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STEM students' career choice for teaching: studying career choice processes using personal projects

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ABSTRACT

Understanding how teaching interest and motivation develop during the academic STEM (science, technology, engineering, and mathematics) study program is essential to design effective interventions to increase teacher recruitment. This article describes a new approach to study STEM teachers' career choice processes. The retrospective method, which is based on personal projects analysis, focuses on the career choice process of STEM teachers during the academic study program as well as on their current personal values and goals, and the interconnection between these two. Evaluation took place in a small-scale explorative study with recently graduated STEM teachers. The results illustrate that the methodology provides insight into STEM teachers' career choice processes in a personally salient and ecologically valid way. The use of personal projects provides structure and focus, but also enables large-scale data collection. Therefore, this research methodology could be positioned to complement survey studies and narrative inquiry.

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Science teacher education; career choice; personal projects analysis; STEM students; STEM teachers

1. Introduction

In many countries there are serious concerns about maintaining an adequate supply of good-quality teachers, especially in school subjects where there is high demand, such as mathematics and science (OECD 2005). More specifically, more than half of the European education systems are reporting teacher shortages in STEM (science, technology, engineering, and mathematics) subjects (Eurydice 2018). In order to develop effective interventions for the recruitment of good-quality STEM teachers, it is essential to understand which processes guide their career choices.

Teachers in higher secondary education are subject specialists, and in many European countries (e.g., the United Kingdom [UK], the Netherlands, and France) as well as in Australia, teacher education follows a consecutive route. This means that students first pursue their academic subject studies and take a professional course in education after completing their academic degree (Eurydice 2012). Most academic STEM students initially choose their study program because of interest in the academic subject and not with the purpose of becoming a secondary school teacher (Aschbacher, Li, and Roth 2010). One could hypothesize that STEM students start their academic studies because of interest in

the academic subject, and for those who become teachers at the end, interest or motivation for teaching has been developed.

Understanding how interest and motivation for teaching originate and develop, and how this interest and motivation could be stimulated and fostered during the academic STEM study program, is expected to contribute to the design of more effective interventions and routes towards a career in teaching. Generally, two types of research methods are employed to study motivation for teaching: large-scale survey studies and small-scale narrative inquiry (Heinz 2015). The advantage of survey studies is the generation of large sets of standardized data, which allow extensive comparative analysis (Watt and Richardson 2007; Watt et al. 2012). Survey studies provide insight into existing motivations of teacher trainees and teachers, but they provide a momentary take and no insight into development processes, unless they are administered during a prolonged period (Manual and Hughes 2006). Furthermore, standardized questions do not reveal any personal nuance underlying the career choice processes. Small-scale narrative inquiry is more suitable to capture the dynamics of the career choice process, also in retrospective (Bergerson 2009; Pike and Dunne 2011; Holmegaard 2015; Prabjandee 2020). Narrative inquiry gives ample space for personal stories and context, but the open nature does not provide much structure, which makes interpersonal comparison an elaborate task while the coding process poses a risk of researcher's interpretations. In order to study the development of interest and motivation for teaching during the academic STEM study program, a method was desired which combines the strengths of both survey studies and narrative inquiry.

A methodology which is conjointly personally salient and interpersonally comparable could bridge the gap between survey studies and narrative inquiry. For such demands, Little (1983) introduced personal projects analysis (PPA). In this methodology, personal projects are the basic units of analysis of individual participants and provide a structuring framework to enable analysis across a group of participants (Little 2007). A personal project is an activity that is significant for the person pursuing it, extended in space and time, contextually embedded within one's life and encompassing interrelated actions led by an intentional sequence of behavior. PPA provides an open-source, multimodular, and flexible research methodology with personal projects as basic analytic units (Little and Gee 2007).

The goal of this study was to develop a methodology to describe and evaluate career choice processes of STEM teachers during the academic study program, which generates personally salient and ecologically representative results, and also allows comparative analysis. To achieve this, the original PPA methodology was redesigned in such a way that personal projects related to the academic subject study and the career choice for teaching are chronologically and retrospectively elicited. The research question of this study is: to what extent does the redesigned PPA for studying Career Choice for Teaching (PPA-CCT) methodology provide personally salient and ecologically representative insights into the process of STEM teachers' career choice for teaching?

2. Conceptual framework – personal projects analysis

2.1. The construction of personal projects and the methodology of PPA

Personal projects were proposed by Little (1983) as units of analysis that uniquely capture features of individuals and the context in which they act. Personal projects are personally

salient because they are significant for the person pursuing them and influenced not only by stable and dynamic personal and contextual features, but also by the behavior of the person in context (Little 2000, 2005, 2007). Furthermore, personal projects are integrative because they result from cognitive, affective, and behavioral aspects of human actions (Little 2000, 2005). Personal projects therefore contain rich information about a person in context. Examples of personal projects are *exercise regularly*, *study for exams*, *teach at an exam institute*, *see friends*, etc.

The first step in personal projects analysis is the elicitation of personal projects. This is done by asking participants to generate a list of personal projects that are representative of their life context. The generated personal projects provide information about the participants and their personal context. In addition, personal projects can be categorized and analyzed with respect to their nature, number, diversity, interaction, etc. In the next step of PPA, the list of personal projects is narrowed to about 10 personal projects, for example by selection of the most important personal projects or thematic selection, such as work- or health-related projects. In PPA, participants are regarded as experts in their own life space, and it is assumed that the processes participants use in funneling personal projects are those that they use in everyday life (Little and Gee 2007).

This selection of personal projects is then evaluated by the participants, the so-called 'project appraisal'. The resulting evaluation of personal projects, such as *exercise regularly*, *study for exams*, *teach at an exam institute*, *see friends*, etc., can be analyzed at the individual level (person-centered measurement) or at the level of normative, comparative analysis (variable-centered measurement) (Little and Gee 2007). In general, people experience more well-being when their personal projects are more meaningful, manageable, positively connected with others, and associated with more positive than negative affect (Little and Coulombe 2015).

In the hierarchy between lower-order (such as activities and behavior) and higher-order (values and goals) aspects of human behavior, personal projects are middle-level constructs, and relate to activities and behavior as well as values and goals (Presseau et al. 2008; Little and Coulombe 2015). The hierarchical analysis module of personal projects analysis employs a laddering technique to link the middle-level personal projects to activities and behavior, which are lower in hierarchy, as well as to goals and values, which are higher in hierarchy. Access to higher-order goals and values is provided by *why-laddering*, which is done by iteratively asking *why* individuals are engaged in each of their projects (Little and Coulombe 2015). Access to lower-order activities and behavior is provided by *how-laddering*. Hierarchical mapping of the interrelation between specific activities and higher-level goals and values results in a so-called goal system (Shah and Kruglanski 2008). Janssen and coworkers (2013) proposed the use of goal systems as practical and useful mental representations for teachers in order to understand, explain, predict, and influence their own behavior, especially concerning the practical implementation of pedagogical innovations (Janssen et al. 2013; Westbroek, Janssen, and Doyle 2017).

Figure 1 illustrates how different research data are generated for an exemplary personal project *teach at an exam institute*. In the appraisal module, the project itself is assessed by the participant based on dimensions which are of interest to the researcher. Particular activities and behavior related to this personal project are revealed by asking questions such as 'How are you going to teach at an exam institute?' In this case, these are activities like *master subject knowledge*, *prepare effective lessons*, *address students' problems*, etc. Personal values and goals

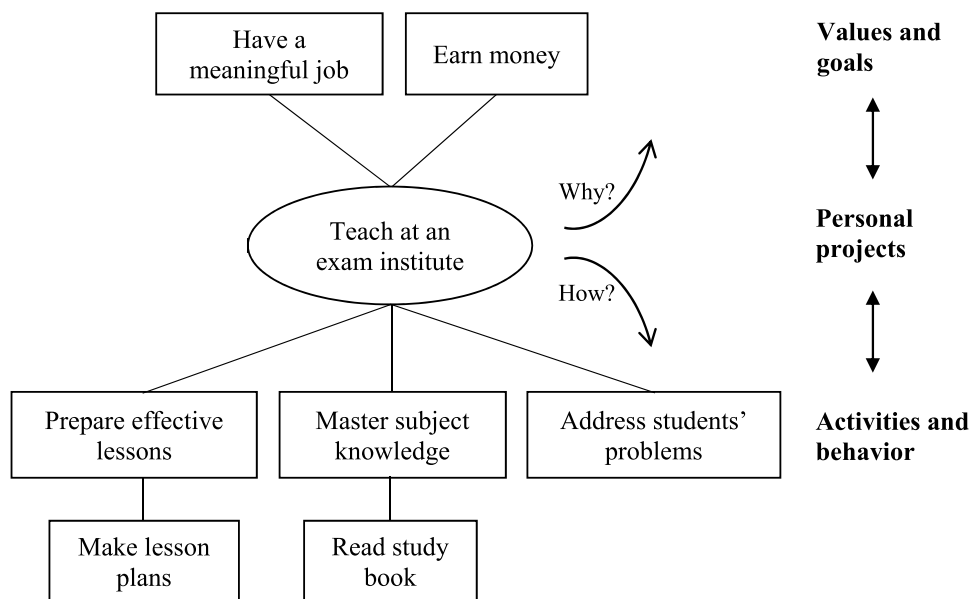


Figure 1. Illustration of the rich information of a person in context enclosed in a personal project. The personal project ‘teach at an exam institute’ can be evaluated using a list of dimensions related to meaning, manageability, connection, and affect (so-called Appraisal). By asking ‘how’ and ‘why’ questions, hierarchical laddering takes place revealing information about daily activities and engagements as well as personal values and goals.

related to the personal project *teach at an exam institute* are revealed by asking why-questions which might lead to answers like *have a meaningful job*, *earn money*, etc. What follows is that the impact of values and goals on particular behavior can be understood from personal projects.

The PPA methodology originated from a combination of personality and social psychology and has been adopted in various fields of social and behavioral sciences, such as psychology (e.g., clinical, health), management, public policy, and other applied settings (Little and Coulombe 2015). The modular structure and the open-ended nature of PPA allow adaptation of modules and dimensions to fit specific research questions, which makes it a flexible research methodology (Presseau et al. 2008).

2.2. Redesigning Personal Projects Analysis to study Career Choice for Teaching (PPA-CCT)

In order to describe and evaluate career choice processes of STEM teachers, the original PPA methodology was redesigned into a retrospective PPA methodology. Two aspects of the career choice for teaching were considered significant to gain insight into the development of interest and motivation for teaching:

- The academic study program, starting with the choice for an academic study in science or mathematics at the end of secondary school, and ending with the choice for teaching as a career.

- The teacher's current appreciation of teaching as a profession, as an indication for motivation for teaching.

Taking into account these two aspects of the career choice for teaching, a stepwise and structured framework was designed to elicit and describe the career choice process of STEM teachers during the academic study program.

The resulting personal projects analysis to study Career Choice for Teaching (PPA-CCT) methodology consists of three interview phases, which are schematically illustrated in Figure 2. The first interview phase concerns the academic study program and the activities and experiences that resulted in the choice of teaching as a career. In this phase, personal projects are elicited retrospectively and chronologically in two consecutive steps. First, the formal study program is elicited in chronological order, starting from secondary school until the first teaching job to make up a personal timeline. In the next step, personal projects are elicited that either positively or negatively affected the choice for

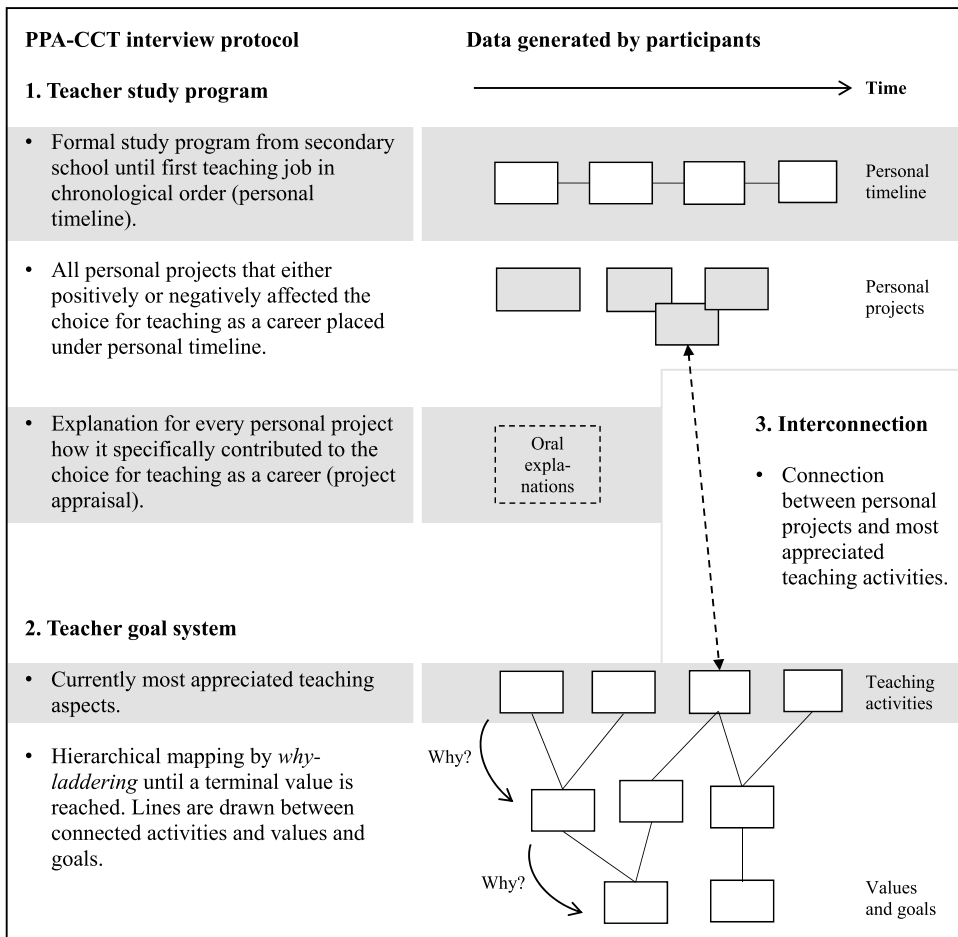


Figure 2. Schematic overview of the structure of the PPA-CCT methodology. All blocks represent a sticky note containing text generated by the participant.

teaching as a career and are placed onto the personal timeline. Examples of such projects could be *tutoring activities*, *giving sports training*, *following specific academic courses*, etc. In the next step, each of these personal projects are appraised by the teacher's explanation of how they specifically affected the choice for teaching as a career.

In the second phase of the interview, current motivations for teaching are elicited using hierarchical analysis. A teacher is asked which aspects of being a STEM teacher he or she appreciates most. These most appreciated teaching aspects (for example, *working with colleagues*, *development of teaching materials*, *flexibility*, etc.) are defined as personal projects. Subsequently, hierarchical mapping of these personal projects by *why-laddering* results in a teacher goal system revealing high-level personal values and goals related to teaching as a profession.

In the third and final phase of the interview, it is evaluated whether and how the currently most appreciated aspects of the teaching profession are related to personal projects that affected the choice for teaching as a career during the academic subject study. This is further elaborated in the method section.

In summary, the PPA-CCT methodology aims to describe the saliency of the career choice process in a concise and interpersonally comparable format. The methodology focuses on the role of personal projects affecting the choice for teaching as a career during the academic study program and the teacher's current motivation for teaching. Furthermore, it makes a connection between these personal projects and the motivation for teaching. In this small-scale explorative study, it was explored to what extent the PPA-CCT methodology provides insight into the process of career choice for teaching by STEM teachers by assessing the methodology on two criteria: (1) whether it generates personally salient and ecologically representative results, and (2) whether it allows comparative analysis of the results.

3. Method

3.1. Context of the study

The study was conducted in the Netherlands among STEM teachers teaching in the highest levels of secondary education with two to five years of teaching experience after graduation. In the Dutch system, teachers in the highest level of secondary schools are required to have a full teaching qualification. At universities, undergraduate students obtain a full qualification after a two-year subject-specific Master in Teaching (for example mathematics, chemistry, etc.). Graduates with a master's degree obtain this full qualification by following a one-year postgraduate teacher education program. This program and qualification are comparable to a Postgraduate Certificate in Education (PGCE) in the UK. Graduates with excellent marks can also enter a two-year postgraduate teaching excellence program combining teaching at a secondary school with an internship at a company. This so-called Teach First program (in Dutch: Eerst de Klas) was inspired by the Teach for America program in the US and the Teach First program in the UK. In addition, universities offer a half-year Minor in Teaching as part of an undergraduate degree, which leads to a teaching qualification for the lower classes in secondary education. To obtain a full qualification after finishing a Minor in Teaching, a student still has to take either a two-year Master in Teaching (with several exemptions) or a half-year postgraduate teacher education program.

Table 1. Main characteristics of the participating teachers at the time of the interview.

Teacher	Gender	Age	Teaching experience	Academic subject	Teacher education	School subject
Livia	Female	27	4 yrs	Physics	One-year postgraduate education	Physics
Ron	Male	27	4 yrs	Architecture	Teach First	Research & design
Jessie	Female	26	4 yrs	Life science and technology	Two-year Master in Teaching	Chemistry
Sam	Male	31	5 yrs	Mathematics	Teach First	Mathematics

3.2. Participants

From the Institute's network, four fully qualified STEM teachers having up to five years of teaching experience were recruited to participate in this study. Recently graduated teachers were chosen because their experience is more representative of the contemporary academic context. In order to explore whether the PPA-CCT methodology could be applied in different personal contexts, four teachers with diverse academic backgrounds were included. The participating teachers originated from three Dutch universities, studied different academic STEM subjects, and as a consequence they all teach different school subjects. All teachers started teaching during or directly after obtaining their master's degree and they currently work at different secondary schools. Table 1 presents an overview of the main characteristics of the participating teachers.

3.3. Interview procedure

Interviews lasted for about 1.5 hours and took place at the schools of the participants. The interviews were audio-recorded and transcribed. The first author conducted the interviews according to the procedure described below, and only asked additional or clarifying questions when required. Each structured interview consisted of three main phases (see Figure 2). After each interview phase, a member check took place (Miles, Huberman, and Saldana 2014).

The first phase focused on the academic study program and the career choice for teaching. The formal study program with personal projects that affected the choice for teaching as a career were elicited and appraised by a stepwise procedure asking the teacher to:

- Write down the formal study program starting from secondary school until the first job as a science or mathematics teacher (personal timeline).
- Place personal projects that affected the career choice for teaching under the personal timeline. A list of exemplary activities was provided during the interview, containing examples such as *research experience during the master*, *tutoring students*, and *giving sports lessons*. Participants were stimulated to think thoroughly and generate variegated activities and experiences, both positive and negative.
- Explain for each personal project how it specifically contributed to the choice for teaching as a career (project appraisal).

In the second phase of the interview, the teacher goal system was produced in two steps by asking the teacher to:

- Write down all teaching aspects that you currently appreciate most.
- Explain for each of the most appreciated teaching aspects why it is important to you, until a terminal value is reached (*why-laddering*). Put answers on sticky notes and draw lines between connected activities and values and goals.

In the third and final phase of the interview, the teacher is asked whether and how currently most appreciated teaching aspects are connected to personal projects that affected the career choice for teaching, and to draw lines indicating connections.

3.4. Data collection

The PPA-CCT methodology generated several types of data. The following data were consecutively generated by the participating teachers:

- A personal timeline consisting of the formal study program, under which personal projects are placed that affected the choice for teaching as a career (as sticky notes).
- Personal projects describing the currently most appreciated aspects of teaching as a profession, with connecting lines to higher level goals and ultimately personal values and goals on top (as sticky notes and lines drawn by teachers).
- Connecting lines indicating the relation between previous experiences (personal projects affecting the choice for teaching as a career) and current appreciation of teaching (personal projects describing the most appreciated teaching aspects) (as lines drawn by teachers).

In addition to these data, we used the oral explanations of how each of the personal projects affecting the career choice for teaching specifically contributed to this career choice. These data were first verbatim transcribed from the audio recordings. For the appraisal of each personal project, the teacher's most specific verbal description of the relation between this personal project and the career choice for teaching were selected as 'key quotes' by the first author. To assess the replicability of the analyses, the second author, who had not been involved in the interviews, evaluated the audio recording of one complete interview to review the selection of key quotes. Minor differences in selection of key quotes between the first and second author were discussed until agreement was reached. An example of discussion was whether a relation between a student teacher and a teacher educator is comparable to the working relation between colleague teachers. It was agreed that these relations were not comparable because of power differences between a student teacher and a teacher educator, which are different or non-existent between colleagues.

3.5. Data analysis

It was first evaluated whether the results of the PPA-CCT methodology were suitable to describe a highly personal process of career choice in different academic and personal contexts. For each individual teacher, the collected data were explored with a primary

focus on the academic study program and personal projects that affected the career choice for teaching. These personal projects together with the appraisals were used to describe and understand how interest in teaching as a career for each teacher evolved during the academic study program, and how these affected the choice for teaching as a career. By considering the goal system and the connecting lines between the goal system and the personal projects during the study program, it was evaluated whether and how the currently most appreciated teaching aspects relate to previous personal projects.

In the next step, the PPA-CCT results of the participants were evaluated on three different levels. The first level of analysis concerned the nature of personal projects affecting the career choice for teaching. For each participant, these personal projects were characterized and evaluated on several dimensions, expected to be relevant for the career choice process and for the eventual identification of effective interventions. The following dimensions were used:

- Timing within the career choice process
- Positive or negative affect (from the project appraisals)
- Nature of the activity (whether related to, or part of academic study or not)
- Impact on career choice for teaching (depicted by the connecting lines with the currently most appreciated teaching aspects).

The second level of analysis concerned a comparison of the course of the career choice process during the academic study program, which was evaluated by the nature and appraisals of personal projects in time.

At the third level of analysis, an attempt was made to gain a better insight in the role of specific personal projects in the development of interest and motivation for teaching. At this level, the coherence between personal projects and the most appreciated teaching activities was evaluated for each participant by the interconnection between the teacher study program and goal system.

4. Results

The PPA-CCT methodology was employed with four STEM teachers. In the next two sections, two case studies of participating teachers are presented in detail together with the PPA-CCT results according to the PPA-CCT methodology (see also [Figure 2](#)). For these two cases, it is evaluated whether the PPA-CCT methodology provides insight into the process of STEM teachers' career choice for teaching and generates personally salient and ecologically representative results. Next, the PPA-CCT results of the individual participants were evaluated on three different levels: categorization of the nature of personal projects, course of career choice process, and the connections and coherence between personal projects and most appreciated teaching activities.

4.1. Livia

Livia is a 27-year-old physics teacher with a passion for science and technology. The top section of [Figure 3](#) shows the results of the first interview phase: Livia's academic study program and personal projects, together with her appraisal. Livia finished a bachelor and

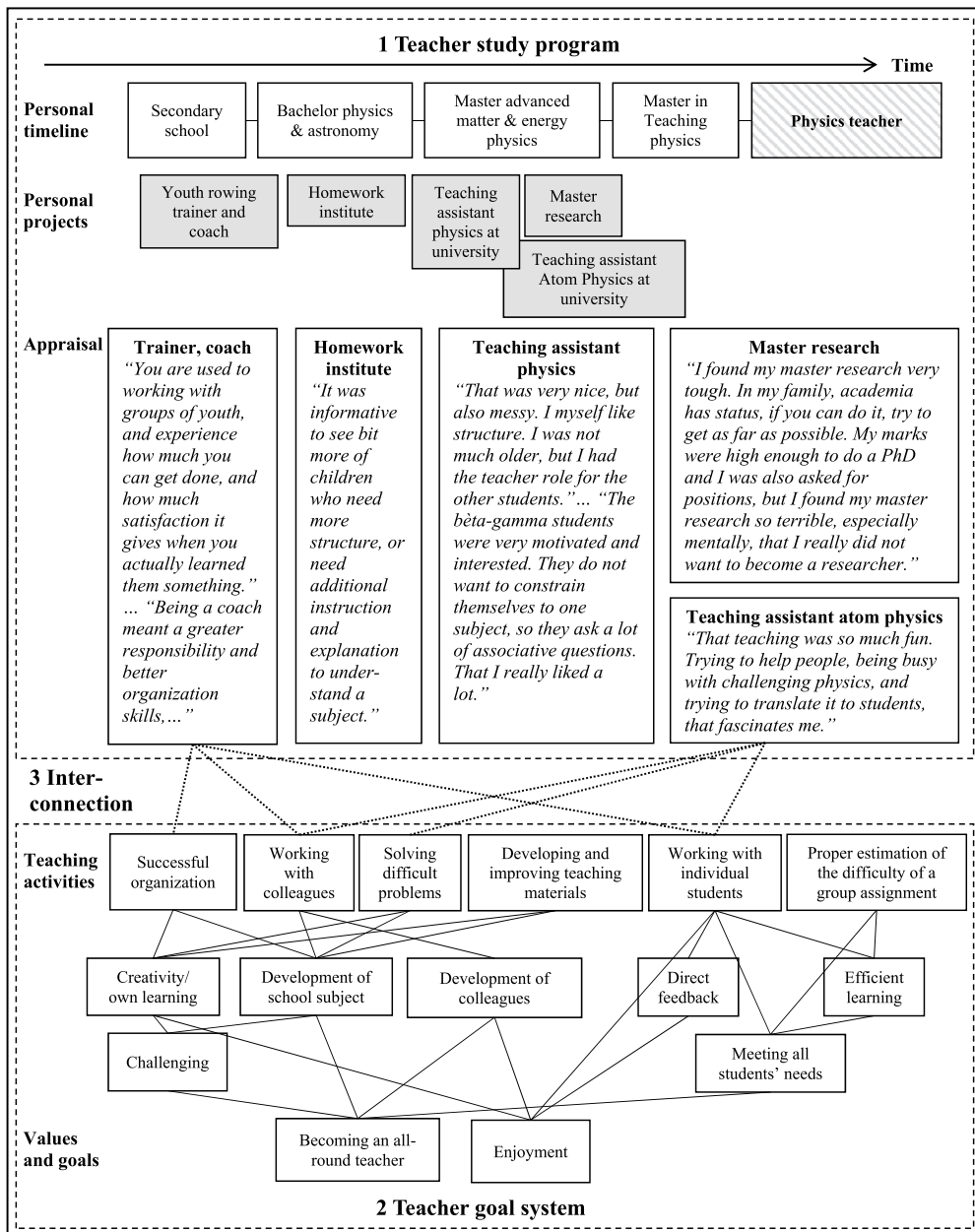


Figure 3. The PPA-CCT results of Livia, a 27-year-old physics teacher, with her study program on top, her goal system at the bottom, and the interconnections marked by dotted lines.

master program in physics, before she entered the one-year postgraduate teacher education program and received a qualification for teaching physics at upper secondary school. Livia's personal projects illustrate that she employed many teaching activities during secondary and higher education but not as a formal part of her study program. She

describes: 'During my studies I wanted to do real physics. I was already engaged in teaching, but I did not want to do it at the expense of physics.'

For Livia, the incentive to pursue a career in teaching was a very negative experience related to her master research project. She found this research project so terrible, especially mentally, that she decided to pursue a career in teaching. Livia had always had an interest in teaching, but her negative experience with research fueled her career choice for teaching.

The bottom section of [Figure 3](#) presents the outcomes of the second interview phase: Livia's teacher goal system based on her currently most appreciated aspects of being a physics teacher. The aspects of teaching that Livia currently appreciates most are *successful organization, working with colleagues, solving difficult problems, developing and improving teaching materials, working with individual students, and proper estimation of the difficulty of a group assignment*. Livia's goal system shows that these teaching aspects are related to high-level values of *becoming an all-round teacher and enjoyment*.

The lines between the upper and bottom part of [Figure 3](#) show the results of the third phase of the interview, the interconnection between personal projects affecting the career choice for teaching and her currently most appreciated teaching activities. Livia connects *successful organization* to her personal project rowing trainer and coach. Her appreciation of *working with colleagues* is connected to her personal project of being a rowing coach, but also to being a teaching assistant for the course atom physics, when she had a good working relationship with her professor. *Solving difficult problems* is connected to her academic study in physics, and her experience as a teaching assistant in atom physics. The other currently appreciated teaching activities, *developing and improving teaching materials*, and *proper estimation of the difficulty of a group assignment*, are not connected to previous personal projects, but to Livia's current experience as a secondary school teacher. Being a physics teacher, she feels responsible for student learning and has become more aware of the diversity in the classroom, which challenges her to improve teaching materials and adapt pedagogy to learning needs.

The PPA-CCT results for Livia show that she has been engaged in teaching activities since secondary school and that she developed a serious interest in teaching, although her academic study program focused completely on physics. The negative experience during her master research project was the incentive for Livia to choose for teaching as a career. Her positive experiences as a youth rowing trainer and coach and as a teaching assistant on the atom physics course are still reflected in her current teacher goal system with the appreciation of *successful organization, working with colleagues and individual students, and solving difficult problems*, which make teaching an enjoyable profession for her and contribute to her goal of *becoming an all-round teacher*.

4.2. Ron

Ron is a 27-year-old research and design teacher who teaches at a secondary school focusing on technical subjects (in Dutch: *Technasium*). Ron's study program and personal projects, together with his appraisal of how these specifically contributed to his choice for teaching as a career, are shown in the top part of [Figure 4](#). Ron finished a bachelor and a master program in architecture. During his master program, Ron spent one semester teaching architecture to bachelor students in his course 'From pupil to master', which he

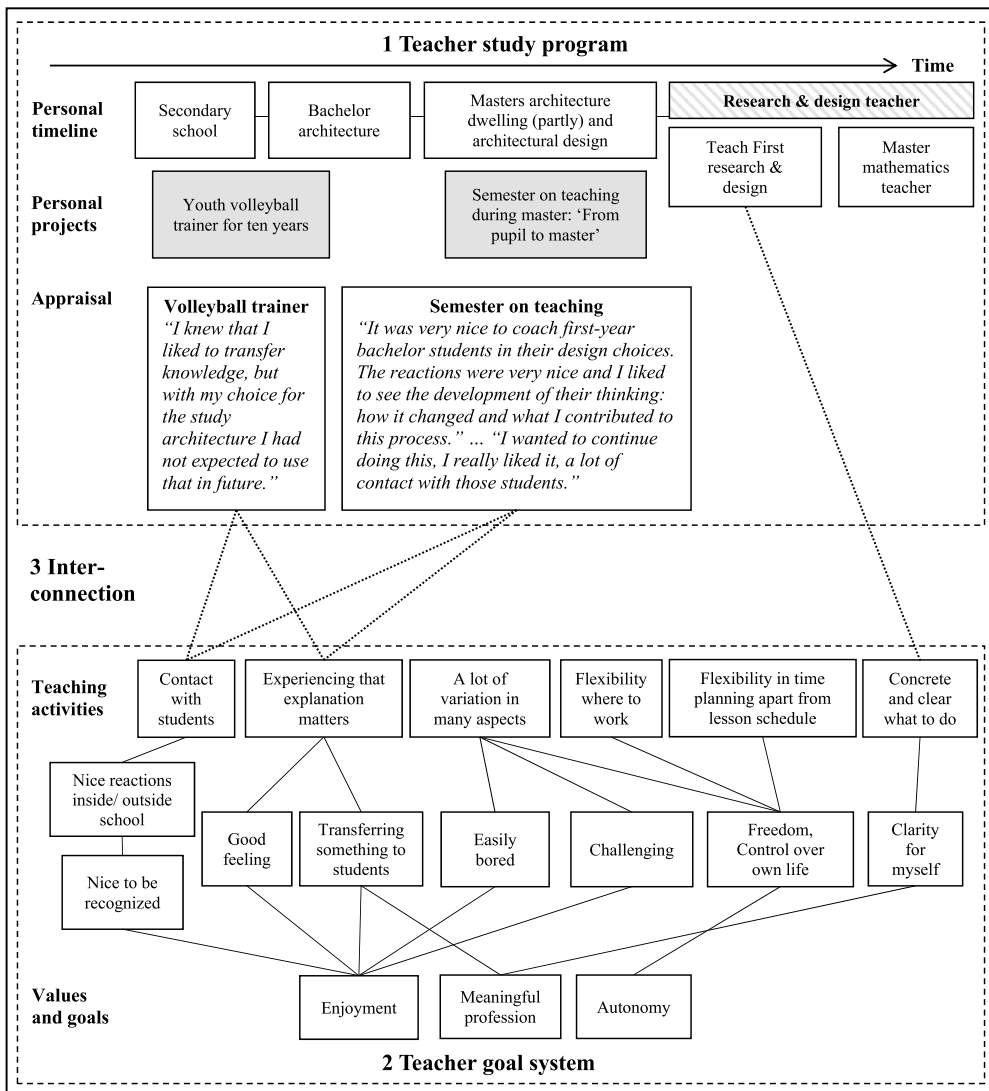


Figure 4. The PPA-CCT results of Ron, a 27-year-old research & design teacher, with his study program on top, his goal system at the bottom, and the interconnections marked by dotted lines.

greatly appreciated and made him want to teach architecture at university. While having difficulty in gaining work experience as an architect, which was required to teach architecture at the university, he accidentally encountered the Teach First program, which gave him the opportunity to start as a research and design teacher without any work experience.

In the second phase of the interview, Ron expressed his currently most appreciated teaching aspects, which are *contact with students*, *experiencing that my explanation matters*, *variation*, *flexibility in place and time*, and *concrete and clear what to do*. From his goal system, it becomes clear that these teaching aspects are for Ron related to high-level personal values of *enjoyment*, *meaningful profession*, and *autonomy*.

In the third phase of the interview, Ron interconnects his personal projects to his currently most appreciated teaching activities. For Ron, his appreciation of *contact with students* and *experiencing that his explanation matters* is related to his experience as a volleyball trainer and during the semester on teaching during his master program. During the Teach First traineeship, Ron experienced that teaching is concrete and has clear goals, in contrast to his placement at a public transport company, which he found vague and rather useless. The currently most appreciated aspects of teaching *flexibility* and *variation* originate from Ron's current experiences as a secondary school teacher. Ron expressed that variation in school activities is especially important for him, as he does not want to restrict himself only to teaching.

Ron's PPA-CCT results show that the positive teaching experience during his architecture master program was the main incentive to make him choose for teaching as a career. This positive teaching experience is still reflected in his current teacher goal system with the appreciation of *contact with students* and *experiencing that my explanation matters*, which make teaching an enjoyable and meaningful profession for him. About the role of his study in architecture in his choice for teaching as a profession, Ron states:

Secretly I think that I found working as an architect very difficult, such as the acquisition of projects. The real work, designing, is only a small part of it. I think that before that, a lot of things need to be done that I don't really like.

4.3. Personally salient and ecologically representative

In the previous sections, two cases of Dutch STEM teachers were presented: Livia and Ron. Both teachers pursued their bachelor, master, and academic teacher training at different universities in the Netherlands. During the interview procedure, both teachers generated their own specific study program with their own personal projects, and a personal goal system. Based on these two cases, it will now be evaluated to which extent the PPA-CCT methodology provides insight into the process of STEM teachers' career choice for teaching and generates personally salient and ecologically representative results.

Both participants started their academic career in a STEM subject and started to work as a secondary school STEM teacher after graduation. For each teacher, the personal projects that positively or negatively affected the choice for teaching as a career provide rich personal information about the process of career choice for teaching. Moreover, for both Livia and Ron the pursuit of teaching as a career can be understood from their positive experiences with teaching-related activities, which took place as part of the academic study program or next to the academic study program. However, for Livia, her negative experience during her master research was the incentive to choose for teaching as a career.

Livia focused her academic study completely on physics and pursued many teaching activities in her spare time, but she found her master research project so terrible that she decided to choose for a career in teaching, which always gave her a lot of fun. Ron enjoyed teaching bachelor students during his master program in architecture so much that he decided that he wanted to teach at the university but ended up teaching at a secondary school.

Participants' goal systems show which aspects of teaching are currently most appreciated and how these relate to personal values and goals. Both Livia and Ron appreciate different aspects of the teaching profession. For example, Livia likes *successful organization* and *solving difficult problems*, while Ron enjoys *experiencing that his explanation matters, variation, and flexibility*.

Further understanding of the career choice process and the role of personal values and goals is provided by the connection between the currently most appreciated teaching aspects and the personal projects that affected the career choice for teaching. Early personal projects, such as being a rowing trainer and coach for Livia, and being a volleyball trainer for Ron, did not influence their choice of the academic subject study at the time. However, retrospectively, both Livia and Ron connect these early personal projects to their currently most appreciated teaching activities. Therefore it can be concluded that, in hindsight, these early personal projects have had a significant impact on their current appreciation of the teaching profession.

In the next stage, the PPA-CCT results of the individual participants were evaluated on three different levels: the nature of personal projects, course of career choice process, and the connection and coherence between personal projects and most appreciated teaching activities. [Table 2](#) gives an overview of these results. The top section of the table contains a chronological list of all personal projects that affected the career choice for teaching, both positive and negative, for each of the STEM teachers. Furthermore, the table shows which personal projects have two or more connections to the currently most appreciated teaching aspects (in bold).

Based on these data, the first level of analysis took place. Livia has four personal projects to which she attributed a positive affect, in sports as well as related to her academic study, but her negative experience during her master research project was the incentive for her career choice for teaching. Ron has two personal projects to which he attributed a positive affect, of which the experience as volleyball trainer lasted more than 10 years, and both were important for his career choice for teaching. Jessie has four personal projects to which she attributed a positive affect, and the experience as an instructor at an exam institute, at which she was quickly promoted to head teacher, when she was struggling with the laboratory projects during her bachelor studies, was pivotal for her career choice for teaching. Her personal projects are all related to her study program and her academic subject. Sam has four personal projects to which he attributed a positive affect, which are also all related to his academic subject. For Sam, his experience as mathematics tutor during his gap year had the most connection to the currently most appreciated teaching aspects.

The course of the career choice process (second level) was evaluated from the timeline and the chronology of the personal projects. [Table 2](#) shows that Livia, Ron, Jessie, and Sam all have one or more personal projects that affected career choice for teaching before they started their academic study program. This level of analysis also provides insight into the role of specific personal projects in the career choice process. For example, Ron's motivation for teaching appears to be sparked by one specific personal experience during the academic STEM study program: the master course 'From pupil to master', which made him realize that he liked teaching bachelor students so much that he decided to pursue a career in teaching. Livia, on the other hand, already had a lot of positive teaching experiences when a negative experience during her master research project made her

Table 2. All personal projects that affected career choice for teaching listed for each participating teacher in chronological order.

	Livia	Ron	Jessie	Sam
Personal projects that affected career choice for teaching (chronological order)	<p>Rowing trainer/ coach (secondary school) +</p> <p>Homework institute (bachelor) +</p> <p>Teaching assistant physics (master) +</p> <p>Teaching assistant atom physics (master) -</p> <p>Master research (master, study)</p>	<p>Volleyball trainer (for ten years) +</p> <p>Semester on teaching 'From pupil to master' (master, study) +</p>	<p>Tutor (secondary school) -</p> <p>Lab work (bachelor, study) +</p> <p>Exam institute (bachelor) +</p> <p>Minor in teaching (bachelor, study) +</p> <p>Colleague chemistry teacher (master)</p>	<p>Tutor (secondary school) +</p> <p>Mathematics tutor (gap year before bachelor) +</p> <p>Academic course 'Orientation on teaching' (master, study) +</p> <p>Teachfirst programme (subsequent to master) +</p>
Currently most appreciated teaching activities which have two or more connections to personal projects	<p>Working with individual students</p> <p>Successful organization</p> <p>Working with colleagues</p> <p>Solving difficult problems</p>	<p>Contact with students</p> <p>Experiencing that explanation matters</p>	<p>Explaining</p> <p>Students' appreciation</p> <p>Students' understanding</p>	<p>Interaction with students</p> <p>Deepening the school subject</p>

Note: The affect of each personal project is designated by a positive (+) or a negative (-) sign. Personal projects that have two or more connections to the teacher's currently most appreciated teaching activities are shown in bold.

choose teaching as a career. Both Sam and Jessie chose specific academic courses to explore their experience of teaching as a profession. For Jessie, this was the 'Minor in Teaching', a national intervention to promote students' career choice for teaching, during her bachelor study program, and for Sam this was an academic course 'Orientation on teaching' during his master study program.

The coherence and connections between personal projects and the most appreciated teaching activities are evaluated from the interconnection between the most appreciated teaching aspects from the teacher goal system and the personal projects that affected the career choice for teaching from the teacher study program (Table 2, bottom section). This interconnection indicates which teaching aspects were experienced and promoted by the teaching-related activities during the study program. For all the participants, this is related to interaction with students. Furthermore, Livia and Sam mention challenges related to their school subject, and Ron and Jessie mention explanation and students' understanding.

The evaluation of the PPA-CCT results for the individual participants revealed several interesting features:

- All teachers elicited either many or long-lasting teaching-related personal projects during their study program, which started already during secondary education. This might be indicative for intrinsic interest in teaching or related activities; however, none of the teachers considered becoming a teacher during secondary education.
- All teachers mention the satisfaction of experiencing that someone has actually learned something from them in an appraisal of a personal project. Those personal projects are connected to the most appreciated teaching aspects by all teachers. From this, it could be inferred that encouraging teaching-related activities during the academic study might promote interest in teaching as a profession.

5. Conclusion and discussion

In this article, a new methodology is presented to describe and evaluate career choice processes of academic science and mathematics teachers. This so-called Personal Project Analysis for studying Career Choice of Teaching (PPA-CCT) methodology is based on personal projects analysis. In a small-scale explorative study with recently graduated STEM teachers, it was evaluated to what extent this PPA-CCT methodology provides personally salient and ecologically representative insights into the process of STEM teachers' career choice for teaching.

The PPA-CCT results from the participating STEM teachers have revealed study and career choices in mutual coherence with personal context, thereby providing insight into the process of career choice for teaching of STEM students during higher education. The development of motivation for teaching has become apparent from personal projects that affected the career choice for teaching, the teacher's current goal system, and their interconnection.

In this small-scale explorative study, it was demonstrated with four cases how analysis may take place by categorization of personal projects on different dimensions and levels. The results of this study could be the basis for further research. For example, it could be further explored whether exposing STEM students to a variety of teaching-related

activities generating positive teaching experiences will contribute to increase interest in and motivation for teaching. For such a purpose, the PPA-CCT methodology could be easily adapted because of its modular structure and open-ended nature. Taking personal projects as basic units of analysis, one could choose to zoom into specific personal projects such as teaching-related activities during the STEM study program, or selectively pick out those specific personal projects. Those personal projects could be evaluated using the project appraisal module, which is offered by the original PPA methodology presented by Little and Gee (2007). This optional quantitative project appraisal module consists of a standard list of 17 dimensions, which can be used to evaluate personal projects on five themes based upon theoretical constructs: (1) meaning, (2) manageability, (3) connection, (4) positive affect, and (5) negative affect (Little and Gee 2007). Especially for large-scale data collections and normative, comparative analysis, the project appraisal module could be a valuable addition to the PPA-CCT methodology presented in this study.

The PPA-CCT methodology is a novel methodology and contains several aspects that deserve reflection and further exploration. The first aspect concerns the retrospective character of the PPA-CCT methodology. The PPA methodology as described by Little (2007) is not applied retrospectively. In the design of the PPA-CCT methodology it was attempted to support the retrospective reconstruction of the career choice process of the participants by first eliciting a personal timeline, which subsequently serves as a reference for the personal projects. Furthermore, in the PPA-CCT methodology, career choice for teaching is explored from two perspectives, being the career choice process during secondary and higher education and the current appreciation of the teaching profession. In this study, the career choice process was studied for a sample of recently graduated STEM teachers. However, because of its retrospective character, the PPA-CCT results might be affected by the time span since graduation and the level of teaching experience. It would therefore be useful to evaluate whether the PPA-CCT methodology also supports the reconstruction of the career choice process of more experienced STEM teachers, and to what extent a teacher's goal system changes with teaching experience.

The current teacher shortage in STEM school subjects requires interventions to promote STEM students' interest and motivation for teaching. Motivation for teaching is a multidimensional construct which includes motivation factors (such as social influences, positive prior teaching and learning experiences, perceived teaching abilities, intrinsic value, personal and social utility values), perceptions of the teaching profession (such as perceived task demand and return), and assessment of experiences of social dissuasion and satisfaction with the choice of teaching as a career. All these factors are captured in the FIT-Choice questionnaire, which is the most widely used instrument to measure teacher motivation (Watt, Richardson, and Smith 2017). What the PPA-CCT methodology adds to what we already know about motivations to teach, is that it reveals how those many factors and dimensions determining teaching motivation develop over time and how these affect each other. For example, in our study, participants connected factors such as 'positive prior teaching and learning experiences' during the teacher study program to factors such as 'perceptions of the teaching profession' in the teacher goal system (see Figures 3 and 4). Furthermore, the dynamic nature of those motivation factors becomes clear from the teacher goal systems, as several teachers described currently most appreciated teaching aspects which were relatively new to them and had developed

during their professional career. For example, Jessie described that over the recent years the 'social utility value' of teaching had become important for her, which arose from her experience of being a mentor and coach for students. Similarly, for Ron, the 'personal utility value' of teaching, related to the flexibility in his working conditions, was something that he experienced during his professional career and became one of his most appreciated teaching aspects.

The PPA-CCT methodology enables studying career choice processes from a novel perspective compared to more common research methodologies such as survey studies and narrative inquiry. Large-scale survey studies and small-scale narrative studies each have their advantages. Survey studies produce large sets of standardized data, which enable interpersonal comparison and statistical analysis, while narrative inquiry, being very open and encouraging personal stories and descriptions, reveals personally salient and ecologically representative information with respect to individual choices and considerations. By using participants' personal projects as structural analysis units, the PPA-CCT methodology combines these advantages and enables the elicitation of the career choice process in a personally salient, ecologically representative, time-efficient, and also structured way, enabling interpersonal comparative analysis without losing the participant's voice.

We therefore believe that the PPA-CCT methodology is complementary to narrative research and survey studies and can be used in conjunction with both of them. The PPA-CCT methodology provides insight into relevant factors affecting the career choice for teaching which can be further validated in large-scale survey studies. In addition, narrative inquiry could be used for more in-depth exploration of salient aspects of the career choice process, such as the role of specific personal projects.

In conclusion, the PPA-CCT methodology provides insight into career choice processes of STEM students, by connecting the dynamic process of career choice (in time and context) to personal values and goals. Understanding how interest and motivation for teaching originates and develops is important because it provides leverage points for the design of effective interventions to increase STEM teacher recruitment and retention. The combination of personal saliency with interpersonal comparability makes the PPA-CCT methodology unique compared to survey studies and narrative inquiry.

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