From University Student to Employee

Trine Brøndt Nielsen[a], Henriette Tolstrup Holmegaard[a]

Corresponding author: trine.nielsen@ind.ku.dk
[a]Department of Science Education, University of Copenhagen, Denmark

Keywords: employability, higher education, transition, job market, physics graduates

Abstract

In Denmark employment rates for physics graduates are high, which suggests that the graduates meet the demands of the job market. Consequently, the transition from higher education physics to employment has been of little concern to either universities or other stakeholders and therefore has not been the subject of research. This study aims to explore this gap in the literature, by studying physics students' experiences and the challenges they encounter in their transition into the job market. The study is based on a questionnaire and interviews with physics graduates from a research-intensive university in Denmark. The results show that despite the high employment rates, the transition experience is both frustrating and challenging for the graduates who perceive it to be their individual responsibility alone to find a job. Firstly, they struggle to identify their own competencies and, as a result, they are challenged in matching them with potential jobs. Secondly, they struggle to identify jobs other than teaching and research careers, which are the jobs being portrayed during their university studies. Thirdly, they experience a lack of both discipline-specific as well as generic competencies such as programming and project management. The results suggest that there is a need, even for study programmes with high employment rates, to support students' transition into work-life. The implications of the study show that in order to enhance student employability, initiatives should be embedded into the curriculum to secure employability as an integrated part of the graduates' competencies.

Introduction

Higher education institutions are, more than ever, facing substantial changes (Shin 2014). With an increasing number of students and the affiliated expansion of public spending, universities can no longer consider themselves as self-contained systems with a primary aim of producing students who pursue tenure track careers within academia. Rather, universities are expected to transform from institutions for knowledge and research in themselves (Knight and Yorke 2003), into institutions that contribute to the development of society in general and economic growth in particular (Cerych and Furth 2013; Trow 2010). This has caused the economic value and accountability of universities to become the centre of political attention (Mayhew, Deer, and Dua 2004). As higher education does not automatically translate into better economic outcomes, higher education institutions face a future where a stronger emphasis must be placed on ensuring that students actually acquire the competencies[1] requested by employers in order to achieve better economic progress (OECD 2013). However, matching the needs of the labour market is not straightforward, as it is characterised by rapidly changing work conditions with temporary and insecure employment, requiring generic and transferable competencies as well as discipline-specific competencies (Stiwne and Jungert 2010).

Study programmes within Science, Technology, Engineering and Mathematics (STEM) have traditionally been perceived to offer students a strong focus leading to well defined jobs (Heery and Salmon 2002), and providing access to a wide range of job opportunities. As a

[1] In this study we use the concept of competence instead of skill. We understand that competency is underpinned by skills but also draws upon knowledge and attitudes (European Commission, 2007).

consequence the debate as to the relevance of graduates' skills has been sparse, and only a few studies have been concerned with the employability of STEM graduates. One reason for this is the public calls for more students to move into STEM studies from school, as there is a demand for more STEM graduates within the job market (European Commission 2004; Kennedy, Lyons, and Quinn 2014; Maltese and Tai 2011; Ryder, Ulriksen, and Bøe 2015). As a result attention has been focused on the leaky pipeline to STEM studies rather than on student employability at the end of study. Finally, research within STEM subjects receives considerable external funding. For example in Denmark where this study is carried out, research within STEM receives about four times more external funding than research within the humanities (Kalpazidou Schmidt, Langberg, and Aagaard 2008), explaining why a large number of STEM graduates continue into a career in research (Fox and Stephan 2001). However, this of course poses challenges for graduate employment if funding for research decreases.

The discussion of STEM graduate employability has taken on an economic rhetoric with a primary focus on employment rates. Therefore we are left without understanding the mechanisms that lead the graduates to their jobs, the challenges they encounter in this transition process, and their experiences with meeting the requirements of their new job. This is the focus of this study. Moving away from the rigid focus on employability as an economic rationale, we will inform our approach by reviewing studies and theories on graduate employability.

There is no single definition of employability. As a result, employability is studied and measured in many different ways leading to an uneven platform for discussion. Different employability studies put emphasis on different actors (students, workers, employers, stakeholders), approach employability from different perspectives (the individual, the organisation, and the industry), and address different points in an individuals' career (during their studies, in employment, out of employment, and retirement). However, in studying graduate employability the focus should naturally revolve around the graduate (Johnston 2003). While some simply investigate graduate employability via measurement of the number of graduates who find employment within a specific amount of time (Mason, Williams, and Cranmer 2009), other studies aim to understand the extent to which students are employable, and what influences such employability. This will also be the focus of this study.

Yorke (2006) defines employability as 'a set of achievements – skills, understandings and personal attributes – that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy' (p. 8). This definition is twofold: it concerns the process of gaining employment as well as the state of being employed. However, in much previous work this definition of employability has simply been translated into comparing the graduates' knowledge, skills and competencies with the knowledge, skills and competence requirements of the labour market (Hennemann and Liefner 2010; Lowden, Hall, Elliot, and Lewin 2011; Nicolescu and Pun 2009; Sharma, Pollard, Mendez, Mills, O'Byrne, Scott, Hagon, Gribble, Kirkup, and Livett 2007). While these studies detected gaps between the competencies possessed by graduates and the demand of competencies by the labour market, they leave an important question unanswered: namely to what degree these gaps constitute a problem or challenges for graduates and their employers. The next step is therefore, to go beyond identifying these gaps and to understand if they have implications, and if so, what these are.

Previous studies tend to leave out the process of gaining employment, which is a crucial part of the transition process (Brown, Hesketh, and Wiliams 2003; McArdle, Waters, Briscoe, and Hall 2007), in which graduates realise that employability is not just about being employed but about the whole process of navigating the job market. Few studies have investigated the entire transition process; rare exceptions are those of Moreau and Leathwood (2006) who investigate how social class, gender, ethnicity, age, disability and the university attended impact students career opportunities and Stiwne and Jungert (2010) who followed cohorts of students through university and into their first year as graduates. In this paper we aim to study the entire transition process from education to work in order to reach a more nuanced understanding of graduate employability. This study therefore focuses on the various phases in the transition process; from graduation, through unemployment and the challenges of trying to find a job, to the first experiences within the labour market.

In this article we investigate the employability of physics graduates because there is limited knowledge of STEM students' transition process to work-life, and because the research-intensive study programme of Physics could provide an interesting case. Informed by the literature review, the study approaches employability through the entire transition process from graduation until employment. The aim is to understand how physics graduates perceive their career opportunities and which challenges they meet in their job search. We map where physics graduates find work and identify the challenges that they meet in their jobs, before taking the next step and trying to understand how these challenges affect the graduates' work.

Methodology

Participants

In Denmark, higher education is free of fees. This means that any person who meets the enrolment requirements has the option to be enrolled into a higher education study programme. All students receive a state study grant of about 700 euro per month, which covers basic living expenses.

The graduates studied here are from a single Danish university, with a Master's programme in physics, which is a research-intensive study programme lasting two years. During this time the students complete what corresponds to one year of coursework and one year of research culminating in a Master's thesis. The programme offers a broad range of general physics subjects and students have the opportunity to specialise within the fields of astrophysics, biophysics and geophysics. The students also have the option of qualifying as upper secondary school teachers by choosing courses within didactics. The study programme in physics aims for the majority of the enrolled students to complete both a Bachelor's and a Master's degree before entering the job market. Therefore this study has focused on the transition from a Master's study programme to the job market.

Approximately 60 students graduate from the physics programme each year (The Faculty of Science - University of Copenhagen 2012). The study was limited to those who graduated within the period October 2007 to May 2013, since their experience of the transition to the job market would be relatively new. As the university did not hold contact information on the selected graduates (n=312), only graduates who were accessible via the internet were directly invited to participate in the study (n=252). In order to contact more graduates the project was publicised via social media, and graduates were encouraged to distribute the survey within their networks.

Approach

To tap into both the breadth and depth of physics graduates' experiences and challenges, a mixed-method approach was applied. An online survey was distributed to physics graduates in the summer of 2013. Alongside the survey, 16 semi-structured interviews were conducted with physics graduates in the spring of 2014.

Survey

A questionnaire was developed drawing on existing graduate surveys (Magisterbladet 2011; University of Copenhagen 2010), statistics on physicists' occupations (Andersen and Fox Maule 2002) and a body of literature concerning graduate transitions to the job market (presented in the introduction of this paper). As an example, Hennemann and Liefner (2010) showed that geography graduates lacked important competencies and transferable skills which were demanded in their jobs. This led us to ask physics graduates to report which competencies (both discipline-specific and generic) they had acquired during their studies and which competencies they found were demanded of them in their jobs. In addition, five short pilot interviews were conducted with physics graduates to inform the questions of the survey.

The questionnaire focused on physics graduates' experiences of the transition to the job market and was divided into four themes: physics graduates' reflections on the job market during their studies; their initial experience with the job market and their first job; their experiences and challenges in their current job; and their feedback to the study programme. The questionnaire consisted of 60 questions which were primarily closed in nature. Also background data were collected (sex, age, graduation year, specialisation within physics). The majority of the questions were formatted as Likert scale items with response options on a 5 point scale from *To a high degree* to *Not at all*, with *Do not know* as a sixth option. The graduates were also given the opportunity to respond to four open-ended questions; these revolved around competencies acquired during their studies, the competencies the graduates find they apply in their job and the differences between the two, as well as a question about feedback on the Master's programme.

The questionnaire response rate was 57%. The distribution of the respondents was compared to the distribution of the total population on available parameters: gender, graduation year and specialisation, using Chi-squared tests. The tests showed that on these parameters the distribution did not differ significantly from the distribution of the total population.

Descriptive statistics were used to interpret the survey data. As this study was exploratory, aiming to identify tendencies within physicists' transitions to the job market, the data were analysed according to variables such as gender, specialisation in physics, job type, graduation year, time from graduation to first job etc. The responses to the open questions and the interview transcripts were analysed thematically (Braun and Clarke 2006). This is a qualitative analytic approach which searches for themes in the data as well as variation within these themes. This analysis began by reading the responses and transcripts as a whole, searching for similarities, differences and complementarities and grouping them into themes which then served as a platform for analysis. The guiding questions of the analysis were: When do the graduates experience challenges in their transition; what are these challenges; what are the graduates' experiences of the challenges and how do the challenges influence the graduates' transition process?

Interviews

In the survey the respondents were asked if they were willing to participate in a subsequent qualitative interview study. 47 graduates volunteered. To obtain variation within the group of informants and to ensure diverse narratives of the transition to work life, participants were selected based on their background variables, current job and their experience finding their first job. 40 graduates were invited to participate in an interview, and of these 16 agreed to participate (see Table 1).

The interviews were conducted using a semi-structured interview guide (Kvale, 1996). The interviews were designed to explore the participants' narratives as a complement to the survey results, as well as have the participants elaborate on selected interesting and ambiguous results from the survey. To obtain this the interviews all started with the question 'Please describe what has happened in your life between graduating university and now'. Depending on which themes and subjects the informants touched upon, the interviews took different directions. To collect extensive knowledge about the informants' reflections on their transition the interviewer took on the role of the 'naive interviewer' (Søndergaard, 1996) asking the informant to explain their reflections and thoughts. The interviews lasted between 60 to 90 minutes and were recorded and transcribed verbatim. The participant selected the place of the interview.

Results

In this section we present the physics graduates' perceptions of their job opportunities, the processes by which they searched for jobs and finally the challenges they experienced when entering the job market.

Job opportunities

In the questionnaire, physics graduates were asked which job opportunities they as students had seen as accessible after graduation. The majority (59%) responded that they had had an idea that they could become employed within many different areas (see Figure 1). Few physics graduates had a more specific vision of what their job opportunities were: 15% had an idea about which type of job they could be employed in whereas just 7% of them knew exactly in which positions they could be employed. In the physics graduates' narratives this result was echoed as they struggled to point to exact career opportunities. When asked to characterise a career in physics, the graduates pointed to becoming a researcher as a typical career choice.

The possibility of becoming a PhD student was quite appealing to the graduates as they perceived it to be an opportunity to engage themselves deeply in a specific subject, as they had done in their Master's projects. But at the same time the desire to continue into a PhD position was symptomatic of not knowing about other job opportunities. For example, Daniel explained:

> *To be honest I did not know what else I could do (…) And if you can get them* [the PhD positions] *then it is like a nice and calm way to continue because the road has been paved for you.*

Table 1 Interviewed participants

Pseudonym	Sex	Age	Specialisation	Months from graduation till first job	Finding first job was:	Job
Oliver	M	25-29	General physics	0	Neutral	High-school teacher
Laura	F	30-34	General physics	0	Very easy	PhD student
William	M	25-29	Geophysics	0	Easy	PhD student
Noah	M	25-29	Astrophysics	0-3	Easy	Substitute high-school teacher
Thomas	M	25-29	Astrophysics	0-3	Very easy	PhD student
Alexander	M	30-34	Geophysics	0-3	Very easy	PhD, Geophysicist in public firm
Jacob	M	25-29	Biophysics	3-6	Difficult	PhD student
Emily	F	25-29	Geophysics	0	Very difficult	Geophysicist in private firm
Olivia	F	30-34	Geophysics	0-3	Very easy	PhD student
Charlotte	F	25-29	Geophysics	6-9	Easy	PhD student
Daniel	M	25-29	General physics and mathematics	0	Neutral	Consultant in bank
Lucy	F	25-29	Geophysics	3-6	Difficult	PhD student
Samuel	M	35-39	General physics and philosophy	0	Neutral	PhD, University researcher
Jessica	F	25-29	Biophysics	0-3	Easy	PhD student
Sebastian	M	25-29	General physics	0	Very easy	PhD student
Oscar	M	25-29	General physics	0-3	Very easy	PhD student

The PhD position became a natural career choice for the physics graduates, and some even described a PhD position as a way to postpone the eventual meeting with the job market. As previously described, funding for PhD opportunities within physics has been generous within the last decades in Denmark which has also led physics graduates to view becoming a PhD student as a clearly accessible path.

However, not all physics graduates aspired towards pursuing a PhD, or had the opportunity to do so. If a Ph.D. was not possible or desirable, teaching was articulated as a natural choice. The number of physics graduates who end up teaching in upper secondary school has decreased in recent decades (Andersen and Fox Maule 2002), leading to a high demand for science teachers. As a result the physics graduates knew that they could gain employment as a teacher quite easily. This was regardless of whether or not they had passed the required teacher training courses. While some found the idea of a teaching-career appealing, others saw this as temporary employment until they found the job they really wanted. Others again perceived teaching as a backup plan if anything else should fail. For example, Oscar, a PhD student, explained:

> *Teaching is something I will always have as a safety net (…) That is if everything goes wrong. If my research results just aren't interesting it could result in no funding for employment in the future… Well then you have to… I mean then you sort of have to take it* [a teaching job] *(…) But it is absolutely not something I consider pursuing actively, it is only if it is not possible to stay within research.*

While teaching was perceived as a backup plan by some, most of the physics graduates who entered the position eventually came to find the job interesting.

If neither research nor teaching was perceived to be attractive or possible, the graduates' explained how they considered finding a job as what the participants described as 'a physicist'. However, it turned out that physics graduates experienced difficulties in explaining more specifically what 'a physicist' does, or what positions and organisations they could be employed in. In their narratives they pointed to general job categories such as 'consultant-statistician', 'engineering-like work' and 'work in the private sector'. Oscar, again, elaborates on this:

> *You can be hired to do programming stuff (…) work in various electronics companies or in biotechnology or something like that (…) There is also something like using statistics and modelling for the stock market in banks and financial institutions. I have not really thought about these things but I think that there are quite a few things that you can do.*

In this way the analysis showed a pattern in the physics graduates' career narratives; going into research being the most obvious and straightforward option, followed by going into teaching as a temporary career while trying to figure out where to find work as a physicist, as shown in Figure 2. On the one hand these results may suggest that the career opportunities for physics graduates are quite limited. On the other hand university advertisements for the study programme claim that job opportunities are found within a wide range of industries (University of Copenhagen 2015). And despite struggling to point to specific career opportunities, the physics graduates expressed confidence that their studies gave them access to a wider range of careers leading them to explore opportunities other than research and teaching.

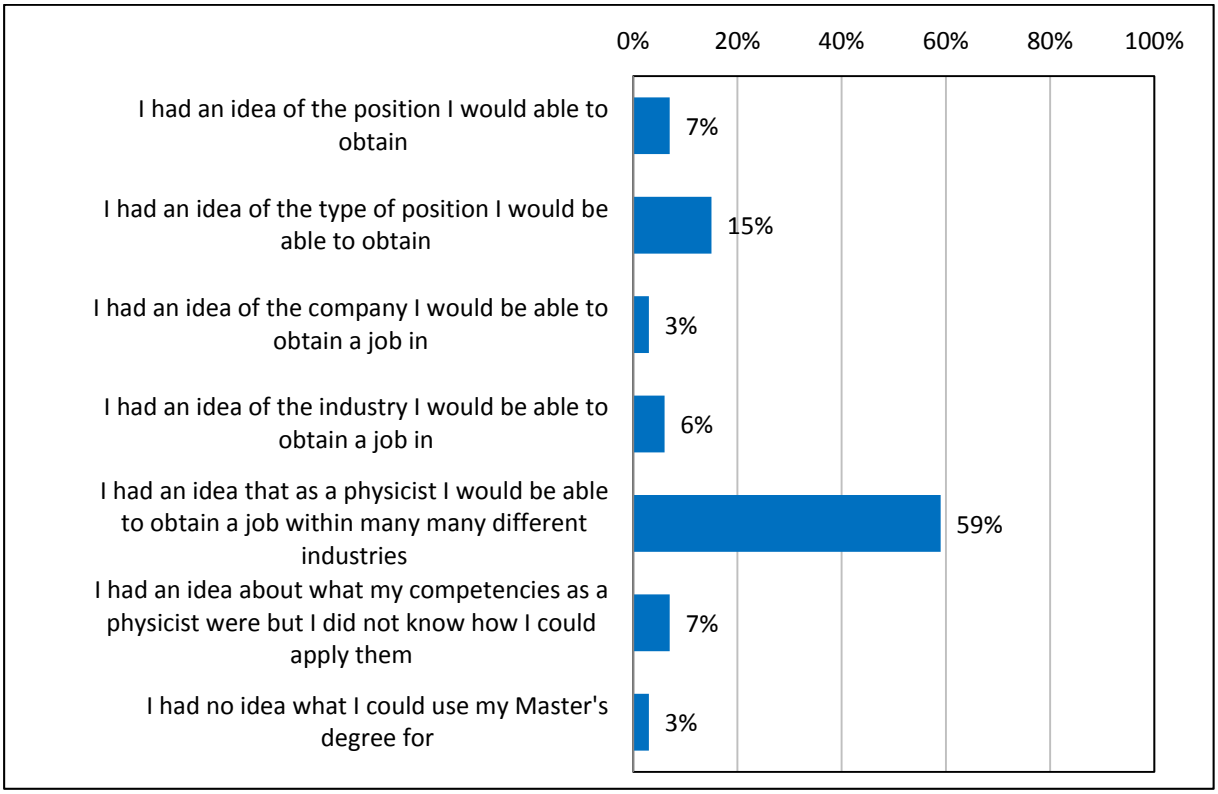

Figure 1 Distribution of graduates' answers to the question 'Which of the options below describes you best regarding how you saw your job opportunities during your Master's programme?'.

Figure 2 The graduates' narratives of career options follow a three step hierarchy.

Finding a job

The physics graduates' limited views of their job opportunities made the process of finding a job difficult. Daniel recalled that in his search for a job he typed 'physicist' in the search field on a job site. To his surprise the only job that showed up was "Mover with good physique". This straightforward, and somewhat naive, way to search for a job was the first approach the graduates applied. But often they realised that finding a job was not that simple. Oliver (who had specialised in theoretical particle physics) frustrated, asked *"I mean, which private companies work with particle physics?"*. While some started rethinking their job search strategy and considered initiatives that could improve their job searching skills, others externalised the problem and declared that relevant companies should take the initiative to gain knowledge about physicists' qualifications, solving the problem of the physics graduates' search for jobs. The graduates' narratives reveal that they first of all did not have any tools for how to approach the job market. Second they were left to figure it out by

themselves, and third as they knew that graduates within physics easily could find a job, the challenges they encountered when finding one, where perceived to be due to the employers deficits rather than their own.

Some physics graduates pointed out the importance of identifying and understanding their own competencies and figuring out where and how these could be applied in the job market. However, when they were asked to describe their competencies, they found it to be challenging. When Laura was asked what her competencies were, she said:

> *Then I honestly have to admit, and this is probably a weakness I share with many others, that I find it difficult to put them into words. If I had to apply for a job right now, other than a research position or high school teacher, then I would find it difficult to describe what I am good at. It would be challenging for me to put into words a set of competencies which I hold.*

This lack of awareness of their competencies meant that the physics graduates found it difficult to match their own competencies with the requirements in the job advertisements. And the graduates who actually had an idea about their qualities found it difficult to explain them to an employer as they found that in many aspects they were generalists rather than specialists and could apply their competencies in a wide range on jobs. As a consequence they found it challenging to construct a narrative about themselves as a part of the company that would appeal to prospective employers.

Interestingly the results indicate that graduates who had had a job during their studies found it easier to secure their first job after graduation, than those students who had not had a job. This tendency was both found for graduates with high and low resemblance between their student job and their first job. This suggests that work experience in itself despite being closely related to the students' field of study provides knowledge and competencies to graduates that allow them to navigate their transition to the job market more easily.

Where do physics graduates go?

Despite the challenges of finding a job, the majority of the physics graduates (88%) actually found their first employment within six months after graduation. At the time of the survey, 50.4% of the physics graduates were PhD students while 15.0% were employed in the education sector (particularly as upper secondary school teachers) (see Table 2). In total, 73.2% of the graduates were employed in the knowledge sector (consulting and research), of whom 13.3% had already finished a PhD at the time of the survey.

Table 2 Distribution of respondents across employment sectors at the time the questionnaire was answered

Sector	Percent of employed physics graduates
Educational sector	**15.0 %**
Knowledge sector – Consulting and research above PhD level – Enrolled as a PhD student	**73.2%** 22.8% 50.4%
Financial sector	**3.1%**
Other industries	**6.3%**
Unemployed	**2.4%**
Total	100 %

Of the remaining graduates, 3.1% were employed in the financial sector (banks, insurance etc.) and 6.3% were employed in various other industries. The survey showed, that 97.6% of the physics graduates were employed, suggesting an overall high employment rate among physics graduates.

A career within research was the most obvious choice to the physics graduates and the numbers also show that embarking on a PhD was a frequent career choice among the graduates. While two-thirds of the physicists had gained a PhD position following graduation, only about one-third of the graduates (36%) continued directly from their Master's programme into the job market.

Challenges in the job

The physics graduates' high employment rates may initially appear to indicate that the physicists meet the demands of the job market. But when asking the graduates about their job experiences they reported challenges with both insufficient discipline-specific competencies and generic competencies.

The physics graduates were asked through an open-ended survey question to describe the competencies they particularly used in their jobs. In their descriptions, programming clearly was highlighted as being a main part of their jobs. Additionally, the graduates were asked to look at a list of both discipline-specific and generic competencies based on the curriculum, and rate to what degree they had acquired the competence during their studies. Between 70% and 84% of the physics graduates replied that problem solving, modelling and using IT were some of the competencies they had gained during their studies (see Figure 3). These numbers and the free-response answers suggest a good consistency between the graduates´ qualifications and their job tasks. However, almost 40% of graduates reported that they lacked knowledge about IT (see Figure 4). This finding was supported in the interviews where the physics graduates explained how they found their competencies to be insufficient for their job. They explained that during their studies they had met a new programming language for every course they followed and had been given pre-made programmes to work with instead of starting from scratch by themselves. As a result, they felt that they had not obtained an in-depth understanding or skills for programming confidently. For example, Emily recalled *"I wasn't really aware of what programming was; when have I made a program and when have I just processed some data?"* The graduates described that in order to make up for their insufficient competencies they had to spend a lot of time to improve their skills both within their work hours and in their leisure time.

Another area in which the physics graduates felt they lacked knowledge was statistics (see Figure 4). In total, 35% of the graduates replied that they *to a high degree* or *to some degree* lacked knowledge about statistics. The graduates had identified possible applications of statistics in their work, but their lack of knowledge and the requisite skills made it difficult for them to apply statistics. This frustrated them, as they perceived it to be a physicists' core competence. For example, as Samuel asked in frustration: "*What kind of physicist are you if you do not know how to do statistics*?"

Lack of generic competencies

While programming and statistics were highlighted in the descriptions of insufficient competencies, the lack of generic competencies was more highly emphasised when the physics graduates' described the challenges they encountered in their jobs. In particular, three generic dilemmas where highlighted in the narratives; finding the balance between immersing

oneself in work while at the same meeting the demands to finish projects within deadlines; figuring out how to work independently, while at the same time being a part of collaborations and teams; and carrying out project management in all parts of work life from smaller assignments to larger projects.

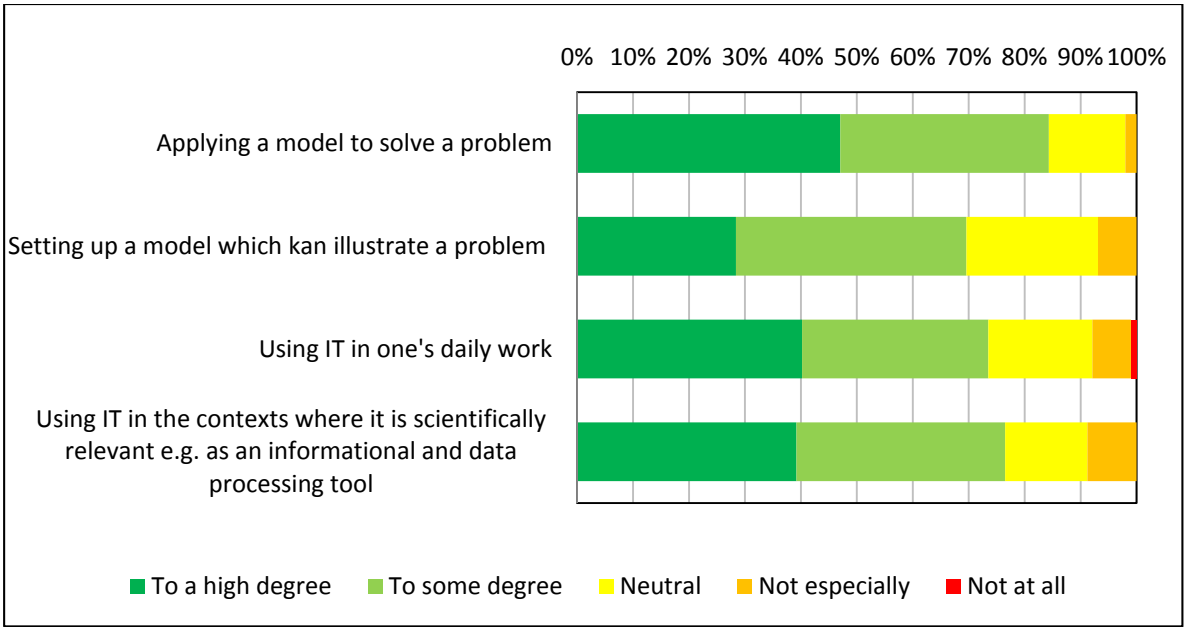

Figure 3 Distribution of graduates' answers to the question 'To what degree did you acquire the listed competencies as part of your Master study programme?'.

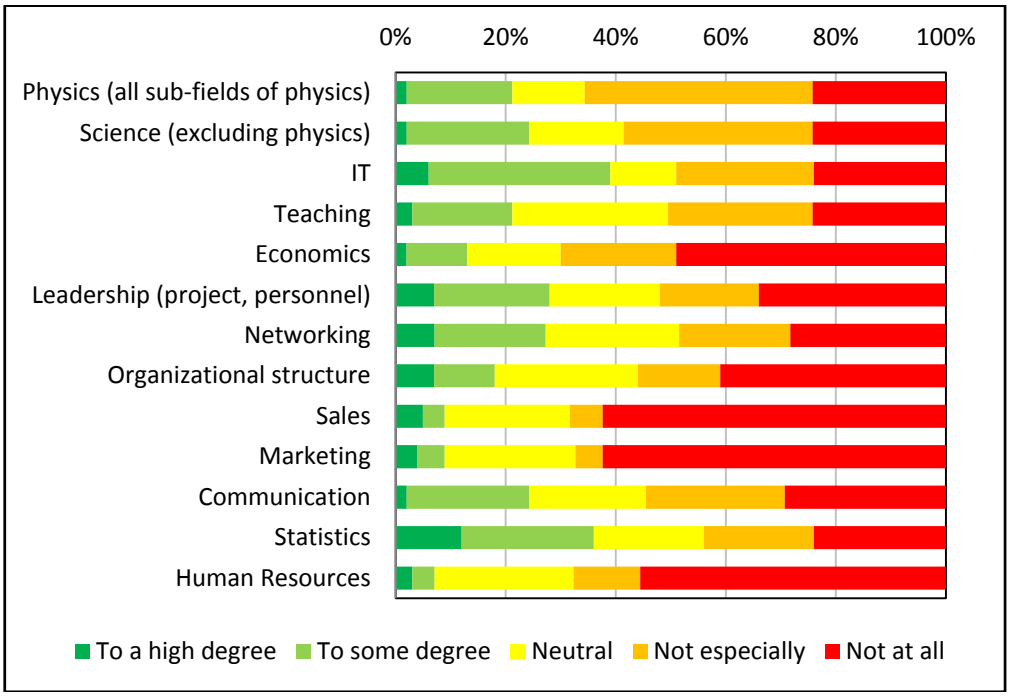

Figure 4 Distribution of graduates' answer to the question 'To what degree, have you felt that you lacked knowledge within the listed areas, in your current/most recent job?'.

The graduates described how they enjoyed engaging themselves with a problem over a longer period of time, just like in their Master's research, and they were seeking to do so in their

jobs as well. Doctoral students pointed to this as the main reason for pursuing a PhD. However, the graduates working outside universities had to work quickly and efficiently and deliver results within short deadlines. They described this pressure to perform as challenging because it meant that they were not able to maintain the standard they preferred. When Emily talked about her first job she said:

> *You work hard until it is 100% done. But sometimes you were in a situation where 80% was what you had to live with. It was difficult for me to accept that I could not do this [the assigned task] exactly as I wanted simply because new tasks kept landing on my desk.*

In this way the graduates felt that they had to make compromises with their work, which led them to feel frustrated and unsatisfied with the tasks they performed.
Teamwork and collaboration were also highlighted as challenging. More than 65% of the physics graduates responded that these competencies were a part of their current job (see Figure 5).

However, while some felt confident in participating in team work, fewer than half of the graduates responded that they had acquired these collaborative competencies during their studies. In the interviews they instead emphasised how they in many cases were used to working alone with their tasks, and that teamwork was challenging. In particular, the biggest gaps between the graduates' competencies acquired at university and the competencies required in their jobs was to work as part of teams with colleagues of other educational backgrounds, to understand their colleagues' reasoning and ways of approaching tasks, and the ability to kick-start teamwork. However, the graduates experienced that having learned to work with colleagues, the facts that others were relying on their work, that they had somebody to spar with, and the feeling of having colleagues that were interested in what they did, were quite rewarding.

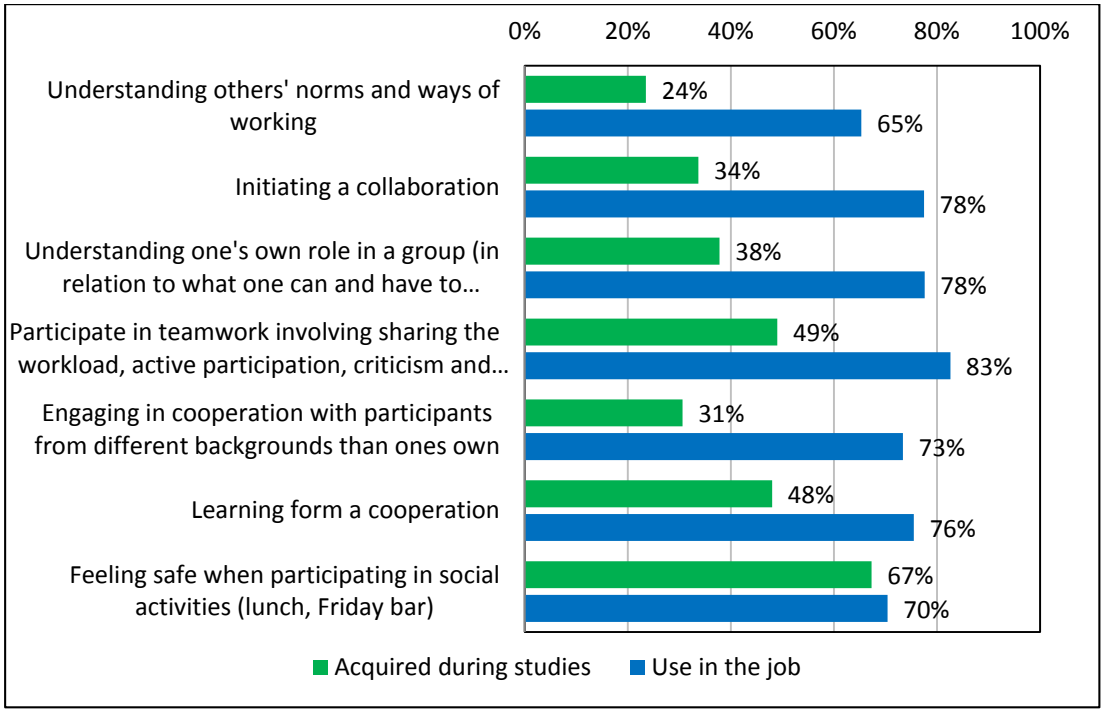

Figure 5 Distribution of graduates' answers to the questions 'To what degree do you: 1) Feel you acquired the listed competencies in the course of your master's programme? 2) Use the listed competencies in your current/most recent job?'.

In both the open and closed questions of the questionnaire, working with and in projects as well as in project management was frequently noted by the physics graduates as being big parts of their jobs. In the closed questions, 88% of the graduates replied that planning longer projects was something they had to do in their job, while only 37% replied that this was a competence they experienced gaining during their Master's studies (see Figure 6). In the interviews the physics graduates expressed their surprise at how much of their job involved project management. For example, Jacob said:

> *I first realised quite late how to apply project management and how much I actually had to do it. Looking back I don't think it was acquired in my studies (...) It has sort of just shown itself like 'Whoops everything is chaos, I have to do something!'*

When the graduates were asked how they handled these challenges that they encountered, some explained how they tried to learn by trial and error, testing out different strategies in the hope that their projects would become more effective by making to-do lists, weekly work-plans, or strict deadlines; others explained that they had given up and now their strategy was to work extra hours in order to catch up on overdue work. And while these different attempts gave the graduates some feeling of control over their projects they still found their lacking competencies to be challenging, influencing all aspects of their job.

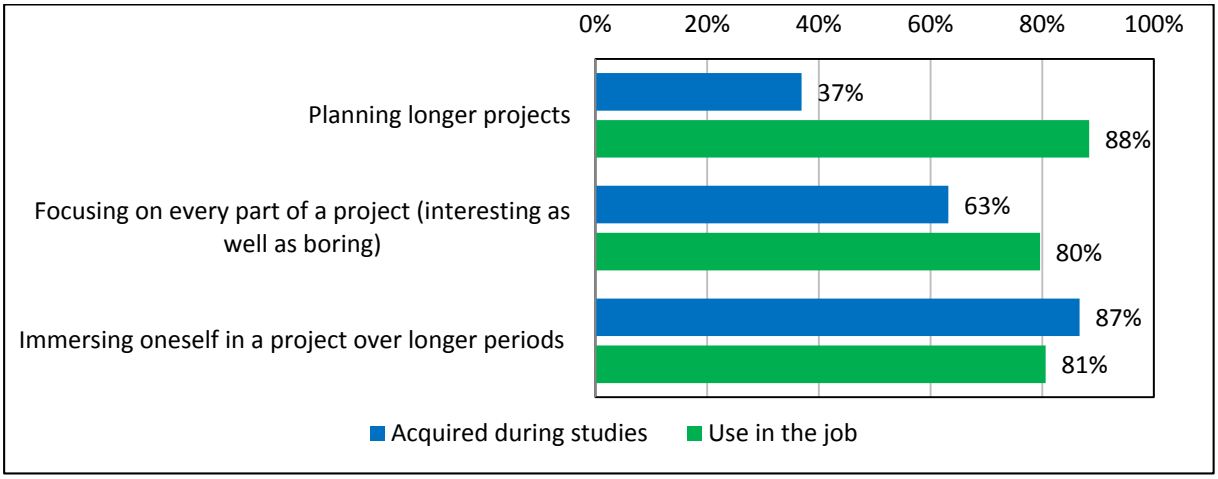

Figure 6 Distribution of graduates' answers to the questions 'To what degree do you: 1) Feel you acquired the listed competencies in the course of your master's programme? 2) Use the listed competencies in your current/most recent job?'.

Discussion and conclusions

This study aimed to understand how physics graduates experienced the transition from university to the job market and to identify the challenges they met. The concept of employability was applied as a way to not only detect the gaps between the graduate and the employee, but also to explore the degree to which these gaps constitute a problem, and to identify which challenges the graduates meet in the transition process from graduating to being employed.

This study showed that physics graduates had limited knowledge about their career opportunities. In their narratives they articulated two obvious career paths: becoming a researcher and becoming a teacher. However, if these paths were found to be either unattractive or unavailable, the graduates struggled to identify other relevant careers. The

limited insights into their career prospects meant that they were challenged in their job search and as a consequence they experienced the process as both frustrating and stressful. This was reinforced by the meta-narrative that gaining a job as a physics graduate would be easy, in line with the prevalent discourse of calls for more scientists. As a consequence of the challenges in identifying relevant jobs, the graduates experienced personal inadequacy. Hasse (2002) showed that physicists possess a strong academic identity, with a clear idea of what a physicist is and can do. This might exacerbate the gap between the graduates' clear expectations of gaining a job as being easy and their actual experience of a range of challenges in the job search. As a consequence, the physics graduates struggled with retaining their academic identity, while feeling challenged and frustrated in the transition to work life. Some of the students began doubting themselves and their capabilities of managing the challenges they encountered. Massive changes in the labour market within the last twenty years have influenced employment patterns, leading to uncertain career paths and a more flexible but also a more insecure job market where lifelong positions belong to the past (Brown et al. 2003; Heery and Salmon 2002). Furthermore a range of jobs have become available for candidates with various qualifications and educational backgrounds (Moreau and Leathwood 2006). In line with this, this study showed how physics graduates discovered that presenting their diploma to a potential employer was not enough to gain a job. Instead they explained how they had to match their competencies to the requirements of the employer and argue why they were the most qualified candidate for a position. The results imply that the graduates' job search strategy might be suitable to the former job market, but that they struggled to meet the requirements of the current situation. First of all they found it challenging to identify their own competencies, and secondly to translate the competencies to different potential jobs. In this way the favourable STEM job market has not supported the graduates in adjusting their strategies.

When entering a job the graduates experienced a number of challenges. A recurring challenge turned out to be lack of discipline-specific and generic competencies. Generic competencies like project management and teamwork were competencies which the physics graduates did not think they had acquired during their studies. This was in contrast to discipline-specific competencies to which they had been exposed. In particular of these, the graduates found their programming competencies to be insufficient. They pointed out how programming was part of the curriculum during their Master studies but that they found it to be insufficient, and hard to transfer from the context of their studies into the cultural context of the workplace. This is in line with the theory of Lave and Wenger (1991), who shows how learning is contextual and that transferring it across contexts requires a lot of the learner. Programming was never introduced in its own right to the physics graduates, but instead was perceived as an implicit part of the physics content. As a consequence the graduates struggled to see the relevance and importance of programming. Also they explained how they had met a new programming language for every course, meaning that they never became familiar with any one particular language and they experienced a lot of confusion. The results suggest that in order to enhance the physics graduates' programming competencies it is important to highlight the purpose and applicability of programming to the students. Moreover, it is important that programming is incorporated into courses as an active tool in relation to the physics content so the physics graduates train the application of programming, rather than programming in itself. This is also the case for the generic competencies. To support the transfer of learning from one context to another, the learner should be presented with various situations where the learning is facilitated. Therefore there is a poor chance that a separate course in programming or project management can solve the challenges alone.

Implication for practice

The Master's study programme could apply a range of initiatives to support graduate employability that range from extracurricular career-oriented initiatives on the one side of the spectrum to initiatives embedded in the curriculum on the other (Knight and Yorke 2002). Examples of extracurricular initiatives that address knowledge of career options are presentations and interactions with alumni physicists, visiting companies who hire physicists, student career counselling, mentor programs and sparring with supervisors etc. However, the physics graduates' challenges were not solely related to career opportunities but also to their awareness of their own competencies, which not only affected their job search but also the quality of their work. Therefore extracurricular initiatives are not enough. The results highlight that an ongoing awareness of the students' learning-process will support the students' awareness of their competencies.

We recommend that educational leaders and teachers of the physics programme enhance student employability through the existing learning and teaching initiatives (lectures, exercises). More specifically the study programme can work actively with formulating clear learning objectives that can be used as a platform for discussing the purpose of the teaching, support the learning process and evaluate the competencies achieved. In this way the students will take an active part in reflecting on their competencies during courses. This of course calls for teaching activities to facilitate a learning process that supports such reflection and maybe even puts student learning in the centre.

This study shows, that if students are taught to become more aware of their competencies during their studies it will both support the graduates in recognising potential job opportunities, and also in applying their competencies in the job.

This study applied a mixed method approach to study graduates' transition experiences. There is potential for future research to apply qualitative longitudinal qualitative methods that over time follow and explore how students' learning-processes evolve during their master studies and how students' awareness of their competencies can be supported by various teaching and learning activities.

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