A LONGITUDINAL STUDY OF STUDENTS’ TRAJECTORIES IN AND OUT OF THE “STEM PIPELINE”

In the discussion of recruitment and retention of students in STEM higher-education programmes, the metaphor of the leaking pipeline is sometimes used, indicating that as students proceed through the educational systems some of them are lost. This paper follows a cohort of upper-secondary school students with an interest in STEM from 18 months before their completing upper-secondary school until three years after their completion. Adopting a mixed-methods design, it follows the reflections and interests of the students concerning their choice of higher education, and, in particular, whether they enter a STEM higher-education programme. Only 22% of the students expressed the same interest during the whole period, and 56% changed between different groups of studies, e.g., between STEM and HEALTH. The considered trajectories of the students showed that the leaking-pipeline metaphor is misleading because it suggests a linear and one-way movement, while there were students moving in as well as out of STEM trajectories.

Keywords: Student choices, STEM education, Decision making

INTRODUCTION

The ‘leaking STEM pipeline’ is frequently used to describe how students lose interest in STEM as they proceed through the educational institutions and therefore opt away from STEM-related trajectories. The metaphor suggests a well-defined flow of students from secondary school through higher education and into the STEM labour market (the pipeline), and that during this flow some students leak out of the pipeline and are lost for the STEM community (Metcalf, 2010).

The metaphor is widely used, but also criticised. Amongst others because it posits a linearity that is not accurate (Cannady, Greenwald, & Harris, 2014) and it appears unable ‘to account for varied career paths, exit, and re-entry’ ("The Ada Lovelace project," ; Metcalf, 2010, p. 9). This study questions the linearity of students’ educational trajectories: Is there a one-way traffic out of the pipeline or does it allow for re-entry? The research questions are thus:

- How stable are STEM-oriented upper-secondary school students’ educational trajectories (in or out of the pipeline) over time?
- What reasons for changing their educational trajectories can be found in the students’ accounts of their educational reflections?

Methods

In order to capture multidirectional flows, we have conducted a longitudinal study of students who took advanced mathematics in general upper-secondary school and therefore met the formal requirements for entering tertiary STEM educations in Denmark. We have focused on their transition from upper-secondary school to tertiary education.
For answering the first research question, we conducted a longitudinal quantitative analysis with three successive points probing 240 students’ educational reflections through a period of three years with the question: *Which thoughts do you have about what you would like to study, and what are your reflections concerning future education and job?* 209 students (87% of the 240 participants) reported educational reflections at all three points.

For answering the second question, we examined a sample of fifteen focus students’ accounts of their reflections concerning their educational choices and trajectories in the transition process from upper-secondary school to tertiary education. Each student was interviewed eight times during upper-secondary and again one and two years after they completed upper-secondary school. The interviews were individual, qualitative and semi-structured. Each interview followed the thread and theme from the previous interview: the students’ educational reflections and attitudes towards tertiary education in general and STEM educations in particular. All the qualitative interviews were recorded and transcribed verbatim.

**Analysis**

The educational reflections of the 209 project participants were categorised according to the groups: STEM, HEALTH, Other and Unsure. Changes over time in students’ educational reflections were then quantified. We used Sankey diagrams to visualise the students’ between-group trajectories across the three reflection-points.

From the interview transcripts, we extracted the sections where focus students referred to their reflections concerning choice of study and intended or actual educational trajectories. The extraction method focussed on the students’ reasons for changing their educational trajectories, and on the incidents and experiences that occurred that were linked to the students’ choices and trajectories. The analysis of each case student was member-checked.

**Results**

Of the participating students, 22% expressed the same intended and/or actual educational trajectory during all three years. Another 22% of the participating students changed between educational trajectories within one group of studies during the three years. More than half the participating students (56%) changed between different groups of studies. Figure 1 visualises the students’ educational trajectories. The horizontal dimension shows time with the three reflection-points indicated at the top. The vertical dimension presents the distribution of the 209 students in the four groups according to which educational trajectory they expressed at each of the three reflection points. The coloured bands illustrate the flows between the four groups of study programmes, the widths of the individual coloured bands are proportional with the share of participating students in each trajectory. The proportion of students who “stay in the STEM pipeline” are thus the wide blue horizontal band at the very top.

Analysis of the qualitative data suggest that students may not always perceive between-group changes as major changes in their educational trajectory. Changing from physics (STEM) to economics (Other) could, for instance, be considered math-stable.
Conclusion and discussion

The students’ ideas about their educational trajectories and their actual movements in general are not stable over time. Students engage in a continuous interpretation of what they experience and in these interpretation and negotiation processes, what at one point directed the students away from a STEM trajectory could in a later context, e.g., based on different experiences, be reinterpreted in a way that would direct the student back into it.

The majority of the students changed their trajectories over time. Moreover, more than half the students’ educational trajectories changed between studies at different faculties. This extent of between-groups changes was surprising and noteworthy. It highlights the dynamics in students’ educational choice processes, and it questions the leaking STEM pipeline metaphor.

REFERENCES

