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# Life Story Analysis of the Longer-term Effects of Kenya's Strengthening of the Mathematics and Science in Secondary Education Project on the Attitudinal and Behavioural Changes of Former Secondary Students

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The aims of this study were to (a) qualitatively determine former students' perceptions of environment, personal and behaviour factor changes that were due to the teachers involved in the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project in Kenya and (b) reveal the long-term influence of these qualitative changes on their lives. The study also clarified the significance of using life story analysis to this end. The theoretical framework we utilised is social learning theory. Data collected from interviews were examined using Steps for Coding and Theorisation (SCAT) analysis, as well as NVivo, to identify respondents' experiences as former SMASSE students. First, SCAT analysis revealed that participants' lives were influenced in the long term owing to changes in: (a) environmental factors, such as interaction with SMASSE teachers and collaboration with other students; (b) personal factors, such as changes in cognitive and affective aspects; (c) behavioural factors, such as learning methods. Second, by using NVivo to integrate all the stories, we showed that former students' perceptions of the environmental, personal and behaviour changes that were due to the teachers involved the SMASSE project were mutually interrelated. The analysis has also identified long-term effects on various aspects of human resource development: post-graduation career development, employment opportunities, and mindset. Finally, the results of this study emphasise the robustness of qualitative research in identifying the qualitative changes in the participants in a multi-dimensional manner for this international project.

**Keywords:** *Social learning theory; behavioural change; attitudinal change; life story; career choice; mathematics and science; long-term effects; SMASSE*

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## Background

Many educational projects (e.g. Burma, 2018; Hugerat et al., 2004; Pather, 2012; Tukombe et al., 2017), particularly international cooperation projects, have a limited period for educational interventions. Thus, they are mostly unable to follow up on the intervention's impact after the project ends. The evaluation of the effectiveness of such interventions is confined to short-term outcomes (e.g. Maruyama & Kurosaki, 2021; Reyneke et al., 2018; Stott, 2017). However, the long-term outcomes of interventions are of greater significance to learners' lives (e.g. Shahali et al., 2018), and may not match short-term outcomes, given the dynamic nature of children's competencies (cf. Organisation for Economic Co-operation and Development, 2020). One of the reasons for a dearth of measurement of long-term outcomes, despite their value, is measurement difficulty. This can be overcome through qualitative life story research (Jacobs, 2010; Otani, 2019; Svensson, 2022), which can offer detailed

descriptions and interpretations of learning and changes in life. This study uses such methodology to evaluate the long-term effects of the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project.

The SMASSE project was aimed at improving the quality of learning in science and mathematics education in Kenya. It was conducted under Kenyan and Japanese international cooperation. The project comprised three phases: the first phase ran from 1998 to 2002, the second from 2003 to 2008 and the third from 2009 to 2013, for a total of 15 years. The SMASSE project promoted activity-based teaching, student-centred learning, and experiment and investigation-based approach and improvisation (ASEI) as a model, because Kenyan teachers tended to focus less on students' thinking than on transmitting the knowledge (Matachi & Kosaka, 2017).

When this project was completed, its short-term quantitative evaluations of students' science performances indicated cognitive improvements (Haraguchi, 2017; Japan International Cooperation Agency, 2007, 2014). In terms of short-term qualitative findings in Kenya, teachers reported qualitative improvements in students' motivation, comprehension levels and overall academic performance. Students reported enjoying science and mathematics lessons and gradually developing critical thinking skills (cf. SMASSE Project, 2007). However, long-term attitudinal changes have not yet been evaluated for this project. Studies which have investigated attitudinal changes of other interventions argue for the merits of such investigations (e.g. Baran et al., 2019; Osborne et al., 2003; Permanasari et al., 2021; Shahali et al., 2018) and have investigated children's attitude towards science. For example, according to the Organisation for Economic Co-operation and Development (2006), developing students' attitudes towards engaging in scientific issues and acquiring and applying scientific and technical knowledge for individual, societal and global benefits is an important goal of science education.

Therefore, this study aims to identify the longer term effects on post-graduation career development and employment opportunities, and the resulting change in the attitudes and behaviours of Kenyan students who had attended science classes taught by teachers experienced in SMASSE In-Service Teacher Training (hereinafter, SMASSE teachers). Moreover, we investigate how qualitative research, namely the life story method, can contribute to identifying subjects' qualitative changes within this educational project for international cooperation in Africa. The research was guided by the following three research questions:

- (1) What do the former students consider to be the characteristics of classes taught by SMASSE teachers and what were the gradual changes in attitude and behaviour in former students as a result of having taken classes with SMASSE teachers?
- (2) How do the former students consider that these changes influenced their later life?
- (3) How can qualitative research affect the evaluation of an educational project for international cooperation?

As SMASSE Phase 3 focused on primary education, we focused on SMASSE Phases 1–2, which were conducted for secondary education and implemented from 1998 to 2008.

## Theoretical Framework

### *Attitudes and Behaviours in Science Education*

Applying social learning theory, we aim to understand the interaction between students' experiences of attending classes held by SMASSE teachers (environment) and the ensuing changes in attitude (personal) and behaviour (behaviour). Furthermore, we investigate how the interaction of these factors (environment, personal and behaviour) has affected their post-graduation career development and employment activities. Social learning theory proposes the concept of interaction, which is modelled on three factors—behavioural, personal and environmental—all interconnected by reciprocal determinism (Bandura, 1985). This theory focuses on identifying, anticipating, reshaping and changing behaviours (Bandura & Hall, 2018; Yildirim et al., 2020). Developed by Bandura (1977), it subsequently evolved into social-cognitive theory (Bandura, 1985). At its core, we find reciprocal determinism, as it describes three main concepts: observational learning, outcome expectations

and self-efficacy. Several studies have utilised this theory in different areas (Yildirim et al., 2020), and reciprocal determinism revealed the relationship between these three components owing to its adaptive nature (cf. Valizadeh et al., 2019). Although the model is classic, it functions well in the current study. The perspective of reciprocal determinism has been discussed in recent publications in many study areas, such as organisational management, governmental system, tourism and water conservation (e.g. Bandura & Hall, 2018; Valizadeh et al., 2019). These studies in different domains paid attention to humans' behaviour and attitude in relation to environment. In the context of science and mathematics education and international cooperation, cognitive domains have been traditionally focused upon; on the other hand, it is worth investigating three relationships in terms of capacity development which includes both cognitive and affective domains. In the current study, therefore, we would like to develop social-cognitive theory's wider use to include these areas.

## Methodology

### ***The Relationship Between Students' Experience of Attending Classes and their Post-Graduation Career Development and Employment Activities***

We adopted life stories as the main framework to understand the relationship between students' experience of attending classes taught by SMASSE teachers and their post-graduation career development and employment activities. The life-story method, a qualitative approach, 'studies the process by which people live their everyday lives (life, living, livelihood), the act of narrating the process of their experience, and the stories that are told about it' (Yamada, 2000: 146–147). Narrative is the underlying way of creating a plot by linking two or more events (Yamada, 2000). Sakurai (2012) defined life stories as narratives of individuals recapitulating events of their past and self-experiences through a process of communicating with listeners. These stories are then continuously interpreted, reinterpreted and retold.

Life stories provide a qualitative overview of the relationship between the experiences of former students who attended classes taught by SMASSE teachers and their post-graduation career development and employment activities.

### ***Interviewees***

Before conducting the study, considering ethical dimensions, we assured the participants that their participation was voluntary. We explained the interview purpose, ensured that the names of people, place and incidents were anonymised, specified that the data would be used for the study only, and obtained written consent. All ethical protocols were followed, and ethical clearance was obtained from the ethical review board of University of Fukui. The ethical clearance number is 128.

Although the interview period was during the COVID-19 pandemic, the interviews were conducted face-to-face with support from the Kenyan research collaborators. The interviewees were selected by snowball sampling. First, collaborative teachers were selected from a list of SMASSE teachers at the Centre for Mathematics, Science and Technology Education in Africa. Next, the authors, through Kenyan educational stakeholders, contacted these teachers and asked them to introduce students who they were in contact with. Finally, 35 former students (18 males and 17 females) agreed to participate in the survey and were interviewed by our research collaborators in Kenya.

These 35 individuals were classified as pursuing careers in the following three categories:

- (1) high school science teachers—15 persons;
- (2) science-related fields (e.g. information and communication technology, medical)—14 persons;
- (3) other fields (e.g. lawyers, police officers)—six persons.

According to Oketch and Somerset (2010), Kenya's public secondary schools are divided into three categories: national schools are in the top tier and very few in number; provincial schools are in the middle tier and are still relatively few; and district schools in the lower tier represent the majority of schools. As of 2022, the schools were divided into four categories: national, extra-country, country and sub-country. The types of schools that provided general information on the academic levels of

the 35 former students were as follows: seven national, 17 provincial, 10 district and one private. Twenty-one interviewees lived in the capital city of Nairobi, seven in the suburbs of Nairobi, and seven in other towns of Kenya.

### **Interview Method**

Semi-structured interviews were conducted. A summary of the basic interview questions is presented in [Table 1](#). During the interview, participants spoke freely about the topic that was introduced. Five interviews were conducted in our pilot study; before formal data collection, we coordinated with the local research assistants on content to verify the questions' credibility, and the questions were revised based on the findings.

The interviews, lasting less than two hours each, were conducted in English and recorded using a digital voice recorder. Verbatim transcripts were prepared and reviewed.

### **Method of the Analysis**

Two analyses were performed in this study. First, we used data analysis tool Steps for Coding and Theorisation (SCAT), proposed by Otani (2008, 2011, 2019), as it combines the function of categorical analysis with the characteristics of sequential analysis. The SCAT analysis was used to identify respondents' experiences as former students of SMASSE teachers, how these experiences changed them, and the influence of the classes in later life. Second, we utilised NVivo, an information and communication technology software for qualitative analysis, to integrate all stories, describe classes taught by SMASSE teachers, illustrate changes former students experienced as the outcome of attending classes and determine the effects of these classes in later life.

In the SCAT analysis of the 35 respondents, six responses were analysed to capture the characteristics of each respondent's current occupation: two from high school teaching, three from science-related fields and one from other fields. Interviewees' responses involving more utterances or details than other respondents were purposively selected from each occupational category. Following Otani's (2019) procedure, we described the segmented data using the following four ordered stages of coding: (a) noteworthy words or phrases from the text; (b) words or phrases outside the text that paraphrase (a); (c) concepts from outside the text that account for (b); and (d) themes and structural concepts emerging from the above. Thus, we assembled the themes and structural concepts necessary for storyline writing. In the SCAT analysis, a storyline expresses the meaning and significance of events described in the data by linking the themes described in (d) (Otani, 2008). To achieve consonance, one person analysed the data; however, when determining the analysis' credibility became difficult, a second person continued the analysis process (cf. Otani, 2019).

In the NVivo analysis, all 35 participants' responses were analysed to synthesise the stories and obtain an overall result. The themes used for the transcripts were as follows: (a) perceptions of

**Table 1.** Summary of interview topics

Basic information	<ul style="list-style-type: none"> <li>• People who have had an impact on your life</li> <li>• Your upbringing and background</li> <li>• Things that impressed you during secondary school years</li> </ul>
Classes taught by SMASSE teachers	<ul style="list-style-type: none"> <li>• Impressions, advice received and lessons learned</li> </ul>
Changes attributable to classes taught by SMASSE teachers	<ul style="list-style-type: none"> <li>• Changes in attitude, relevance to national examination results, comparison with traditional classes</li> <li>• Changes in behaviour and study methods, impact on higher education and relevance to later life</li> </ul>
Relevant experience of attending classes taught by SMASSE teachers to later life	<ul style="list-style-type: none"> <li>• Impact on life and work, role in life and parenting</li> <li>• Impact of changes in attitude on life and work and societal role of what was learned</li> <li>• Impact on career choices and livelihood</li> <li>• Evaluation of classes attended at that time</li> </ul>

characteristics of classes taught by SMASSE teachers; (b) perceptions of changes that former students experienced as the outcome of these classes; and (c) relevance in later life. Under each theme, we recursively set codes and subgroups to identify detailed meaning in the transcribed data. Accordingly, we discussed the two analyses' findings and revised them as appropriate to improve the credibility of the selected codes. The 35 stories were then synthesised and discussed.

## Findings

### **Three Examples of Storylines**

Owing to space constraints, we present three of the six storylines within this manuscript. The underlined text represents SCAT step (d): themes and structural concepts. Respondent #12 studied chemistry with SMASSE teachers in Forms 3 and 4 (Grades 11 and 12), pursued higher studies starting university after graduation, and is now working as a high school chemistry teacher.

#### *Respondent #12's storyline and discussion*

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In classes taught by SMASSE teachers, unlike traditional classes where teachers explain while writing on the blackboard, we experienced collaborative inquiry-based learning—exploring solutions to problems in collaboration with other classmates. Our teachers taught us based on students' comprehension level to update us from what we had already studied to what needs to be learned. They also encouraged multiple solutions to a single problem, emphasised the links between daily life and chemistry, and created teaching tools out of familiar materials. The classes inspired changes that influenced our later career choices. These changes included affective responses (e.g. arousing interest and love for chemistry), cognitive changes (e.g. improved marks in science), and an increase in self-efficacy. They also promoted changes in attitude such as reading books in the library during breaks and seeking out teachers to ask questions. Now, as a teacher myself, I endeavour to use the skills and attitudes of scientific inquiry that I had learned during my school years, create teaching tools using available materials, and implement collaborative inquiry-based learning for exploring solutions to problems with others.

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This respondent experienced SMASSE teachers' classes based on ASEI as intended in the Kenyan SMASSE. This can be understood based on collaborative inquiry-based learning, where he explored solutions to problems in collaboration with other classmates. One of the goals of ASEI-based classes was to foster knowledge and skills through activities. These classes were focusing on students thinking. In other subjects, non-SMASSE teachers often presented the study content and explained it from the start of the lesson. In contrast, SMASSE teachers only specified the study purpose or content later in the class, with the intention of making students think about what the study content could be and identify what they had already learned and what they needed to learn. Furthermore, SMASSE teachers strived to emphasise the connections between chemistry and daily life.

Cognitive changes—improved marks in science and improvement in self-efficacy—were observed as a result of taking these classes. Changes in affective responses were also recorded, such as arousing an interest and love for chemistry, and changes in attitude, such as reading books in the library during breaks and seeking out teachers to ask questions.

Currently, Respondent #12's support for scientific inquiry can be seen in his work ethic as a classroom teacher: he applied the skills and attitudes of scientific inquiry, such as using his observation skills developed in his secondary school chemistry classes to guide students through problems and seek solutions. Additionally, with reference to SMASSE teachers' classes, he creates teaching tools using available materials (e.g. using models made from wire and clay in the shared bonding class) and promotes collaborative inquiry-based learning, which emphasises working together with others to find solutions to problems through cooperative exploration.

This respondent's career development was affected by his SMASSE teachers, their attitudes towards science and the cognitive and emotional changes they inspired. Along with the classes taught by SMASSE teachers, their attitudes towards science influenced his current career choice.

Respondent #14 took biology classes with SMASSE teachers in Forms 2 and 3 (Grades 10 and 11), pursued advanced studies starting university after graduation and is now a practising doctor.

#### *Respondent #14's storyline and discussion*

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My SMASSE teachers were full of love for nature and living beings and drive and passion for education. They taught by keeping their students in mind rather than in a detached manner. They offered after-hours classes and individualised attention, prepared experiments and provided students trial-and-error learning opportunities, created teaching tools using familiar objects, and promoted conceptual understanding using small steps and real objects rather than cramming. My SMASSE teachers' passion for education changed my emotional orientation towards biology and influenced my career choice to become a doctor. I also became aware of the efforts required for success and began to focus on self-realisation and sacrifice. Currently, I interact with my patients outside of work hours, emulating my SMASSE teachers, with the belief that if you have passion, you can influence those around you. I am passionate about my work and committed to building relationships as a mentor in training junior staff.

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While many non-SMASSE teachers taught students only during class time, the SMASSE teachers offered after-hours classes, individualised attention and prepared experiments. They taught by focusing on their students rather than in a detached manner. The student also experienced ASEI-based teaching, as intended in the Kenyan SMASSE. This can be understood through the following three points: (a) trial-and-error learning opportunities; (b) teaching tools using familiar and real objects; and (c) conceptual understanding using small steps rather than cramming the story line.

Along with class content, the passion for work of the SMASSE teacher led to a change in the affective aspect of biology, which led the student to choose a career as a doctor. Through the SMASSE teacher's work, he realised that additional efforts were required to succeed and, thus, he was able to make sacrifices, including giving up leisure activities to devote himself to his studies and succeed in his career.

He currently works as a doctor, but also sees patients outside of work hours, inspired by the belief instilled by the SMASSE teacher that, if you show passion, you can influence those around you. He was also influenced by the SMASSE teacher's work in training younger colleagues and strives to build relationships as a mentor, sharing his passion for the job.

Respondent #14 was influenced by SMASSE teachers in general, but even more so by their 'love for biology and passion for education', which became a decisive factor in his pursuing a career in medicine. Furthermore, SMASSE teachers' work ethics had a substantial influence on respondent #14's work values. The respondent's attitudes towards continuous professional development were influenced by SMASSE teachers.

Respondent #28 attended physics classes with SMASSE teachers during Forms 3 and 4 (Grades 11 and 12), pursued university education after graduation, and is now working as a police officer.

#### *Respondent #28's storyline and discussion*

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My learning with SMASSE teachers was hands-on, with many experiments and observations outside the classroom, and rich in emphasis on collaborative group inquiry learning. My SMASSE teachers explained the significance of collaborative exploration and offered advice on approaching the subject matter. These classes inspired within me a positive attitude towards working with others, a shift from passive to active learning, and an awareness of the relevance of what I was learning in real life. Although my teachers did not directly affect my career choice, I like my job because it is highly related to the subjects I studied in high school. Currently, I have adopted the approach of solving problems through collaborative inquiry in my work and life, and I also feel that I can apply what I have learned in physics to my work. SMASSE teachers educate children to become independent through acquiring life-relevant knowledge in formal education.

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Respondent #28 experienced the ASEI-based teaching that was intended in the Kenyan SMASSE classes. This can be seen as learning based on a hands-on approach, many experiments and observations outside the classroom, and the emphasis on collaborative group inquiry learning in the story line. SMASSE teachers explained the significance of collaborative inquiry, such as that wisdom and knowledge are not based on one person, and that exchanging ideas is essential. Moreover, they gave advice on how to approach subjects (e.g. no subject is difficult if you have a positive attitude and like the subject).

Through these lessons, respondent #28, who was reserved as a student, was able to develop a positive attitude towards working with others, gaining confidence in talking to and explaining things to others through group discussions and voicing his opinions as a group leader. He also began to use his learning in physics to make real-life connections with what he was learning, for example, connecting wires from light bulbs to activate musical instruments at a home party.

Currently, he works using brainstorming and solving problems through collaborative inquiry. He also applies what he learnt in physics to his work, such as the way guns and weapons fire and their paths. For example, when a cell phone no longer works, he works with his son teaching him how to unscrew it and reassemble it. He also uses his schooling to educate his son to become independent by acquiring living knowledge.

The SMASSE teachers' influence is further evident in that the respondent currently utilises collaborative group inquiry learning in life and work.

### **Findings from NVivo**

In the NVivo analysis, we analysed the responses of all 35 participants to synthesise the stories. The theme used for the transcripts were as follows: (a) characteristics of classes taught by SMASSE teachers; (b) changes that former students experienced as the outcome of these classes; and (c) relevance to later life. Under each theme, we recursively set codes and subgroups to identify more detailed meaning in the written statement data transcribed from the interview and audio recordings in an inductive manner. To this end, we discussed the findings of the two analyses, and revised them as appropriate, to improve the credibility of code selection. The major codes and subgroups from the NVivo analysis are shown under each theme in [Table 2](#). The synthesis of these findings and the SCAT findings is described in the discussion section below.

**Table 2.** Results of the qualitative analysis of interview statements

Theme	Subgroup	Major codes
(1) Perceptions of the characteristics of classes taught by SMASSE teachers	Teaching methods	hands-on activity, group work, interactive, experiment/laboratory/outside learning, an inquiry learning approach
	Impressions of a former student	fun, interesting, unique
	Example of lesson content	teaching aids
(2) Perceptions of the changes attributable to former students' class	Teacher's character	teacher's character
	What I learned from class	positive attitude, personal development, good results
	Mindset change	attitude toward science, confidence
(3) Perceptions of the relevance to later life	Behavioural change	group activities and interacting with people
	Science- or work-related	ways of working and thinking, professional skills
	Career	careers and career development
	Mindset	personal development, collaboration
	Education for the next generation	importance of mentorship



## Discussion

### ***RQ1: Perceptions of Characteristics of Class Taught by SMASSE Teachers and Gradual Changes in the Attitude and Behaviour of Former Students as a Result of Having Taken Classes with SMASSE Teachers***

The findings suggest that former students consider that SMASSE teachers' mentoring created an environment that differs from the classroom situation created by non-SMASSE teachers. Moreover, it can be inferred that SMASSE teachers created a mindset that differed from that of other teachers. Their teaching methods differed from those of other teachers by practising group work, an inquiry learning approach, and interactive teaching methods that promote scientific inquiry, inspiring former students to collaborate actively with others. Usually, as indicated by Collet and Nakawa (2022), Kenyan teachers do not focus on collaboration and students' learning and thinking, while they plan, implement and assess their lessons during lesson study activities. Matachi and Kosaka (2017) also reached similar conclusions that most of the Kenyan teachers do not focus on students' thinking. These narratives showed that the SMASSE teachers' behaviours were, to some extent, different from those of typical Kenyan teachers, and these differences seemed to have positively influenced students' behavioural changes.

Regarding the perceptions of change in attitude, the support for scientific inquiry, self-confidence as a science learner, and interest in science were all important characteristics. The findings suggest that SMASSE teachers motivate and inspire confidence and self-reliance in science students, which has also been reported in several previous studies. Collet and Nakawa (2022) and Radford (2021) mentioned that learning was related to social interactions and had a clear connection to human affections. Our findings empirically support this statement.

Regarding the perception of behavioural changes, this study's findings suggest an influence of learning methods on career choices and life contexts outside of science. The findings show that SMASSE teachers' tutelage and character influenced respondents' career choices, increased their self-reliance as science students, influenced their professional work ethics and exerted considerable influence in life contexts outside of science. According to Storme and Celik (2017), career decision-making is highly complex. It also relates to cognitive self-efficacy. The findings infer that SMASSE teachers influenced students' career decision-making and self-efficacy. In terms of the environment, teachers influenced the social situation of their former students in Kenya.

Focusing on the interaction of the three elements, the specific teaching methods utilised by SMASSE teachers, their personalities, and their outlook on life and work could have had an influence on former students' attitudes, such as positive attitude and personal development, and behavioural changes, such as group activities and interacting with others. Moreover, collective efficacy and collaborative learning have been shown to have the potential to balance students' performances and their socio-economic status, and particularly impact low achievers by creating higher cognition (Bandura, 1993; Black & William, 1998; Clark, 2012; Crossouard, 2011; Goddard et al., 2000; Goddard, 2001).

The findings also show that attitude and behaviour changes are reciprocal. For example, Respondent #12 said that, through SMASSE teacher's classes, he witnessed attitude changes, such as interest and love for chemistry, and behaviour changes, such as going to the library during holidays. Respondent #14 became more dedicated to his studies than before because he realised that success requires hard work. This is a change in behaviour owing to a change in attitude. Moreover, Respondent #28 said that the experience of voicing his opinion as a group leader gave him confidence. This is a change in attitude owing to a change in behaviour. These changes in behaviour and attitudes have resulted in changes in the environment. For example, Respondent #28 created an environment for collaborative learning with others.

### ***RQ2: Perceptions of Relevance to Later Life***

The environment created by SMASSE teachers may have caused changes in attitude, while the behavioural changes it inspired have exerted a mutually reinforcing influence on former students' current working environment, their behaviour and personal factors. Furthermore, these elements are not

short-term changes that disappear after attending the class. The SMASSE training made it possible to create a long-lasting effect in students' career choices and development. This has also been mentioned in another study (Craig, 2010), which explored the influence of students' identity formation on their future career choices in engineering education. Once a programme or project succeeds in motivating students' interest towards science, they can maintain this positive attitude in adulthood. Learning has been applied to various aspects of their daily lives outside of science and the next generation, as these students pass on the benefits of the environment created by their SMASSE teachers. Thus, we identified long-term effects that have been difficult to capture in previous studies of international cooperation.

### ***RQ3: Effectiveness of the Qualitative Research in Evaluating Educational Project***

This study confirms that students underwent attitudinal transformations during the project. Moreover, these attitudinal transformations influenced their later lives, which in turn influenced their career choices and the way they live. SMASSE teachers motivated some of the former students to become teachers, indicating that they were influenced not only through science education, but also in terms of decision-making and career choices. This fact became clear through our use of the life story approach, in which the interviewees shared about themselves after reflecting on their life. This approach also revealed that long-term positive influences, in other words, long-term lifelong learning perspectives, were retained by former students (cf. Svensson, 2022). When examining the effects of educational interventions from a long-term perspective, as in this study, it is academically valuable to show that life story research can reveal the effects and outcomes of education from the perspective of the people involved.

In educational intervention projects for international cooperation, quantitative evaluations methods tend to be emphasised and evaluated based on limited indicators such as learning achievement test scores. However, in this study, the fact that the project impacted students' holistic growth holds educational value. As Svensson (2022) pointed out, from a sociocultural perspective, students not only gained scientific knowledge and skills as a result of science education, but also experienced social processes in complex social phenomena. These aspects are not easily apparent when using only quantitative methods. Therefore, the academic contribution of this study is that future qualitative evaluations may reveal the effects of the educational intervention from a broader perspective than estimated on the short-term.

### **Limitations and Scope for Future Research**

After approximately 13 years since the completion of the project, we have been able to conduct an analysis of former students from a long-term perspective, which is usually difficult to pursue and investigate. Our findings have revealed long-term effects of the various aspects of scientific-related competencies, general attitudes and behaviours. Overall, the findings show a substantial influence on former students' career choices and life contexts outside of science and confirm that these elements are mutually interrelated.

However, this study has limitations and certain issues should be addressed in future studies. First, the findings are limited because the respondents remain associated with SMASSE teachers. Their responses may be biased owing to their fondness for their teachers. Second, future studies should examine the demographics of respondents, including those employed in other occupations and unemployed. Third, further studies should assess how SMASSE teachers formed their personalities and outlook on their life and work to provide a comprehensive overview of the findings obtained in this study. Finally, more importantly, future studies should match respondents' statements to their actions to confirm the fundamentals of actual teaching behaviours.

### **Data availability statement**

The data are not publicly available owing to ethical restrictions.

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## Disclosure statement

No potential conflict of interest was reported by the author(s).

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