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INVESTIGATIONS

Academic Success Experiences: Promoting Research Motivation and Self-Efficacy Beliefs among Medical Students

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ABSTRACT

Theory: Medicine is facing a physician-scientist shortage. Medical training could contribute to developing physician-scientists by stimulating student research involvement, as previous studies showed this is related to research involvement in professional practice. Motivation for research and research self-efficacy beliefs are related to student research involvement. Based on social cognitive theory, success experiences in doing research may enhance research motivation and self-efficacy beliefs. However, the role and type of success experiences in promoting research self-efficacy beliefs and motivation especially early in medical training has not yet been investigated. Therefore, we examined if academic success experiences within an undergraduate course in academic and scientific skills increased research motivation and self-efficacy beliefs among medical students. Furthermore, type of success experience was taken into account by looking at the effects of academic success experiences within standard (i.e., exam) versus authentic (i.e., research report and oral presentation) assessments. *Hypotheses:* It was hypothesized that academic success experiences increase intrinsic motivation for research and self-efficacy beliefs. Furthermore, 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. *Method:* First-year undergraduate medicine students followed a course in academic and scientific skills in which they conducted research individually. Their academic success experiences were operationalized 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 1 year after the course in their 2nd year (i.e., postmeasure). Both the baseline and postmeasure surveys measured intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy beliefs. Linear regression analyses were used to examine the relationship between academic success experiences and intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy beliefs on the postmeasure. We adjusted for prior research motivation and self-efficacy beliefs at baseline. Therefore, this adjusted effect can be interpreted as an increase or decrease in motivation. In addition, we adjusted for age, gender, and grade point average (GPA) of the first 4 months, as these variables were seen as possible confounders. *Results:* In total, 243 of 275 students participated (88.4%). Academic success experiences in writing and presenting research were related to a significant increase in intrinsic motivation for research. After adjusting for prior GPA, only the effect of presenting remained. Experiencing success in presenting enhanced research self-efficacy beliefs, also after adjusting for prior GPA. Higher grades on the exam did not affect intrinsic motivation for research or research self-efficacy significantly. Also, none of the success experiences influenced extrinsic motivation for research. *Conclusions:* Academic success experiences on authentic research tasks, especially presenting research, may be a good way to enhance intrinsic motivation for research and research self-efficacy beliefs. In turn, research motivation and self-efficacy beliefs promote research involvement, which is a first step in the physician-scientist pipeline. Furthermore, this study established the applicability of the social cognitive theory in a research context within the medical domain.

KEYWORDS
Motivation; physician-scientist workforce; self-efficacy; social cognitive theory; undergraduate research

Introduction

The medical field is currently facing a global physician-scientist shortage. A decrease in interest among medical graduates to pursue a continued research career combined with an aging physician-scientist workforce is noted in the United States, Canada, and Europe.[1–7] Consequently, serious concerns have been raised regarding the future of academic medicine.

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Physician-scientists devote a substantial amount of their professional time to both clinical care and research.[8] Consequently, physician-scientists have the unique ability to identify relevant clinical problems that can be translated into adequate research questions and designs. At the same time, these physician-scientists take a leading role in the translation and implementation of research outcomes into clinical practice.[9–14] Therefore, physician-scientists are believed to be key in bridging the gap between science and clinical practice, and thus for making advancements within the medical domain.

The question of how to train and retain the physician-scientist workforce is much discussed the past few decades.[1,8,13,15–17] One of the mentioned possible solutions is to engage medical students in research during early phases of medical training.[1,4,18–20] Furthermore, in general, engaging medical students in research is needed to deliver graduates with an academic mindset who are able to use research in clinical decision-making, thereby practicing evidence-informed medicine. The importance of developing academic skills has been underlined by many medical educational frameworks and accrediting bodies.[15,21,22] To this end, many research-related courses within or on top of the curriculum are emerging within medical school.[18,23,24] These research-related courses and programs could contribute to students' ability to use research in future daily clinical practice and may help to enhance their motivation to engage in research and, in turn, to pursue a research-oriented career[1,6,25]

Motivation has been researched from various theoretical perspectives. Self-determination theory (SDT) describes two types of motivation: intrinsic motivation (i.e., involvement in an activity out of pure interest or enjoyment) and extrinsic motivation (i.e., involvement in an activity because it is rewarding, with the rewards being external in nature). Intrinsic motivation is believed to be of better quality, as it promotes better academic performances, deep learning, and general well-being among individuals. Thus, SDT advocates that intrinsic motivation should be stimulated to reach these desired outcomes.[26,27] However, regarding extrinsic motivation, it is important to mention that a process of internalization could take place, referring to "taking in a behavioral regulation and the value that underlies it."[28(p.333)] Selective application of external rewards can lead to increased feelings of autonomy and ultimately intrinsic motivation.[28]

According to Bandura's social cognitive theory (SCT), mastery of an activity and experiencing success within an activity are related to higher self-efficacy beliefs and motivation. SCT focuses on task- or domain-specific self-efficacy, which can be defined as the belief someone has in being able to accomplish a certain task. This means that successfully performing a task can foster positive self-beliefs about the ability to accomplish that task. In turn, this can motivate people to perform the task more frequently. Thus, success experiences lead to positive self-efficacy beliefs, which in turn can reinforce future behavior.[29]

Within the context of undergraduate research, this could mean that a success experience within a research-related course may contribute to medical students' research self-efficacy beliefs and intrinsic motivation for research. If this is indeed the case, evidence-based strategies could be implemented to promote research-based success experiences among undergraduate students. As motivation for research is related to research involvement during medical school,[30] which in turn is related to research involvement in professional practice,[31] the first steps to fostering graduates with an academic mindset, or even future physician-scientists, could be made early on in medical training.

However, the role and type of success experiences in promoting research self-efficacy beliefs and intrinsic motivation for research, especially early in medical training, have not yet been investigated. Some previous studies did focus on how medical students can be motivated for research, but these studies mainly focused on later clinical phases and did not examine the role of academic success experiences.[1,32,33] Additionally, studies directly examining research success while studying the impact of different types of success experiences are absent. Investigating the role and type of direct research-related success experiences could offer important implications for designing and implementing interventions to promote research engagement.

Therefore, the aim of this study is to examine if an academic success experience within an obligatory research course relates to an increase in motivation for research and research self-efficacy beliefs. Furthermore, this study investigates if the possible effect of a success experience differs when the type of assessment is taken into account, looking at standard (i.e., written exam) versus more authentic (i.e., written report and oral presentation) assessments. We hypothesized that authentic, domain-specific assessments such as a written report and oral presentation influence intrinsic motivation for research and research self-efficacy beliefs to a larger degree than standard assessments such as an exam, as the authentic assessments mirror real-world practices of researchers and aligns with SCT's task or domain specificity.

Methods

Design and participants

This prospective cohort study is part of a larger longitudinal study that is currently running, in which one cohort of medical undergraduates is followed through medical school. All students who started their 1st year of medical training in 2016 at Leiden University Medical Center (LUMC) were asked to participate in this study and invited to fill in a questionnaire (Appendix A) each year. The first request to fill in a questionnaire was at the start of medical school in 2016. Students were asked to fill in the same questionnaire in all consecutive years of medical training. Furthermore, grades of every participating student before the research-related course were obtained. In the present study, all students who participated in both the first and second survey were included. Thus, participants were surveyed before the course when entering medical school (i.e., baseline measure) and 1 year after the course in their 2nd year of medical training (i.e., postmeasure) to measure intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy beliefs on both time points.

Context

The LUMC is one of eight medical faculties in the Netherlands providing students with medical training. All faculties are comparable in the structure of their educational program with 6 years of undergraduate medical study, divided in a 3-year program leading to a bachelor's degree and a subsequent 3-year program leading to a master's degree in medicine. All eight faculties developed and implemented their educational program in line with the Dutch National Blueprint for Medical Education, which is based on the Canadian Medical Education Directives for Specialists (CanMEDS) and the U.S. Accreditation Council for Graduate Medical Education (ACGME) Core Competencies.[21,22,34]

At the start of the second semester, the LUMC offers 1st-year students a mandatory course on academic and scientific skills, in which all students individually conduct a short 2-week research project by (a) gathering and processing patient data, (b) formulating their own research question, (c) analyzing data, (d) writing a research report, and (e) presenting their research to teachers and other students.[25,35] To scaffold this process, students follow three in-depth workgroup sessions led by the same teacher. Students are assessed in a standard way with an exam (focusing on statistical and epidemiological knowledge predominantly), representing 60% of the eventual grade for the course. Furthermore, students are assessed in a more authentic way, as they write a research report and orally present their research, both accounting for 20% of the eventual course grade. The research report and presentation are graded with a rubric (Appendix B) by their workgroup sessions teacher. These teachers are PhD candidates or physician-scientists. Before the start of the workgroup sessions, the teachers attend a briefing for information on the content of the sessions and on grading students' written report and oral presentation.

Materials and definitions

Motivation for research and research self-efficacy were measured with a questionnaire that was based on existing and validated scales.[30] Motivation for research was measured with two scales: Intrinsic Motivation for Research, which was based on five items of the Interest/Enjoyment Scale of the SDT questionnaires, and Extrinsic Motivation for Research, which was based on four items of the Value/Usefulness Scale of the SDT questionnaires.[26,36] Because the SDT scales focus on an activity in general, we adjusted these scales with a focus on research activities. For instance, one item of the Interest/Enjoyment scale of the SDT was "This activity is fun to do," which we have adjusted to "Doing research is fun." Furthermore, the Perceived/Usefulness scale consists of items such as "I think that doing this activity is useful for . . . ." We filled in the blanks and made one of our items: "I think doing research is useful for my resume." Also, we made sure to take the medical education setting into account. For instance, as can be found in previous studies, one of the most important extrinsic motivators is securing a competitive residency spot. As the SDT questionnaires did not originate within the medical education setting, we critically evaluated the existing items and adjusted them when deemed necessary. One of the items in the original scale is "I think this activity could help me to . . . ," which we adjusted to "I think doing research improves my chances for my preferred residency spot." As a result, the Intrinsic Motivation for Research scale measured the degree of wanting to be or being involved in conducting research out of interest or enjoyment, and the Extrinsic Motivation for Research scale measured the degree of wanting to or being involved in conducting research, because it is rewarding, for example, to secure a competitive residency spot.

Research self-efficacy was defined as beliefs that students have regarding their ability to conduct research. The Research Self-Efficacy scale, consisting of three items, was self-developed and inspired by the Dutch General Self-Efficacy Scale and the Academic Efficacy Scale.[37,38] For example, the Academic Efficacy Scale contains, among others, the item "I am certain I can master the skills taught in class this year," which inspired one of our items in the research self-efficacy scale: "I feel I master the skills to do research." Students were asked to score the scale items on a 7-point Likert scale ranging from 1 (*totally disagree*) to 7 (*totally agree*).

Academic success experiences were operationalized as the grades students obtained on the mandatory course on academic and scientific skills in the 1st year of medical training, in which students individually conducted clinical research within an authentic setting. Students received a grade on their exam; a grade on their written report, including delayed written feedback after 2 weeks; and a grade on their oral presentation, including direct oral feedback. Within this study, grades were seen as a proxy for academic success experiences, and higher grades were believed to represent more positive academic success experiences among students.

Procedure

After adjusting the existing motivational scales and developing the Research Self-Efficacy Scale, the questionnaire was translated from English to Dutch by using the forward and backward translation procedure. The questionnaire was pretested on medical students from a different cohort, who were at that time 2nd-year medical students, leading to a few minor adjustments to two items. All 1st-year medical students of the targeted cohort were approached in the first semester of the 1st year of medical training in 2016. They were asked to complete the questionnaire during a scheduled workgroup session (T1 baseline measure; November 2016). In the second semester of the 1st year, students followed the obligatory course in which they individually conducted clinical research (January 2017). The students were approached again with the same questionnaire in the first semester of their 2nd year of medical training (T2 postmeasure; January 2018).

At both T1 and T2, students were informed that the study investigated scientific training during medical school. The students were notified that participation was completely voluntary and that all data would be processed anonymously. Furthermore, they were asked their consent to link data from both questionnaires and to gather data regarding the obtained grades of participating students. Students followed three courses that were not related to research (e.g., cell biology) before following the course on academic and scientific skills (January 2017). The grades of these prior courses were used to operationalize students' grade point average (GPA) of the first 4 months. The study was approved by the ethical review board of the Netherlands Association for Medical Education (reference number 952).

Analysis

We used descriptive statistics to report age and gender of the included students. To estimate the reliability of the scales, we calculated Cronbach's alpha. We calculated mean scores for intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy. We applied mean substitution for missing values if students answered more than 70% of the items on a scale (applied in 1.7% of the students). Furthermore, we calculated students' GPA of the first 4 months by calculating a mean score of the grades obtained in the three courses prior to the scientific course in the 1st year. If students missed one of the three grades, we applied mean substitution for missing values (applied in 3.7% of the students). To assess if an academic success experience within scientific education leads to an increase in motivation for research and research self-efficacy, we performed linear regression analysis with success experience (i.e., grade for the exam, presentation or report, analyzed in separate linear regressions) as the independent variable and motivation or research self-efficacy in the 2nd year (i.e., T2) as the dependent variable. We adjusted for the scores that students had on motivation for research and research self-efficacy at the start of medical training (i.e., T1 baseline scores), so this adjusted effect can be interpreted as an increase or decrease in motivation. Within this relationship, we wanted to adjust for multiple possible confounders, one of which is prior GPA. To avoid interfering within the causal path, only the GPA before the start of the course in which academic success experiences were examined could be included, which is the GPA of the first 4 months of medical training. Furthermore, we adjusted for age and gender. We present 95% confidence intervals (CIs) and consider $p < .05$ as statistically significant. We analyzed all data using IBM SPSS Statistics version 23.

Results

Of the 275 students, 243 participated in both the first (T1) and second (T2) survey and were thus included in this study (88.4%). This study consisted of 57 male (23.5%) and 186 female (76.5%) participants. Students had a mean age of 19.7 years ($SD = 1.1$). Mean scores of students on intrinsic motivation for research, extrinsic motivation for research, and research self-efficacy beliefs on both time points, as well as the Cronbach's alpha of the scales, can be found in Table 1.

Intrinsic motivation for research

Linear regression analyses showed that an academic success experience on the exam was not related to higher levels of intrinsic motivation for research ($\beta = .059$, $p = .170$), 95% CI [−.025, .143], whereas an academic success experience on the oral presentation ($\beta = .115$, $p = .022$), 95% CI [.017, .214], and research report ($\beta = .114$, $p = .022$), 95% CI [.017, .211], were significantly and positively related to an increase in intrinsic motivation for research. However, after adjusting for the T1 baseline scores, age, gender, and GPA of the first 4 months, only an academic

Table 1. Mean scores of students on baseline measure (T1) and postmeasure (T2), reliability and sample items of the scales.[a]

	T1 Mean (SD)	T1 Cronbach's α	T2 Mean (SD)	T2 Cronbach's α	Sample item
Intrinsic Motivation (5 items)	5.52 (.69)	.76	5.29 (.81)	.80	Doing research is fun.
Extrinsic Motivation (4 items)	5.65 (.78)	.76	5.61 (.89)	.82	I think doing research improves my chances for my preferred residency spot.
Research self-efficacy (3 items)	4.86 (.93)	.87	4.75 (.97)	.86	I feel I am competent enough to do research.

Note: Based on a 7-point Likert scale from 1 (*totally disagree*) to 7 (*totally agree*).
[a]$n = 243$.

Table 2. Cumulative linear regression model of the effect of a success experience in an exam, oral presentation, or written research report within an obligatory research course during the 1st year of medical training on levels of intrinsic motivation during the 2nd year of medical training.

	Intrinsic Motivation (T2)				
	Crude	Adjusted for T1 baseline scores	Idem + age	Idem + gender	Idem + GPA 4 months
Exam, β [95% CI] p, R^2	.059 [−.025, .143] .170, .008	.041 [−.037, .119] .300, .156	.044 [−.034, .123] .264, .161	.043 [−.036, .121] .283, .164	.002 [−.088, .092] .966, .177
Presentation, β [95% CI] p, R^2	.115 [.017, .214] .022, .024	.128 [.037, .218] .006, .190	.128 [.038, .218] .006, .193	.123 [.032, .214] .008, .195	.099 [.001, .197] .049, .202
Report, β [95% CI] p, R^2	.114 [.017, .211] .022, .024	.090 [.000, .180] .050, .175	.090 [.001, .180] .048, .179	.085 [−.006, .176] .066, .182	.058 [−.037, .154] .339, .192

Note: Idem = with every step in the regression model, one confounder is added on top of the variables specified in the previous line; GPA = grade point average.

Table 3. Cumulative linear regression model of the effect of a success experience in an exam, oral presentation or written research report within an obligatory research course during the 1st year of medical training on levels of extrinsic motivation during the 2nd year of medical training.

	Extrinsic Motivation (T2)				
	Crude	Adjusted for T1 baseline scores	Idem + age	Idem + gender	Idem + GPA 4 months
Exam, β [95% CI] p, R^2	.020 [−.075, .115] .680, .001	−.010 [−.095, .075] .822, .216	−.012 [−.097, .073] .776, .220	−.009 [−.094, .076] .827, .229	−.043 [−.141, .054] .384, .236
Presentation, β [95% CI] p, R^2	−.029 [−.142, .083] .606, .001	−.029 [−.128, .071] .570, .221	−.029 [−.129, .070] .559, .225	−.020 [−.120, .081] .701, .232	−.046 [−.153, .061] .399, .238
Report, β [95% CI] p, R^2	.011 [−.099, .122] .838, .000	.003 [−.094, .101] .944, .220	.003 [−.095, .100] .958, .224	.012 [−.086, .111] .807, .231	−.007 [−.111, .097] .895, .236

Note: Idem = with every step in the regression model, one confounder is added on top of the variables specified in the previous line; GPA = grade point average.

success experience on the oral presentation remained significant (β = .099, p = .049), 95% CI [.001, .197]. An overview of the cumulative regression model of intrinsic motivation can be found in Table 2.

Extrinsic motivation for research

Academic success experiences were not significantly related to an increase in extrinsic motivation for research (Table 3).

Research self-efficacy beliefs

Linear regression analyses showed that academic success experiences on the exam and research report were not related to an increase in research self-efficacy (β = .043, p = .408), 95% CI [−.060, .147], and (β = .057, p = .343), 95% CI [−.061, .175], respectively, also after correcting for the T1 baseline scores, age, gender, and GPA of the first 4 months (β = .059, p = .276), 95% CI [−.048, .166], and (β = .063, p = .270), 95% CI [−.050 − .176], respectively. Academic success experience in orally presenting research was not significantly related to research self-efficacy on its own (β = .099, p = .104), 95% CI [−.020 − .218]. However, after adjusting for the T1 baseline scores, age, gender, and GPA of the first 4 months, an academic success experience on the oral presentation was significantly related to an increase in research self-efficacy (β = .122, p = .039), 95% CI [.006, .237]. An overview of the cumulative regression model of research self-efficacy is presented in Table 4.

Discussion

In line with our hypotheses, our results suggest that academic success experiences in writing a research report and orally presenting research are related to an increase in

Table 4. Cumulative linear regression model of the effect of a success experience in an exam, oral presentation or written research report within an obligatory research course during the 1st year of medical training on levels of research self – efficacy during the 2nd year of medical training.

	Research Self – Efficacy (T2)				
	Crude	Adjusted for T1 baseline scores	Idem + age	Idem + gender	Idem + GPA 4 months
Exam, β [95% CI] *p*, R^2	.043 [−.060, .147] .408, .003	.056 [−.037, .148] .235, .206	.063 [−.029, .155] .180, .222	.064 [−.028, .156] .170, .224	.059 [−.048, .166] .276, .224
Presentation, β [95% CI] *p*, R^2	.099 [−.020, .218] .104, .012	.113 [.006, .220] .035, .209	.114 [.008, .220] .035, .226	.121 [.014, .228] .027, .229	.122 [.006, .237] .039, .229
Report, β [95% CI] *p*, R^2	.057 [−.061, .175] .343, .004	.063 [−.043, .169] .244, .198	.065 [−.041, .170] .228, .215	.070 [−.036, .176] .195, .218	.063 [−.050, .176] .270, .218

Note: Idem = with every step in the regression model, one confounder is added on top of the variables specified in the previous line; GPA = grade point average.

intrinsic motivation for research among undergraduate students. However, after adjusting for students' GPA of the first 4 months, only the effect of a success experience in orally presenting research remained. Furthermore, our results show that after adjusting for the T1 baseline scores, age, gender, and GPA of the first 4 months, a success experience in orally presenting research contributes to increasing research self-efficacy beliefs in the 2nd year of medical school. A higher grade on the exam does not affect motivation for research or research self-efficacy, and none of the measured success experiences influence higher levels of extrinsic motivation for research.

A higher grade on the exam had no influence on motivation for research or research self-efficacy beliefs among students. This could be because an exam is not part of the process of conducting research and mainly focuses on knowledge instrumental to conducting research. Thus, an exam is a less authentic way to assess students' research performances. Success experiences within more authentic assessments such as a written report or oral presentation, however, seem to affect intrinsic research motivation and research self-efficacy. Although overall average intrinsic motivation for research and research self-efficacy beliefs did not noticeably change from baseline measure (T1) to postmeasure (T2), differential outcomes (i.e., increased or decreased motivation and self-efficacy) resulting from differing levels of academic success experiences may account for this apparent lack of change.

An academic success experience in writing a research report, on its own, influenced students' intrinsic motivation for research, but it did not seem to affect their research self-efficacy beliefs. A possible explanation could be that students enjoy writing a research report but also find it difficult. Indeed, a previous qualitative study showed that students perceive writing as a fun but difficult part of conducting research.[39] Subsequently, it could be that writing a research report does not contribute to students' feelings of competence in conducting research. Furthermore, the possibility for dialogue is crucial for the uptake of feedback among students.[40] Within the course, students received written feedback on their report after about 2 weeks, without engaging in a feedback dialogue with teachers or peers. This could be a barrier to student uptake and understanding feedback, which may impact students' self-perceived learning outcomes. In turn, this could explain why the grade and feedback on the research report did not contribute to an increase in research self-efficacy beliefs.

After adjusting for student GPA of the first 4 months, the crude effect of success experiences in writing a research report on intrinsic motivation disappeared. The GPA in the first 4 months could well be a confounder in the relation between success experiences in writing a research report and intrinsic motivation for research, as it may influence both the grade on the written report and intrinsic motivation for research. This would imply that "excellent" students perform better, displaying both better academic performance and higher levels of motivation. An explanation could be that high grades at the start of medical training contribute to positive general and academic self-efficacy beliefs, which in turn may be related to further academic performance and motivation.[29,33] Associations between GPA and research-related parameters are not uncommon; for instance, a study by Hren and colleagues showed an association between higher GPA and attitudes toward research.[41]

Contrary to the writing success experiences, success experiences in orally presenting research were positively related to both intrinsic motivation and research self-efficacy, also after adjusting for GPA of the first 4 months. Why would successfully presenting research enhance both intrinsic motivation and research self-efficacy among undergraduate students? According to Merrill, learning is especially promoted when students have the opportunity to discuss or defend new knowledge.[42] Orally presenting research suits this goal and contributes to feelings of ownership. Presenting research outcomes is a fundamental part of conducting research, which is also recognized by students.[43] Nonetheless, students in this course perceived presenting as a challenging and exciting task, for which they were quite nervous. They feel great relief when they conclude their presentation and receive direct feedback on their performance. This feedback immediately provides them with some sense of how they performed, which is very important and could contribute to their enhanced research self-efficacy beliefs and researcher identity.[31,43] Furthermore, presenting research in front of a critical audience and receiving feedback allows students to observe their own progress, which is very motivating as well.[42]

Where the feedback on the report usually lacks opportunities for interaction, giving an oral presentation is well suited for feedback dialogue. This dialogue not only promotes student uptake of feedback but also encourages elaboration and further thinking on research-related content among students.[40,43] This is in line with the social cognitive career theory (SCCT), which to a large extent builds on SCT and proposes that social interactions are important for strengthening self-efficacy beliefs. According to SCCT, verbal persuasive communications (i.e., verbal encouragement) play a crucial role in enhancing self-efficacy beliefs and forming positive outcome expectations.[44] Our finding that mainly presenting one's research contributes to enhanced research self-efficacy beliefs and intrinsic motivation for research could thus be clarified through this perspective as well, as verbal communication and encouragement is common during or after an oral presentation.

Viewing our results through the lens of SCCT also provides some important implications for cultivating research self-efficacy, and in turn intrinsic motivation for research, among students from minority groups. SCCT states that background characteristics (i.e., race or sex) both influence and interact with the type of learning experiences to which one is exposed. In shaping how, for instance, students see themselves, these background characteristics play an important role, as they elicit responses from the environment.[44] Among other things, this could mean that research self-efficacy beliefs and intrinsic motivation for research could decrease if ethnic minority groups receive implicit signals of disapproval during their oral presentation. However, as the population within our study is quite homogeneous, further research is needed to examine this perspective.

Last, none of the success experiences affected extrinsic motivation for research. Perhaps these young medical students did not connect success experiences within a 1st-year research course with the possible rewarding character of conducting research for future career prospects, for instance to secure a competitive residency spot. This is in line with findings by Rosenkranz and colleagues that students in the clinical years of medical training agreed that conducting research is advantageous for their medical career.[32]

To summarize, in line with SCT, an academic success experience within an obligatory course does seem to relate to the development of higher levels of intrinsic motivation for research and research self-efficacy among undergraduate students. However, the type of assessment should be taken into account, as the effect of a success experience is present only when using authentic assessments, such as writing a research report or giving an oral presentation. This underpins the importance of authentic assessment methods, strongly related to aim of and learned content within the course. Type and timing of feedback should be taken into account as well, as experiencing success in orally presenting research with direct feedback dialogue seems to have the greatest influence on both intrinsic motivation and research self-efficacy beliefs among students.

Our results provide some implications for practice. Many medical schools offer research-related courses to medical students, though in many different forms (e.g., both obligatory and voluntarily).[1,31] If the preeminent goal is to deliver graduates with an academic mindset who are, for instance, able to practice evidence-informed decision-making and/or to cultivate future physician-scientists, it seems valuable to promote academic success experiences during undergraduate research courses and to assess students' research-related performance in an authentic manner. Our findings suggest that particularly orally presenting and justifying their own research is a good method and assessment format to both monitor students' performance and increase intrinsic motivation for research and research self-efficacy beliefs early in medical school. In turn, this could contribute to students' engagement in research later in medical school and future professional practice.[1,30,31] In a wider perspective, our results imply that choosing the assessment type in such a way that it is directly connected to a success experience is of great value within education to increase student motivation and self-efficacy beliefs. To conclude, our study also contributes to theory building, as it showed the applicability of SCT in a research context within the medical domain with real-world data.

Limitations, strengths, and future research

First, our research was conducted within one institute. Furthermore, our cohort consisted of a homogeneous and largely female population with participants of a young age. This could impact the generalizability of our findings. However, the medical curriculum of our institute, the male/female distribution, and the mean age are comparable with other medical curricula in the Netherlands. All the curricula are based on the same framework (Dutch National Blueprint for Medical Education). Moreover, this framework is aligned with the CanMEDS and ACGME Core Competencies. In addition, many medical schools provide students with research experiences during medical training.[1,45] Although the way medical schools do this may depend on the national (i.e., school system) and local (i.e., medical school) context, we do believe that our findings are generalizable in the sense that research skills are generic skills that can be taught to students throughout various stages of medical school. Finally, we used oral presentations and research reports as research-authentic proxies for success experience. These forms of assessment may very well be used in other educational contexts as well.

Second, we did not ask students about their success experiences directly. Instead of relying on self-reports, we relied on student grades as a proxy for an academic success experience. This can be seen as an objective yet indirect measure for an academic success experience. Additional research could focus on how students perceive grades as success experiences and how this varies among students. Nonetheless, we do believe that a higher grade always reflects a better feeling among students, which is fostered by including grades as a continuous variable in our analysis. Moreover, high grades can be seen as mastery experiences as stated by SCT.[29]

Third, as this was an observational and not a randomized controlled study, it could be that there are some unmeasured confounders in the relation between an academic success experience and research motivation or self-efficacy beliefs. However, building on theory and previous studies, we do believe that we included the most important confounders. Furthermore, we adjusted for a sound baseline measurement of research motivation and self-efficacy beliefs as measured at the start of medical training, 2 months before the research-related course.

For future research it would be interesting to qualitatively explore students' perceptions of success experiences within a research-related course and how these perceptions influence their intentions to do research in their future career. Furthermore, it would be valuable to monitor how motivation for research and self-efficacy beliefs develop during medical training and how a series of subsequent, research-related courses (perhaps both obligatory and voluntarily) with increasing levels of difficulty affect motivation, self-efficacy, and the development of a researcher identity among future physicians.

Conclusion

In line with SCT, we verified our hypothesis that academic success experiences within a research course are related to increased intrinsic motivation for research and research self-efficacy beliefs among undergraduate medical students. However, type of assessment seems to play an important role, as the effect is present only when using authentic assessment methods, in particular oral presentations of the conducted research. Therefore, we argue that orally presenting research during a research course is a good way to both assess students' performance and stimulate intrinsic motivation for research and research self-efficacy beliefs in early phases of medical training. Subsequently, this may stimulate student engagement in research during medical training and in future professional practice and may provide possibilities to counteract the decline in the physicians-scientist workforce.

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Conflicts of interest

The authors have no conflicts of interests.

Ethical approval

Approved by the ethical review board of the Netherlands Association for Medical Education, reference number 952.

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Appendix A. Questionnaire scales

Motivation for research

1. Doing research is interesting.
2. Doing research is fun.
3. Doing research is challenging.
4. I like solving puzzles and problems.
5. I am able to develop myself by doing research.
6. I think doing research is useful for my resume.
7. I think that doing research could help me to distinguish myself from others.
8. I think that doing research could help me to get a good job in the future.
9. I think doing research improves my chances for my preferred residency spot.

[Intrinsic motivation for research: Items 1–5 / Extrinsic motivation for research: Items 6–9]

Research Self-Efficacy

10. I feel I am good in doing research.
11. I feel I am competent enough to do research.
12. I feel I master the skills to do research.

Appendix B. Rubrics for grading presentation and report

			Presentation											
			Design (max 5x2 points)					Content (max 5x2 points)					Strengths	Points for improvement
nr	student name	student-number	a	b	c	d	E	a	b	c	d	E		
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														

Design (0/1/2 points per category)**:**

a. Time management: in time + distribution of time within presentation.
b. Quality of slides: readability, clear, not too full, etc.
c. Structure: opening, introduction, question, method, results, discussion (relating findings to literature and/or discussing limitations of the research), conclusions.
d. Orientation toward audience: eye for public, intelligible, clear argumentation.

E*maximum of 1 or 2 extra points*
**judgment of design is formative and does not count for the grade of the presentation*

Content (0/1/2 points per category):

a. Research question results from introduction in a logical manner.
b. Method is clearly described to understand the results.
c. Main results (as an answer to the research question) are discussed correctly.
d. Interpretation: going beyond just mentioning the main results – scientific caution, limitations, elaborating on results in light of what is previously studied, implications for practice, conclusions. Within the given time it is not feasible to discuss every aspect mentioned here, however some aspects need to be elaborated on.

E*maximum of 1 or 2 extra points*
**judgment of content is summative and is used to grade the presentation*

			Report												
			Design (max 5x2 points)					Content (max 5x2 points)					Strengths	Points for improvement
nr	student name	student-number	a	b	c	d	E	a	b	c	d	E		
1														
2														
3														
4														
5														
6														
7														
8														
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10														
11														
12														
13														

Design (0/1/2 points per category)**:**

a. Size and balanced structure: about one page and two tables or figures. Every part has enough space, three references are included.
b. Text lay-out is sufficient: margins, paragraphs, and tables are all clear.
c. Structure: opening, introduction, question, method, results, discussion (relating it to literature and/or limitations of the research), conclusions.
d. Language use: academically written in correct Dutch.

***E**maximum of 1 or 2 extra points*
**judgment of design is formative and does not count for the grade of the report*

Content (0/1/2 points per category):

a. Introduction is a clear argumentation that works toward the research question. Three references are used adequately within this section.
b. Method is clearly described in order to replicate the study if needed (in line with a scientific article).
c. Results section provides a clear picture of the main results. Tables and/or figures are clear and relevant.
d. Discussion section puts findings in perspective while elaborating on previous research, gives implications for practice and a clear conclusion as an answer to the research question. This is a hard part for students, so keep in mind that it does not need to be perfect.

***E**maximum of 1 or 2 extra points*
**judgment of content is summative and is used to grade the report*