Future physician-scientists: let's catch them young! unravelling the role of motivation for research

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Summary

In *chapter 1*, we set the stage for the research conducted within this thesis. Medical education should contribute to delivering future physicians that are able to use research in order to practice evidence-informed decision making. However, physicians conducting research are needed as well. These physician-scientists are in the unique position to connect practice and research, and are thereby important to make advancements within the medical field. Currently, the medical field is facing a physician-scientist shortage and the need to identify how medical training could contribute to cultivating future physician-scientists inspired the main focus of this thesis: provide insights into the role early phases of medical education could play in developing future physician-scientists, by unravelling the role of motivation for research and extracurricular research programmes. These insights could help to shed light on practical implications and determine possibilities for interventions to enhance motivation for as well as involvement in research, both intra- and extracurricular. As previous research showed that involvement in research during medical training is related to further research involvement during professional practice, first steps to foster the future physician-scientist workforce could well be made early on in medical education.

In *chapter 2* we identified levels of intrinsic and extrinsic motivation for research among first-year medical students. Furthermore, we examined factors influencing their levels of research motivation at the start of medical training. We administered a questionnaire within the first three months of the medical bachelor programme. Students reported their intrinsic motivation for research, extrinsic motivation for research, self-efficacy beliefs, perceptions of research, curiosity, and need for challenge on a 7-point Likert scale. Out of the 316 approached students, 315 participated in this study (99.7%). On average, students scored 5.49 on intrinsic, and 5.66 on extrinsic motivation for research. Self-efficacy beliefs, perceptions of research, curiosity, and need for challenge were all positively associated with intrinsic and extrinsic motivation for research, also after adjusting for gender and age. These constructs together explained 40% of the variance in intrinsic motivation for research, while only explaining 14% of the variance in extrinsic motivation for research. The findings from this study imply that first-year medical students enter medical training motivated for research. Furthermore, motivation for research could be enhanced by stimulating positive self-efficacy beliefs, positive perceptions of research, and curiosity. In addition, it is important to identify

students with a need for extra challenge, as they could be stimulated to fulfil this need by conducting research.

In *chapter 3* we identified conditions under which students develop positive perceptions of and motivation for research, by using a grounded theory approach to elucidate how first-year medical students perceive research and which factors contribute to motivation or demotivation to conduct research. We conducted individual interviews with 13 purposively sampled first-year medical students. This study revealed that first-year medical students differed greatly in their perceptions of and motivation for research. However, they were able to identify many aspects of research, thereby showing a broad perspective of what conducting research entails. Among other things, students mentioned acknowledgment, autonomy, and inspiring role models as motivating factors. Lack of autonomy, lack of relevance, and inadequate collaboration, on the other hand, were labelled as demotivating. Our findings were partly in line with some major motivational theories, like the Self-Determination Theory (SDT). In line with the SDT, our findings implied that autonomy, relatedness, and competence are important in influencing motivation for research. Additionally, relevance, need for challenge, curiosity, and inspiring role models were identified as positively influencing motivation for research. In order to motivate students for research, it therefore seems important to create research environments in which these motivating factors are stimulated, for instance by providing students with choices within their research. In addition, our results suggested a relationship between perceptions of and motivation for research, as some perceptions were identical to motivating or demotivating factors to conduct research, like the relevance of research for practice and performing statistics respectively. As our results suggested that perceptions of research are related to motivation for research, this offers possibilities for interventions to promote motivation for research through students' perceptions of research.

In *chapter 4* we had the aim to examine if medical students' motivation for research is related to actual research involvement. In addition, we distinguished intrinsic and extrinsic motivation for research to investigate if type of motivation mattered in the relation between research motivation and research involvement. We conducted a prospective cohort study in which students filled in a questionnaire at the start of medical training, reporting on intrinsic motivation for research, extrinsic motivation for research, self-efficacy beliefs, perceptions of research, and curiosity on a

7-point Likert scale. One year later, students involved in research were identified. Research involvement was operationalised as 1) participating within the research-based Honours programme of Leiden University Medical Center, or 2) conducting extracurricular research outside of the Honours programme. A total of 315 out of 316 approached students participated (99.7%), of whom 55 were identified as involved in research (17.5%). Our results suggested that students with higher levels of intrinsic motivation for research were more often involved in research, also after adjusting for gender, age, extracurricular high-school activities, self-efficacy beliefs, perceptions of research, and curiosity. Higher levels of extrinsic motivation increased the odds of research involvement, however after adjusting for the above mentioned factors the effect of extrinsic motivation for research on research involvement disappeared. In addition, the effect of intrinsic motivation for research remained after adjusting for extrinsic motivation for research, whereas the effect of extrinsic motivation disappeared after adjusting for intrinsic motivation for research. Thus, our findings showed that extrinsic motivation for research did not contribute on top of intrinsic motivation for research. Our findings suggest that type of motivation matters and particularly intrinsic research motivation influences research involvement. This is in line with the SDT, stating that intrinsic motivation is of better quality. Therefore, intrinsic research motivation could be targeted to stimulate research involvement and could be seen as a first step towards success in fostering the physician-scientist workforce. Subsequently, within our following studies we shifted towards investigating how in particular intrinsic motivation for research could be enhanced during early phases of medical education.

In *chapter 5* we examined if success experiences within an undergraduate course in academic and scientific skills increased intrinsic motivation for research and research self-efficacy beliefs among medical students. Furthermore, we elaborated on type of success experience as we studied the effects of academic success experiences within standard (i.e. written exam) and authentic (i.e. written research report and oral presentation) assessments. Regarding this secondary aim, we hypothesized that authentic assessments influence intrinsic motivation for research and self-efficacy beliefs to a larger degree than standard assessments, as the authentic assessments mirror real-world practices of researchers. To answer our research questions, students following an obligatory course in academic and scientific skills, in which they conducted research individually, were included in this study. Their academic success experiences were operationalised as their grades on two authentic research

assessments (written report and oral presentation) and one less authentic assessment (written exam). We surveyed students before the course when entering medical school (i.e. baseline measure) and one year after the course in their second year (i.e. post-measure). Both at the baseline and post-measure surveys, we measured intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy beliefs. In total, 243 out of 275 students participated within this study (88.4%). Our findings suggested that, after adjusting for motivational baseline scores, age, gender, and GPA of the first four months prior to the obligatory research course, only an academic success experience in orally presenting one's research is related to an increase in both intrinsic motivation for research and research self-efficacy beliefs. Higher grades on the exam did not affect intrinsic motivation for research or research self-efficacy significantly. Thus, our findings imply that an academic success experience within a research course could be related to enhancing intrinsic motivation for research and self-efficacy beliefs, however, authentic assessment is important. In particular presenting your own research seems to be a good way to enhance intrinsic motivation for research and research self-efficacy beliefs, which in turn promotes research involvement. Furthermore, this study established the applicability of the Social Cognitive Theory in a research context within the medical domain.

In *chapter 6* we expanded the success experience perspective by perceiving publishing research as a form of experiencing research success. The aim of this study was to examine the relationship between academic publishing during medical education and post-graduation publication careers. In total, 4145 graduates receiving their degree between 2005 and 2008 from all eight Dutch university medical centres were included in the current study. These students were matched to their publications indexed in the Web of Science, published between 6 years before and 6 years after graduation. For sensitivity analysis both automatic assignment on the whole group and manual assignment on a 10% random sample was performed. Our findings showed that students who had published before graduation were almost two times as likely to publish after graduation, published more papers, and had a slightly higher citation impact after graduation. These results cautiously suggest that successful early involvement in research could influence long-term research involvement among medical graduates.

Chapter 7 is a commentary, in which we elaborate on motivation for research among medical students as preparation for their residency. Our key message within this

commentary is the importance of acknowledging the dynamic character of motivation for research. From our studies, it seems that mainly intrinsic motivation for research should be targeted. However, we do think it is important to acknowledge the possibility that extrinsically motivated students can become intrinsically motivated for research along the way. Intrinsic motivation for research is, according to our studies and the SDT, related to better outcomes. Nonetheless, according to SDT, one can shift on the motivation continuum and a process of internalization could take place. This corroborates the idea that extrinsic motivation could indeed turn into intrinsic motivation. Within this chapter we discussed that students might start participating in research because of extrinsic motivators, like for instance conducting research to secure a competitive residency spot, but that these same students could become intrinsically motivated while becoming more and more familiar with research. Through research involvement, students for instance might as well discover their own talents and research competencies, which could then contribute to enhancing intrinsic motivation for research.

In *chapter 8* we described the research-based Honours programme of Leiden University Medical Center, an initiative to engage future physicians into scientific research in early stages of medical training. Our programme starts in the second year of medical training and is comprised of four different tracks (i.e. MD/PhD track, Journey into Biomedical Sciences track, Clinical Research/Epidemiology track, and Free Research track), sharing the common goal to involve students in research. As a result of the unique multiple-track model, attracting diverse students with varying interests, the programme accommodates about 50-70 students (25% of the entire cohort) each year. The programme has a duration of two years, and is mainly based on self-selection without very strict institutional criteria. To get a certificate for this programme, students need to obtain 30 extra credits (ECTS, i.e. European Credit Transfer and Accumulation System, which means that students have to invest 30 x 28 hours of active study). At the same time, they have to obtain 180 regular ECTS for their three-year Bachelor programme with a grade point average (GPA) of at least 7 on a 10-point grading scale. Internationally, this programme could be seen as an extracurricular research programme, which are believed to play a possible important role in cultivating future physician-scientists.

In *chapter 9* we reported on the role of grades in selecting students for an extracurricular research programme, by comparing students with lower and higher

previous academic performance on subsequent academic performance, extracurricular research programme performance, and motivational factors (i.e. intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity). Within a prospective cohort study, students filled in a yearly questionnaire on the motivational factors. Two groups participating in an extracurricular research programme were compared: students with first-year GPA ≥7 versus <7. Students in the <7 group had a significantly lower third-year GPA and significantly higher odds for drop-out from the extracurricular research programme. Students in the <7 group did, however, obtain their bachelor degree in the same amount of time and were not inferior to the ≥7 group in terms of intrinsic motivation for research, perceptions of research, and curiosity. Intrinsic motivation for research, perceptions of research, and curiosity are all factors underlying research involvement in future professional practice. Therefore, if the pre-eminent goal of extracurricular research programmes is to develop physician-scientists, our findings imply that it seems beneficial to shift from an emphasis on selecting solely based on grades towards selection based on a combination of grades and non-cognitive criteria, such as motivation.

In *chapter 10* we aimed to identify effects of an extracurricular research programme. Previous studies into the effects of extracurricular research programmes are mainly retrospective, lacking baseline measurements and control groups. Therefore, we conducted a prospective study with a longitudinal design, sound baseline measurements, and a comparable control group to investigate the effects of our extracurricular research programme. Ideally, one would aspire a randomized controlled trial (RCT) in order to examine the effects of the extracurricular research programme, dividing students who expressed interest in the programme in a participating and a non-participating group at random. However, as randomization is not possible here, we tried to mimic an RCT by comparing students starting the extracurricular research programme to students that have showed interest in the extracurricular research programme, but eventually decided not to participate, on academic achievement (i.e. in-time bachelor completion, bachelor GPA) after two years and motivational factors (i.e. intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity) after 18 months. Furthermore, we adjusted for potentially relevant baseline differences to make the groups as comparable as possible. Our findings suggested that starting in the extracurricular research programme is positively related to in-time bachelor completion. Furthermore, starting the extracurricular research programme was related to higher levels of intrinsic motivation for research,

also after adjusting for gender, age, first-year GPA, and motivational baseline scores. No effect was found on research self-efficacy beliefs, perceptions of research, and curiosity. As previous research suggested that intrinsic motivation is related to short- and long-term research engagement, the extracurricular research programme may be seen as an important first step into the physician-scientist pipeline.

Chapter 11 is a theoretical essay in which we tried to connect our research to theory and expand our theoretical view on the SDT by including an authenticity framework to shape undergraduate research experiences and promote student wellbeing. We elaborated on the importance of authentic undergraduate research experiences, while using Wald and Harland's three definitions of authenticity: 1) authenticity as relating to the real word (e.g. learning mirroring the real world), 2) the existential authentic self (e.g. developing self-identity and feelings of ownership to become an independent learner), and 3) a degree of personal meaning (depending on wat students deem important on a personal level). Based on these definitions and the proposed authenticity framework, we discussed ways to design higher education curricula in such ways that learning spaces are inclusive and foster wellbeing. This could be achieved through promoting autonomy, competence, and relatedness as proposed by SDT and by stimulating social connectedness between students and mentors as well as students and peers.

In *chapter 12* we tried to connect our research to practice by proposing twelve tips to offer students the experience to conduct research individually as part of the core curriculum. Most medical schools educate large numbers of students at the same time, especially in early phases of medical training. Large scale education on the one hand and individually providing students with authentic experiences on the other hand is considered not that easy to achieve. Therefore, building on our own experiences, existing literature, and theories we proposed the following twelve tips to design and implement a course in which authentic individual research experiences can be provided to a large group of undergraduate students: 1) provide an experiential opportunity by involving students in every stage of the scientific research process, 2) provide authentic research experiences with real patient data and opportunities to answer relevant clinical research questions, 3) distribute data collection over all students to make it feasible within a short course, 4) stimulate curiosity with relevant clinical examples, 5) give students autonomy in conducting their own research project, 6) provide research experiences to students in large

as well as smaller group sessions, 7) use the smaller group sessions to scaffold the research processes, 8) use inspiring researchers as teachers of the small group sessions, 9) implement peer discussion within the course, 10) let students disseminate their work by writing a professional academic piece, 11) let students orally present or display their final work, and 12) include different types of assessment and provide feedback on both the report and presentation.

In *chapter 13* we discussed our reflections on the findings from the studies described in the previous chapters, in order to provide insights into the impact early phases of medical training may have on cultivating future physician-scientists. We elaborated on the role of awareness and intrinsic motivation for research, discussing that in order to stimulate young medical students to acknowledge the possibility for a physician-scientist career and subsequently pursue this career path, our studies altogether suggest that three overarching topics play an important role: awareness, motivation, and opportunity. As our results showed that even the first-year students are already aware of the importance of research for clinical practice and that they enter medical education motivated for research, in line with the title of this thesis we believe that we could indeed 'catch students young'. Furthermore, we elaborate on ways to stimulate intrinsic motivation for research according to existing theoretical perspectives and our research findings, the role of extracurricular research programmes within medical training (i.e. the 'opportunity'), and the dynamic character of motivation for research, resulting in practical implications for medical training in general and practical implications for exposing students to research opportunities. Practical implications for medical training in general are: 1) connect research to practice, 2) expose students to inspiring scientific role models, 3) spark students' curiosity, 4) identify students with a need for extra challenge, and 5) expose students to research opportunities during early phases of medical training. In addition to the twelve tips as proposed in chapter 12, practical implications for exposing students to research opportunities are: 1) offer students the chance to work on their research learning goals and mastery of research activities, 2) make extracurricular initiatives widely accessible for medical students in early phases of medical education, 3) target unrealistic perceptions of research, 4) let students apply statistics to authentic research questions, 5) let students experience autonomy and the ability to work independently, 6) provide students with opportunities to learn from and rely on an experienced research mentor, 7) promote feelings of social connectedness, and 8) implement authentic assessment of students within research courses.