanticised idea about it. […]
> It is *evident* that you need to know that mathematics and have the mathematical foundation to be able to understand it at all. […]This understanding, we won’t get it until two years time, three years when we know all this compulsory stuff and so on. At least I hope it will. But this big revelation hasn’t come to me yet. But of course, I’m only at the end of my first year…

We thus observe a diminishing appreciation of how the curriculum content and related activities can be connected to their idea of physics. As a resort they come to rely on being able to defer their need for intellectual gratification; a reliance that has implication for the quality of learning in relation to the content and curriculum structure. Some students are able to mobilize an intrinsic interest in the detailed theoretical models as such. The student above is practicing her ability to appreciate mathematics – maybe because a condition for belonging is the ability to appreciate mathematics. But others seem to resign themselves in ways which lead to surface approaches to learning.

Implications

It appears as if a curriculum that is foundations-focused might impede students’ opportunity for immediate intellectual and academic gratification, and thus lead to surface learning. Is it possible to design a curriculum which provide intellectual gratification and thus maintain students’ intrinsic interest, and at the same time provide the necessary foundation in physics? We think so. Some kind of problem based curriculum where the problems relate to students’ ideas of physics is one possibility; another one is to systematically relate a certain percentage of student work throughout the year to their idea of physics.

References

[1] Seymour, E., Hewitt, N.M. *Talking about leaving – Why undergraduates leave the sciences.* Oxford, Westview Press, 1997.

[2] Johannsen, B.F., Linder, C., Rump, C.Ø. ”Experiences of causality of attrition: a perspective from former physics undergraduates students.” In Bilsel, A., Garip, M.U. (eds): *Frontiers in Science Education Research.* North Cyprus, Eastern Mediterranean University Press, 2009, pp 51-60.

[3] Gee, J.P. *An Introduction to Discourse Analysis. Theory and method. Second edition.* London, Routledge, 2005.