

Article

Education for Sustainable Development: How Seminar Design and Time Structure of Teacher Professional Development Affect Students' Motivation and Creativity

Cathérine Conradty *  and Franz X. Bogner 

Department of Biology Education, Centre of Maths and Science Education, University of Bayreuth, 95447 Bayreuth, Germany; franz.bogner@uni-bayreuth.de

* Correspondence: catherine.conradty@uni-bayreuth.de

Abstract: Teachers need to adapt teaching styles to the goals of modern education. The Starwalker project has developed an approach for strengthening students' self-efficacy and has provided professional development (PD) to teachers. The present study measured the effectiveness of PD indirectly by changes in students' motivation and creativity as indicators. Two PD designs with the same time budget were examined: (1) a traditional lecture with a single feedback session; (2) repeated supervision sessions. Students completed questionnaires on school motivation, self-reported creativity and personality measures at the beginning and end of the school year. Four classes each were selected for both treatments and a control group ($N = 281$; Mean-Age = 10.82). At baseline, with no difference, the second PD design showed a significant increase in motivation and creativity, while the first PD design showed no differences compared to the control group. Spearman's correlations of personality with motivation and creativity confirmed the presumed role of Agreeableness and Conscientiousness, while Grade Motivation and Flow were independent of personality. Structural equation modelling (SEM) confirmed the importance of creativity for motivation. The study proves that PD can be evaluated indirectly through its effects on students and confirms the Starwalker approach. Frequent brief interventions are recommended for attitude change.

Keywords: motivation; creativity; professional development; personality; science classroom; education for sustainable development



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1. Introduction

1.1. Educational Change for Stronger Self-Efficacy

Our society is becoming increasingly complex. With democracy, open sources of information, multicultural life, and globalisation, people are becoming aware of the world's complexity, which is leading to perceived insecurity and uncertainty. This requires complex problem-solving skills [1]. In the spirit of Education for Sustainable Development (ESD), citizens need to make decisions collectively. At the same time, there is an awareness that people will never possess all the information needed due to complexity. Consequently, networked, creative minds will have to solve problems that we may not even be able to survey today in a multifactorial context. Following these goals, the UNESCO Roadmap [1] suggested a triple action approach to educational change:

- “Field of action 2: Holistic transformation of learning and teaching environments: Integrating sustainability principles into education and training contexts. Field of action.
- Field of action 3: Capacity building of educators and multipliers: Strengthening the competencies of educators and multipliers for more effective ESD outcomes.
- Field of action 4: Strengthening and mobilising youth: Introducing more ESD measures for young people”.

The increasingly complex problems of our global, post-industrial culture require an education that fosters skills such as self-responsibility, creativity, and reflection. Dealing with that requires complex products that need multi-level creativity to develop. For a possible solution, the ability to generate and pre-select ideas through imagination is needed [2]. Reactive real-time creativity is characterised by spontaneity with improvisational and immediacy skills [2]. This high level of cognitive creativity is not innate and requires constant training. Modern education should provide various opportunities for creative thinking that are rich in form and subject matter. Hsu indicated that an incubation period prior to creativity was crucial for various individual traits relevant to creativity [3]. This highlights the importance of the classroom setting. Educators should guide individuals to link different aspects of imagination to develop creativity.

ESD focuses on skills that enable and empower individuals to reflect on their actions by considering social, cultural, economic, and environmental effects from both a local and global perspective. It requires individuals to act sustainably in complex situations, to explore new approaches and to participate in socio-political actions. This entails moving towards sustainable development gradually. In this way, ESD aims to empower learners to act responsibly, contributing to sustainable societies now and in the future. It develops the skills, values and attitudes that enable citizens to live healthy and fulfilling lives, make informed choices and respond to local and global challenges [4,5].

Exceptional cognitive performance is needed to achieve the above-described skills, which cannot be developed without appropriate support and training. Intellectual development is considered an ongoing biological process of assimilation and accommodation [6] to adapt appropriately to the environment [7]. To activate these processes, impulses from the environment are needed. They can be experienced subconsciously in everyday life or consciously through educators. At present, most public institutions lack support to promote these processes in a targeted manner. This could hinder cognitive and emotional maturation and be the reason for many known problems of immature young adults in the current generation [8,9].

1.2. Starwalker: Fostering Maturity through School Motivation

Starwalker[®] acknowledges ESD goals and is based on the concept of maturation [10]. The maturation process should develop self-confidence, moral judgement, advanced personality traits, defence mechanisms, behavioural maturity, planning competence, and concepts of personal career goals. This requires the promotion of self-efficacy and self-responsibility within school life to support long-term maturity. Three learning steps are recommended, each of which is tested in a corresponding conflict situation: (i) non-violent communication for conflict resolution [11], (ii) visualising/imagining and making plans [12], and (iii) managing and carrying out challenges and dealing constructively with failure [13,14].

In the first phase, students learn self-referential empathy based on non-violent communication, which, according to [11], requires vocabulary to recognise feelings, needs, and skills for peaceful conflict resolution. With a more differentiated perception of triggering needs, both conflicts with other people and inner conflicts become more comfortable to handle. Students are supposed to learn to imagine their future in the next step: "What is the result of my action, and what options do I still have? What makes a difference?" They express wishes and goals for the following weeks, the coming year, and their concept of individual life on a larger scale. These goals need to be checked to assess whether they are realistic. This imagination training fosters planning and creative thinking abilities. Creativity includes creating an original and useful product suitable for the area it was designed [15]. Perkins claimed creativity was a result of cultural contexts [16]. According to Csikszentmihalyi, the natural gift for creativity requires appropriate environments, stimuli, and interaction between individuals [12]. A creative individual solves problems, designs products, or defines new issues which are acceptable within a cultural context [17]. In one-person projects and class tests, the students test the strategies for achieving the goal.

The open-mindedness of teachers allows students to succeed in their goals, just as they can fail. This experience fosters the ability to deal with conflict and to endure ambivalence and uncertainty.

The challenges of the third phase practice, “Management by Objectives”, builds upon the SMART-goal setting and self-reflection [13]. As an acronym, this covers a decisive goal that should be: Specific, Measurable/motivating, Activating/Appropriate, Reasonable, and Time-phased. Not every successful challenge can act as a successful challenge. The goal may have been too simple so that a challenge is without gains despite achieving the goal. On the other hand, a challenge can be constructive even if a goal was not met because the students learned more about themselves and personal hurdles. Students adapt their goals in the reflection phase according to their motivation and skills discovered in the first round of the challenge.

1.3. Teachers Starwalker[®] PD

In order to ensure sustainability, Starwalker[®] lessons were part of teacher professional development modules. Instead of Starwalker trainers, students experienced lessons implemented by their teachers. These teachers had successfully passed an internal training program that focused on encouraging motivation and improving students’ learning success by enhancing educators’ professional knowledge and skills [18]. In most cases, teachers’ attitudes are not on the PD curriculum, although these are likely to have a considerable effect on students [18,19]. In the face of changing social needs and demands of the 21st century, and the fact that teachers are in office decades after leaving universities, PD’s methodologies are critical to upgrade teachers’ efficacies [20]. Flexible teaching practice is needed that makes educators more readily adaptable to the ecological, social, and economic challenges [21,22].

Most PD activities still follow traditional forms: mainly through lectures, 1-day workshops, seminars, and conferences, which are not situated in the workplace; teachers play a passive and receptive role, and the content is not adjusted to problems and issues of the daily teaching practice [23]. These traditional forms may not be sustainable, neglecting the specific features of the context. They may construct lists of possible solutions, which gives the illusion that following these lists would result in successful education [19].

Teachers play an active role in innovative PD forms, with a strong focus on the subject matter, active and inquiry-oriented learning and professional learning communities. Thereby, time is essential for the success of PD [24]. Behavioural change requires at least 80 h of teacher training [25]. A different aspect of duration is the sustainability of the intervention (e.g., [24,26]). Isolated, short-term interventions might be less effective than long-term interventions combined with continuing support, such as follow-up interventions, permanent support of group collaboration, and ongoing facilitation of teacher learning. Some studies point to the importance of learning communities [24,27]. Other studies emphasise the need for time [28] but rarely consider actual school conditions and teachers’ workload [23].

Starwalker considers the strengths and weaknesses of PDs, as mentioned before. Since learners imitate the educator, the form of teacher training was not frontal teaching in a lecture-style but focused on the interests and needs of the students. Teachers should regard students as learning partners who work as independently as possible. Existing knowledge and experience are examined, acknowledged, and identified for their usefulness. The form of training should be chosen accordingly. The training takes place at local schools in small regular interventions, in which participants are moderated by instructors but not lectured. Through mediation and short impulse presentations from current science, teachers are motivated to rethink. Problems of everyday school life are discussed, and previous attempts at solutions are reviewed to strengthen self-efficacy.

An initial informative teaser meeting with current research findings may better convince teachers that it is easier to change the classroom by developing skills and attitudes than to change students’ behaviour—which is hardly possible [29]. After a first seminar,

the PD is designed as regular 40-minute lesson interventions. The process was moderated as mediation and stimulated by reports on current research results. The training was conceived as a process in which teachers first presented problems of everyday practice, described their goals, and worked on solutions based on existing knowledge and impulses of the Starwalker design. Teachers had the opportunity to adapt the interventions to their everyday work. This freedom of choice promotes motivation and the will to cooperate [30]. Working materials for the project classes function as repeating homework for participating teachers.

1.4. Objectives of the Study

The study followed the four proposed hypotheses. First, the Starwalker[®] program is supposed to promote school motivation and student creativity, although typical creative interventions such as art were not part of the intervention. Therefore, our second hypothesis is that the success of a one-year in-service teacher training is indirectly measurable by the increased motivation of the students of the participating teachers. The third hypothesis is that professional staff learn content-based training quickly, not attitude-based teaching. Therefore, we assume that teachers need time and space to change their self-perceptions about good classroom management to successfully teach the Starwalker lessons because the in-service training was not about content but attitudes. Therefore, teachers will not be able to implement attitude-based Starwalker lessons effectively after a single day of the course. The training will be conducted in two different time frames to test this hypothesis. Our fourth hypothesis is that the promotion of self-efficacy and imagination influences motivation. Accordingly, a model is created that depicts the promotion of motivation through creativity as a function of personality.

2. Methodology and Methods

2.1. Programme

The teachers' professional development training named "Reduce stress! Motivated students, relaxed teachers" was given in two different forms. Treatment 1 involved attending an initial training of 2.5 h, briefing them with the latest news from research, information about the Starwalker[®] program and distributing working materials, with which teachers could implement Starwalker[®] lessons. After four months, a feedback meeting for supervision and exchange of experiences followed. Another four months later, a second supervision followed. Treatment 2 started with a shorter teaser training of one hour about the latest research of the Starwalker[®] program, including an exchange of experiences of previous attempts to involve students more actively in school life and reduce workload and stress. Afterwards, the Starwalker concept was presented and discussed, and students' material was distributed. There was the opportunity to get in contact with the coach. The 40-minute follow-up supervision sessions took place approximately every five weeks in a small, low-threshold setting during the lunch break. The total amount of the training had as many hours as Treatment 1 with the blocked course with three meetings. Teachers worked with the material with their classes in the regular teacher-hour once a week.

2.2. Participants

A total of 281 students completed questionnaires for this survey ($N_{\text{total}} = 281$). Four 5th grade classes per treatment participated, resulting in 200 students ($N_{\text{treatment1}} = 87$; $N_{\text{treatment2}} = 113$). Four classes participated as a control group without treatment ($N_{\text{control}} = 81$). Gender was almost evenly distributed (48.4% female). The mean age was $M_{\text{age}} = 10.82$, $SD_{\text{age}} = 0.809$. Gender and age were similarly distributed in all treatment groups.

A Kruskal–Wallis Test was calculated to determine differences in motivation factors between the three treatment groups (treatment 1, treatment 2, control). There was no statistically significant difference in motivation between the groups ($p > 0.077$; Table 1).

Table 1. Kruskal-Wallis-Test for pre-test motivation, group variable treatment.

	SD	SE	IM	GM
Kruskal-Wallis H	0.742	0.370	5.131	0.440
df	2	2	2	2
Asympt. Sig.	0.690	0.831	0.077	0.803

2.3. Test Design

The data were assessed at the beginning of the school year via paper-and-pencil questionnaires. These included sociodemographic data and a Creativity and a School Motivation Questionnaire. Questionnaire completion required about 40 min. After participating for one school year, changes in creativity and School Motivation were measured in a post-test (8 months later). The control group filled in only the post-test.

2.4. Research Design and Test Tools

We applied four subscales of the SMOT [31] based on the science motivation questionnaire [32], using a 5-point Likert scale pattern ranging from “never” (1) to “always” (5) (Table 2). The questionnaire was rewritten to be less specific (focusing on scientific motivation only) but to ask for general school motivation.

Table 2. School Motivation Questionnaire SMOT [31].

<i>For Each of the Following Statements, Please Indicate How True It Is for You:</i>
Self-Determination
5 I spend a lot of time studying.
6 I am preparing well for school assignments and projects.
7 I’m studying hard.
8 I’m trying hard enough to learn.
9 I use strategies that enable me to learn well.
Self-Efficacy
17 I am confident that I will do well on reviews.
18 I think I can get very good grades.
19 I believe that I can master the content and practical requirements in class.
20 I am confident that I will do well in internships, projects or presentations.
Intrinsic Motivation
1 Learning makes sense of my life.
3 Learning is interesting.
4 I like to learn.
Grade Motivation
14 Good grades are important to me.
15 Good assessments in internships or tests are important to me.
16 I’m thinking about what grade I will get on a test.

For creativity measurement, we focused on the level of motivation and attitudes associated with personal creativity, which can be conceptualised as the cognitive (thinking) and non-cognitive (motivation) dimensions of creativity [33]. We applied two subscales following the CPAC (cognitive processes associated with creativity) modified by Conrady & Bogner [34] and extended by Roth et al. [35] (Table 3). *Act* quantifies cognitive processes of conscious and active thinking that can be taught and practised. *Flow* monitors typical

elements of a flow experience [12], which supposedly assesses motivational experiences at school related to creativity. The creativity measure employed a 4-point Likert scale ranging from “never” (1) to “very often” (4).

Table 3. Creativity test [35].

<i>During the Past School Year—How Often Have You Done the Following?</i>
Act
When I tackled a topic, I tried to find as many ideas as possible.
To find a possible solution to a problem, I asked other people for help.
In order to find a solution, I looked at the problem from different points of view.
I brought together very different ideas to develop a new idea.
I built an old solution in a completely new way.
I have created a connection between a current problem/task and a similar situation.
I imagined a possible solution in the mind’s eye to check its usefulness.
Flow
When I work intensively, I don’t like to interrupt.
When I was working on a problem or task, I was totally immersed in it.
I totally lost track of time when I worked intensively.
I felt that entertaining work was automatic and effortless.
When I work intensively, I have the “overall picture” of my project in mind.

Data Analysis Procedure

For statistical analyses, IBM SPSS Statistics 26.0 was used.

Our data were not normally distributed, assessed by the Shapiro–Wilk Test, $p < 0.05$. The Mann–Whitney U test was applied to calculate group differences, such as between gender or the treatments and control group.

Structural equation model (SEM) analysis was applied to evaluate the relation of Personality, Creativity and Motivation. The SEM was based on theoretically valid variables, bivariate correlations and a maximum likelihood solution. Gender showed no effects and was therefore not included in the model.

Creativity and Personality were used as covariates to control effects on Motivation, measured by four subscales.

The goodness of fit of the models was based on a chi-square test. While technically, chi-square should be non-significant in model testing ($p > 0.05$), this is very hard to achieve due to the usually large sample required for it [36]. Despite a small sample, all fit indicators meet the requirements for significant results [37]. That is why we rely on more reliable benchmarks such as RMSEA, NFI, TLI and CFI. We assume indices of NFI (Normed Fit Index), TLI (Tucker–Lewis Index), and CFI (Comparative Fit Index) (good fit > 0.90 , or better > 0.95), and RMSEA (Root Mean Square Error of Approximation) reasonable fit < 0.08 , good fit < 0.05 [38]. Standardised beta coefficients and R2 values reflect the variance explained by the predictor variables.

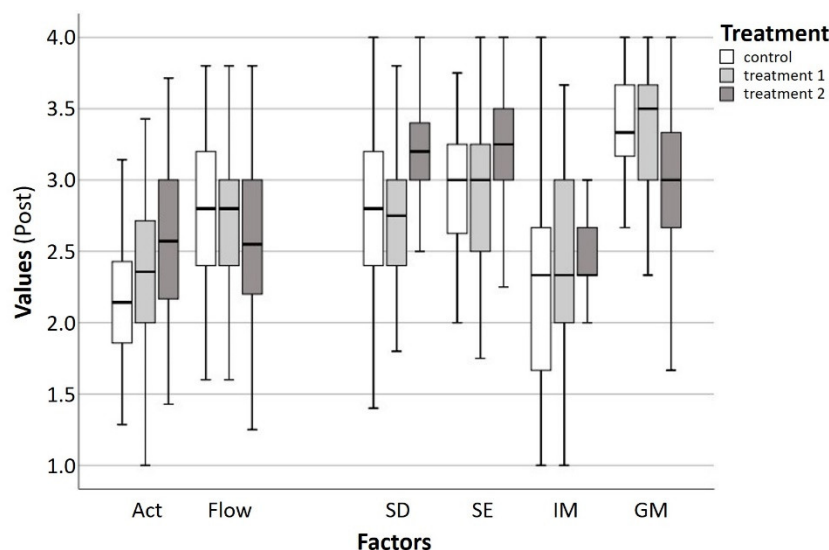
3. Results

Neither the three groups (Treatment 1, Treatment 2, or control) nor the entire sample revealed differences in gender at any assessment point.

Treatment 1 only differed in factor *Act* from the control. All other factors of creativity and motivation were similar to the control group (Table 4, Figure 1) and did not change.

Table 4. Mann-Whitney U test for differences between Treatment 1 and control.

	Act2	Flow2	SD2	SE2	IM2	GM2
Mann-Whitney-U	2431.000	3040.000	2671.500	3119.000	2965.500	3077.500
Wilcoxon-W	5752.000	6121.000	5752.500	6359.000	6286.500	6317.500
Z	−2.516	−0.412	−1.690	−0.004	−0.673	−0.152
Asymptotic significance (2-sided)	0.012	0.680	0.091	0.997	0.501	0.879

**Figure 1.** Post-test values control Treatment 1 and Treatment 2.

Treatment 2 differs from the control significantly in all parameters of creativity and motivation (*Act*, *SD*, *SE*, *GM*; $p < 0.001$, *Flow* $p = 0.013$, Table 5, Figure 1). Even though the differences in *IM* are small, they are still significant ($p = 0.033$).

Table 5. Mann-Whitney U testing for differences between Treatment 2 and control.

	Act2	Flow2	SD2	SE2	IM2	GM2
Mann-Whitney-U	2211.500	3249.500	2699.500	2622.000	3383.500	2412.500
Wilcoxon-W	5532.500	8502.500	6020.500	5862.000	6704.500	7665.500
Z	−5.407	−2.489	−4.062	−4.196	−2.132	−4.832
Asymptotic significance (2-sided)	<0.001	0.013	<0.001	<0.001	0.033	<0.001

Students of Treatment 2 gained better scores in all factors than students of Treatment 1, except for *GM* and *Flow*, which decreased (Table 6, Figure 1). There is no difference between both treatment groups in *IM*, but both are slightly but significantly higher than the control group. In Treatment 2, the *IM* values show less dispersion.

Spearman's Rho Correlations of the SMOT and Creativity with Personality were calculated (Table 7).

In the pre-test, Agreeableness was highly correlated with *SD* ($\rho = 0.303$, $p < 0.001$), and Conscientiousness with *SD* ($\rho = 0.345$, $p < 0.001$), *SE* ($\rho = 0.319$, $p < 0.001$) and *IM* ($\rho = 0.367$, $p < 0.001$). Calculating an overall Mean Score for School-Motivation (SMOT1) as recommended by Schumm and Bogner [32], the correlations become clearer: Motivation was correlated with Agreeableness and Conscientiousness. Personality was never correlated with *GM*.

Table 6. Mann–Whitney U test for differences between both Treatment groups.

	Act2	Flow2	SD2	SE2	IM2	GM2
Mann-Whitney-U	2912.000	3211.000	1951.000	2677.500	3585.500	2395.000
Wilcoxon-W	5993.000	8464.000	5032.000	5758.500	6666.500	7648.000
Z	−3.086	−2.229	−5.898	−3.811	−1.151	−4.668
Asymptotic significance (2-sided)	0.002	0.026	<0.001	<0.001	0.250	<0.001

Table 7. Spearman rho personality with creativity and motivation.

		Creativity			School Motivation		
		Act1	Flow1	SMOT1	SD1	SE1	IM1
E	Cor. Coef.	0.140	0.112	0.149	0.121	0.219 **	0.104
	Sig. (2-tailed)	0.069	0.148	0.060	0.127	0.005	0.190
	N	169	169	160	160	160	159
A	Cor. Coef.	0.226 **	0.078	0.261 **	0.303 **	0.214 **	0.222 **
	Sig. (2-tailed)	0.003	0.315	0.001	<0.001	0.006	0.005
	N	169	169	160	160	160	159
C	Cor. Coef.	0.271 **	0.177 *	0.380 **	0.345 **	0.319 **	0.367 **
	Sig. (2-tailed)	<0.001	0.021	<0.001	<0.001	<0.001	<0.001
	N	169	169	160	160	160	159
N	Cor. Coef.	0.122	0.017	0.127	0.190 *	0.079	0.133
	Sig. (2-tailed)	0.115	0.831	0.110	0.016	0.319	0.095
	N	169	169	160	160	160	159
O	Cor. Coef.	0.055	0.152 *	0.091	−0.019	0.004	0.134
	Sig. (2-tailed)	0.480	0.048	0.251	0.815	0.965	0.092
	N	169	169	160	160	160	159

Big5: E = Extraversion, A = Agreeableness, C = Conscientiousness, N = Neuroticism, O = Openness.
* = signification level < 0.5; ** = signification level < 0.01.

Flow appeared independent of Personality. *Act* was correlated with Agreeableness ($\rho = 0.226^*$, $p = 0.003$) and Conscientiousness ($\rho = 0.271$, $p < 0.001$) in the pre-test. Only the correlation of conscientiousness with *Act* was found in the post-test ($\rho = 0.339$, $p = 0.008$), indicating the correlation's power.

Because the stability of the Personality was assumed, the Big5 test was only completed in the pre-test. There is no correlation of Personality (pre-tested) with the post-test Motivation and post-test Creativity (Table 7).

Motivational factors were significantly correlated with Creativity (Table 8). Remarkably, *Flow* did not correlate with SD in the pre-test (Table 8). Calculating with the Mean Score SMOT, the correlation with creativity was highly significant with a high correlation coefficient (*Act*—SMOT $p > 0.001$, $\rho = 0.508$).

The path model is presented in Figure 2. The model fit the data after the treatment well. The sample size of 188, however, must be considered critically small [39]. Furthermore, the data suggested that Personality was not as stable as assumed. Nevertheless, the criteria indicate that the model fit. Because of the small sample size, the NFI is low, but IFI, TLI, and CFI are appropriate. RMSEA is still significant, albeit at a low level. The chi-squared statistic was insignificant ($\chi^2 = 47.607$, $df = 41$, $p = 0.222$) and the values of the relevant statistics of the goodness of fit were acceptable (NFI = 0.836; IFI = 0.974; TLI = 0.953; CFI = 0.971; RMSEA = 0.029).

Table 8. Spearman rho creativity and motivation.

		Pre Test					Post Test				
		SMOT1	SD1	SE1	IM1	GM1	SMOT2	SD2	SE2	IM2	GM2
Act1	Cor. Coef.	0.431 **	0.240 **	0.402 **	0.249 **	0.186 *					
	Sig. (2-tailed)	<0.001	0.002	<0.001	0.002	0.018					
	N	159	160	160	159	160					
Flow1	Cor. Coef.	0.255 **	0.054	0.307 **	0.167 *	0.222 **					
	Sig. (2-tailed)	<0.001	0.498	<0.001	0.036	0.005					
	N	159	160	160	159	160					
Act2	Cor. Coef.						0.508 **	0.473 **	0.424 **	0.419 **	0.247 **
	Sig. (2-tailed)						<0.001	<0.001	<0.001	<0.001	0.001
	N						179	179	179	179	179
Flow2	Cor. Coef.						0.355 **	0.221 **	0.321 **	0.303 **	0.384 **
	Sig. (2-tailed)						<0.001	0.003	<0.001	<0.001	<0.001
	N						180	180	180	180	180

SMOT1 = Mean Score of all School Motivation Factors; * = signification level < 0.5; ** = signification level < 0.01.

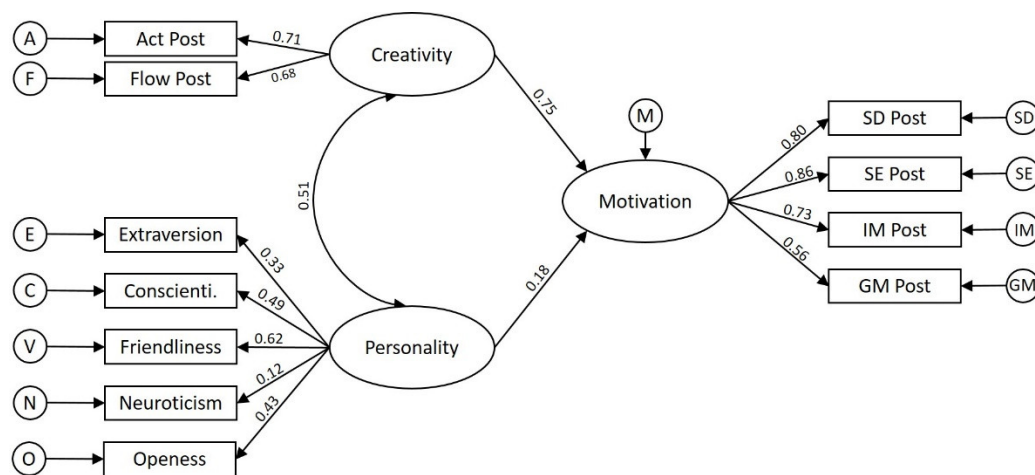


Figure 2. Model personality and creativity effecting motivation (post-test).

4. Discussion

As the four-factor structure of SMOT [31] and the two-factor structure of the CPAC [34,35] were once again confirmed, they provide validity for subsequent analyses. Consequently, we can use this student questionnaire to measure the teacher indirectly. In the present study, a year-long teacher training was evaluated with trustable results, which indicate that the Starwalker teacher training has the potential to change student motivation positively. The second hypothesis was confirmed, as the impact of teacher training can be evaluated indirectly through teachers’ students by the measured differences in student motivation. The differences in student motivation between the treatment groups proved the third hypothesis that professional staff learn content-based training quickly, not attitude-based teaching.

Using the Starwalker's way with regular supervision sessions, teachers acquire practical coaching skills under supervision based on attitude change. All motivation subscales of the students of coaching teachers increased, except grade motivation, which we interpret as a reorientation away from external assessment towards the students' responsibility for their learning [40,41]. The drop in grade motivation and the concurrent increase in SE and SD confirm our concept as promising to promote students' self-responsibility [42]. At this point, it is worth mentioning anecdotally that the grades did not deteriorate, which further strengthens our assertion. However, corresponding data could not be collected due to restrictive data protection regulations.

In line with the self-determination theory, school environments often insufficiently satisfy three basic psychological needs of youths during maturation: autonomy, competence, and relatedness [43]. Consequently, insufficient satisfaction might account for the decline in intrinsic academic motivation during adolescence [41]. The Starwalker® PD provided teachers with clever everyday methods that meet students' needs of experiencing competence and autonomy and also improve social dynamics within the classroom. These findings support the notion that an adequate satisfaction of three basic psychological needs is crucial for maintaining intrinsic academic motivation, especially during adolescence.

Similar results are also reported for the tertiary education sector. Students at universities who receive narrative assessments have higher intrinsic and autonomous motivation than students who receive multi-level grades [44]. Given the potential of grades to undermine basic psychological needs and academic motivation, it is not only higher education institutions that should reconsider whether and in what formats grades are appropriate or necessary.

A similar controversial discussion about the meaning, effect and form of usage of grades is the more modern debate about creativity in education, albeit particularly in the wake of the transition from STEM to STEAM [45]. In this study, creativity was not considered part of STEM education but more generally as a creative way of thinking in general education [34]. The results give a deeper insight into the importance of *Act* as a practical and *Flow* as an emotional factor of creativity.

The nature of *Act* and *Flow* is particularly evident in the pre-test. *Act* as the active part of creativity with imagination and communication is mainly determined by SE, followed by SD and IM. On the other hand, *Flow* was mainly determined by SE (Figure 2) and correlates strongly with GM (Table 7), reinforcing the nature of *Flow* to be sensitive to external factors and strongly influenced by the social environment [46]. After participating in Starwalker teaching, the close relationship between creativity and motivation became even more significant.

The Starwalker way of teaching can reduce the workload for each teacher. Instead of constantly fighting the students' lack of motivation, the teacher explicitly pushes the students' motivation and self-responsibility for learning [47,48]. This approach transforms the teacher's role into a coach who supports learners in the individual learning process. Thus, learning content is just one aspect of a rich training environment. Instead of focusing on the learning content, competencies needed to acquire the content knowledge in a motivated and sustainable way are of interest. However, the attitude of a coaching teacher fundamentally differs from a lecturing teacher, which has a decisive effect on the students and their motivation [49]. Therefore, the participating teachers need regular supervision to adopt the attitude required to work effectively with the Starwalker® method.

Consequently, the teacher training did not work even in an intensive full-day seminar with only two feedback meetings. Treatment 1 hardly differed from the control group. *Act* was the only parameter increasing in this group. The changeability of the *Act* scale is based on the addressed active creativity techniques and had already been noted in earlier studies [50,51]. The Starwalker approaches often queried and trained active creativity techniques such as collaboration, imagination and thought experiments. As such, *Act* included methods that can be reliably taught even in a short PD and through the provided workbook. *Act* did not require a significant change in the teaching behaviour of the

teacher. This result supports our third hypothesis that concise training is sufficient for subject content.

On the other hand, Flow is an emotional factor of creativity and needs a safe and undisturbed space with a benevolent environment. The coaching teacher is likely to create a working atmosphere that is conducive to flow. Nevertheless, flow could not be increased in the present study. Interactive teaching may not be well suited to flow events. Many artists describe the flow state as a moment of happiness of the highest concentration, which only occurs after an appropriate immersion period [12]. Although micro-flow is described as happening several times a day, the *Flow* scale did not measure micro-flow but asked for flow experiences at school. Short teaching units are probably not suitable for complete immersion in a task. Frequent interruptions or even just the possibility of being disturbed can prevent immersion and thus flow. However, achieving flow states was not an aim of the interactive Starwalker interventions, which did not offer space for contemplation. This space would generally be desirable to be facilitated more in the classroom but would have been beyond the scope in the present study. Since we wanted to ensure that the Starwalker lessons were established, flow-supporting work phases, which require a fundamentally different lesson design, were dispensed. Flow is an emotional component of creativity. Since flow is a very positive feeling, conducive to creativity and productivity, how to provoke flow has long been asked. A key question is whether flow can be learned or is an individual talent. Csikszentmihalyi [12] had already proven *Flow* to be independent of gender, which is confirmed again in the present study. Because the present study could not reveal any *Flow* correlations with the Big5, we consider flow to be primarily determined by the (social) environment that enables the person to immerse her-/himself in the creative process.

In the Treatment 2 group, even decreasing *Flow* values were reported, probably because the students have become aware that they do not experience flow in everyday school life.

In the present study with very young subjects, *Flow* was independent of gender as well as Personality. Evidence of gender differences in creativity [51,52], as well as evidence of their absence [50] can be found in the literature. The impact of sociocultural factors was, among other hypotheses, used to explain the observed differences [53]. In the present study, missing gender differences may be caused by two factors: the age of the participants and the sociocultural background [54]. As the age group in this particular study is relatively young, participants have not yet fully developed gender roles. Additionally, in Germany, the educational focus is on gender equality. Future studies will prove that younger generations benefit from a more gender-sensitive education and do not show any differences. Older studies on creativity have been conducted with adults, often in an occupational context, which leads to a pre-selection of participants, which could also explain the frequently found gender effect [55,56].

To conclude, this common ground between the otherwise very different factors of GM and *Flow* could be based on both dependences on external factors and the social environment. Grade motivation has been conceptualised as a factor of extrinsic motivation [40]. It is the only motivational factor that shows no correlation with Personality in either the pre- or post-test. Whether grades drive someone's motivation is not based on the learner's personality but solely on external circumstances, a mixture of education, experience, and personal interpretation.

In the present study, motivation is mainly defined by SD and SE and driven by conscientiousness and agreeableness. These findings support the theory that motivation can be increased with teaching forms that appeal to SD and SE. It was anticipated that motivation is strongly determined by conscientiousness in the school context. Successful school coaching courses have relied on this correlation for 40 years [57]. "Learning to Learn" courses train the ability to organise one's learning, including effective management of time and information. The results of the present study confirm the learning to learn hypothesis.

Agreeableness was very significant for motivation. This is probably due to the effectiveness of the personality trait, which strengthens a person's ability to establish bonds. Agreeableness supports the ability to build a good relationship. In school, learning success

is more accessible when the relationship with the teacher is friendly [58], which in turn results in higher motivation. Thus, it can be expected that more motivated students have higher Agreeableness scores.

In the present study, motivation was correlated with Personality, but this relation became insignificant in the post-test. This may be an artefact of the Personality that changed within the school year. Unfortunately, the present study's design did not consider this plasticity of young people's personality, which is not fully developed at this age. Thus, Personality was not measured in the post-test. Personality is not a genetically fixed characteristic but develops with experience and the individual interpretation of this experience [59]. "The longitudinal stability of personality is low in childhood but increases substantially into adulthood" [59]. In a meta-analysis, Briley & Tucker-Drob proved that this is due to the substantially stronger influence of the social environment than genetics in personality development [59]. This allows the conclusion that in personality development, one should not underestimate the influence of education and thus of life at school. Following the postulate that experiences form personality, an environment that promotes friendliness, openness, and conscientiousness will encourage individuals to express themselves in a correspondingly friendlier, more open and orderly manner.

The strong correlations of the personality factors Conscientiousness, Friendliness, and Openness for both motivation and creativity are in line with expectations according to the theories of creativity and motivation. Prabhu, Sutton and Sauser, have found similar connections in their model of personality and creativity as we have in our model of personality, motivation and creativity [60]. The development of SE-based motivation and *Act* (as the socially active part of creativity) need friendliness and openness, both mental and in the environment. Not surprising for school motivation is the influence of Conscientiousness [61,62], even though it contradicts frequent findings among creative professions, which often postulate particular chaos as the basis of creativity [63]. In school, the inclination towards Conscientiousness is undoubtedly helpful, as the inner structure helps maintain a safe framework in school [61], strengthening motivation.

The differences in the literature in the correlations between Personality and Motivation or Creativity certainly have various reasons. On the one hand, different tests were used, which certainly do not measure the same aspect of motivation or creativity [64–68]. Especially in the case of creativity, different aspects are considered, various definitions are assumed and measured on different levels, such as the product, and pre-selected groups, such as architects, are interviewed [69]. Motivation, on the other hand, is a more stable construct that is more clearly defined and understood. The differences with the literature are also likely to be found in the participating subjects. Whereas many studies were conducted with highly pre-selected groups of adult subjects, our young participants are likely to show a broad cross-section through the population, although the sample per se is small [53,63].

The model on the promotion of motivation via personality and creativity often shows the assumed correlations [37,46,70], but above all, it is an interesting pedagogical approach. The present model was only valid for the post-test data of the treatment groups, implying a correlation between the effects of Creativity and Personality on School Motivation in an appropriately supportive classroom.

Motivation is primarily driven by creativity, even though Personality is of importance. The most substantial factors are SD, SE, and IM. The model shows a subordinate role of GM, which is a strong contrast to the functional role of grades in everyday school life, which are still given despite lively discussion in the hope of motivating students to learn [44,71,72]. The present results contradict this often anecdotally confirmed task of grades. Instead, students feel motivated by Self-Efficacy and Self-Determination. Grades lead to performance-avoidance goals. Motivation, which may not be intrinsic but is autonomous, is crucial for the willingness to perform, whereas grades seem rather to undermine it [71].

This result is found in the pre-test as well as increasingly in the post-test of the treatment group. Even in the usual school routine, the students do not seek motivation

through grades but want to work through Self-Efficacy and Self-Determination. Since creativity is also strengthened by Self-Efficacy and Self-Determination, and all three are considered key competencies of future generations, it is strongly advisable not to apply grades as motivational support.

It should be emphasised that the praxis of grades is not being questioned in this context. The tradition and practice of daily life testify to a certain value of grades. The very way students are told their grades could become more effective, helpful and purposeful. If grades are given to increase motivation extrinsically, this could even work against the very educational goal of self-efficacy and self-determination. Successful students learn to measure their self-esteem through external assessment. Low-performing students are devalued, and the breadth of talents and abilities is hardly reflected in grades [73]. In the Starwalker[®] classes, teachers and students learned to reflect on successful and failed challenges. They learned to recognise error culture, error management and development opportunities. This also had an impact on everyday school life with exams and grades. With appropriate reflective guidance, the student and the teacher can discuss a different path of improvement [74]. Grades need to be communicated as what they should be used for in practice and in adulthood in the workplace: constructive feedback on the current state of development with opportunities for improvement and strategies for further work [73]. Since this feedback is what employees deserve for effective self-improvement, this should also be used with students.

5. Conclusions

The school environment often inadequately satisfies adolescents' three basic psychological needs during maturation that are essential according to self-determination theory: autonomy, competence and relatedness [43]. This could be one of the highly sought-out reasons for the decline in intrinsic academic motivation during adolescence [41]. In this framework, the need of teachers' coaching skills is increasingly emphasised [75], and experimentation with modern forms of teaching is taking place. Nevertheless, there are still hardly any tools to systematically monitor the success of innovative programmes. The Starwalker[®] project fills these gaps in two ways: it adapts a tool to measure teacher development indirectly (in press). Furthermore, it develops a teacher training programme to advance teachers' coaching competencies in school practice.

The developed motivational model emphasises the importance of creativity and self-efficacy and points to the need to consider these when designing lessons. The Starwalker[®] PD provided teachers with a teaching style using clever everyday methods that meet students' needs for experiences of competence and autonomy while improving social dynamics in the classroom. Students demonstrated increased self-efficacy and self-determination with less orientation to external motivators such as grades [40,41], suggesting that Starwalker[®] instruction promotes student ownership [42]. Motivation, while not intrinsic, is autonomous and has a critical impact on achievement, whereas grades seem to undermine it [71,72].

Ultimately, Starwalker[®] teaching reduces teacher workload and increases classroom productivity. The teacher no longer has to fight students' refusal to work and lack of motivation [47,48] but guides students to self-regulate their motivation. In the tutor's role, the teacher supports learners in their individual learning process and explicitly leaves the students in charge of their learning.

Although the methods are not large-scale interventions, they have a tremendous impact on the students. This underlines the fact that the influence of the social environment on personality development cannot be underestimated [59]. Educators have the opportunity to decisively influence the development of young people's responsibility, performance and social skills [58,59]. Following the postulate that experiences shape personality, an environment that promotes friendliness, openness and conscientiousness will encourage individuals to behave in a more friendly, open and orderly manner.

The motivational model developed emphasises the importance of creativity. Unfortunately, the promotion of creativity was not the focus, even though imagination was

used and thus, creativity factor *Act*, but not *Flow*, was strengthened. Flow is a moment of happiness with maximum concentration and only occurs after an appropriate period of immersion [12]. Short teaching units are probably not suitable for flow, which requires an appropriate time budget and social environment [12]. It would undoubtedly be desirable to find out how (micro-)flow moments can be promoted in the classroom to integrate the emotional, self-rewarding phase of creativity into teaching. Large-scale studies on the practical adaptation of teachers' specific teaching skills should follow.

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