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Experimentation and Differentiated Instruction in Biology Lessons

Examining the Effects of Incremental Scaffolds on the Students' Interest

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Abstract

Science courses are characterized by a heterogeneous student body. Besides the students' heterogeneity, a decline in interest during the school career was observed in biology. The implementation of experiments could face this decline in interest. However, complex experimentation causes difficulties for students, especially if students have different learning backgrounds. Incremental scaffolds could be used as instructional and internally differentiating instruments to enable autonomous experimentation in biology lessons. Additional incremental scaffolds in mathematics lessons could further address the difficulties in mathematical evaluation of complex experiments. The present study investigated the influence of incremental scaffolds during experimentation in biology and mathematics lessons on the students' situational interest. 75 students (55.2 % female; M_{age} = 16.50 ± 0.80 years) conducted an experiment on the subject of osmosis and were taught on the subject of linear functions in mathematics lessons. Data on students' individual and situational interest in biology classes was collected. The results of a multivariate analysis of covariance showed significant effects of the treatment on the *value-related* component of students' situational interest and descriptive differences regarding the subscales *emotional* and *cognitive* in favor of the students who used incremental scaffolds during the biological experiment. Thus, the use of incremental scaffolds during experimentation could provide a useful support to promote students' interest in biology.

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Introduction

The promotion of biological interest can be described as an important goal of biology teaching. However, a strong decline in interest in biology lessons can be observed (Krapp & Prenzel, 2011). This could be countered, for example, through the stronger Please adapt this word to American English as follows: contextualization of lesson content and the inclusion of student-oriented forms of work, such as inquiry-based learning and experimentation (Minner et al., 2010). Inquiry-based learning allows learners to be actively involved in the problem solving process and thus can foster learners' engagement (Abd-El-Khalick et al., 2004; Darling-Hammond et al., 2020). Encouraging students to be active learners is in turn associated with the promotion of interest (Mitchell, 1993). However, open and complex experimental tasks cause a variety of challenges for the students in biology lessons (Arnold et al., 2014; de Jong & van Joolingen, 1998). These problems are more pronounced when learners have different learning backgrounds (e.g., different prior knowledge, motivation, etc.) (Furtak et al., 2012; Kalyuga, 2013). Such challenges can be addressed by means of instructional support (Kalyuga, 2013). The implementation of incremental scaffolds could provide this instructional guidance. While the learners are offered a learning-strategic or content-related prompt for processing the task in a first step, they receive the possible task solution in a second step (Hänze et al., 2010). In particular, the difficulties during the evaluation of experiments that result from learners' lack of mathematical competence (Wellnitz & Mayer, 2013) could be addressed by additional incremental scaffolds in mathematics classes. The mathematical content could then be used in biology classes during the analysis and interpretation of the data from the experiment. From a learning psychology perspective, the incremental scaffolds thus offer instructional guidance while promoting independent work (Arnold et al., 2014). As internally differentiating means in biology and mathematics classes, the incremental scaffolds might contribute to promoting interest.

Theoretical background

Inquiry-based learning and experimentation

Inquiry-based learning can be described as a central goal in science education (KMK, 2020). Due to the student-centred character of inquiry-based learning, learners are actively and collaboratively involved in the learning process (Abd-El-Khalick et al., 2004; Hmelo-Silver et al., 2007). Inquiry-based learning enables learners to fully engage in the scientific research process by independently developing research questions and hypotheses, selecting and applying research methods, and interpreting results (Furtak et al., 2012). In this way, students can develop an understanding of the nature of science (Abd-El-Khalick et al., 2004). Based on a meta-analysis by Pedaste et al. (2015), the following five phases of inquiry-based learning can be distinguished: *Orientation*, *Conceptualization*, *Investigation*, *Conclusion*, and *Discussion*. The orientation phase focuses on stimulating interest and curiosity about a topic. This phase results in a problem definition. Based on the developed problem, the research questions or hypotheses are formulated in a theory-driven manner in the phase of conceptualization. In the subsequent phase of investigation, explorations or experiments are planned and carried out, and the data obtained are analysed and interpreted. During the conclusion phase, conclusions are drawn from the collected and interpreted data, which are related to the questions and hypotheses that have been formulated. The discussion phase consists of a communication phase, in which the results are presented to others, and a reflection phase, in which the process of inquiry-based learning is critically reflected (Pedaste et al., 2015). One method of scientific inquiry is experimentation (Osborne et al., 2003). As a complex problem-solving process, experimentation can be described as cognitively demanding for the students (Abd-El-Khalick et al., 2004). Various empirical studies have shown that open and complex experimentation causes a variety of challenges for students in biology lessons. In addition to the development of research questions and hypotheses as well as the planning of experiments, students show particular deficits in the evaluation of experiments (Arnold et al., 2014; de Jong & van Joolingen, 1998). In this context, students lack mathematical competencies to evaluate experiments in biology classes (Wellnitz & Mayer, 2013). Furthermore, students show deficits in explaining and interpreting experimental results (Germann et al., 1996). If the tasks are too demanding, they could have a negative effect on the learning process of the students. Too high cognitive load could lead to a reduction in learning success (Paas et al., 2003), this could also be accompanied by a loss of motivation (van de Pol & Elbers, 2013). The perception of task difficulty depends on the students' individual learning prerequisites (e.g., prior knowledge) (Kalyuga, 2013). For this reason, the described difficulties during open experimentation may be more pronounced in heterogeneous learning groups. To address these deficits and to enable working on complex tasks, such as open experimentation (Abd-El-Khalick et al., 2004), in heterogeneous learning groups, means of instructional support adapted to the students' individual learning background should be implemented (Blanchard et al., 2010; Kalyuga, 2013).

Instructional support during experimentation and incremental scaffolds

Based on the degree of structure and guidance, different forms of instructional support during experimentation ranging from direct instruction to open discovery learning can be distinguished (Sadeh & Zion, 2012). However, both direct instructions and open designed minimal instructions can lead to a decrease in students' learning process (Kirschner et al., 2006; van de Pol & Elbers, 2013). On the one hand, direct experiment instructions contradict the learning idea of constructivism and thus reduce the authentic character of experimentation (Hmelo-Silver et al., 2007). On the other hand, minimal instructions cause high cognitive challenges for the students during inquiry-based experimentation (Kirschner et al., 2006). In order to provide support and structure in the experimentation process and to preserve the authentic character of experimentation, scaffolding could be implemented in science lessons. Scaffolding offers an opportunity to address the learners' individual learning backgrounds (e.g., subject-specific prior knowledge) (Kame'enui et al., 2002). Scaffolding elements can thus be classified as means for initial differentiating. According to Letzel et al. (2020), internal differentiation is defined as a collective term for various homogenizing measures to compensate for different learning requirements of students as well as for measures for individual support considering the heterogeneity of the learning group.

Incremental scaffolds can be described as one type of scaffolds (Schmidt-Weigand et al., 2008). They were developed explicitly for science teaching and complex tasks such as experimentation (Leisen, 2010). Incremental scaffolds provide instructional guidance while encouraging learners to work independently on complex experimentation tasks (Hänze et al., 2010). Based on a concept of Leisen (2010), incremental scaffolds consist of two parts. In the first step, the students can receive content-related or strategic prompts to work independently on the experimental tasks. These prompts include strategies for learning and problem solving, such as paraphrasing, elaborating subgoals and activating prior knowledge (Schmidt-Weigand et al., 2008). In the second step, learners can compare their own partial solutions with example solutions (Hänze et al., 2010). Due to the character of incremental scaffolds, they play an important role as methods for individualising learning processes in heterogeneous learning groups (Schmidt-Weigand et al., 2008). Based on a taxonomy of differentiated instruction by Pozas and Schneider (2019), incremental scaffolds are categorized as *staggered nonverbal learning aids*. They define this form of differentiated instruction as sequential learning aids with varying levels of difficulty. These learning aids contain information that learners can use to solve a problem (Pozas & Schneider, 2019). While working on the task, learners can use the assistance of the incremental scaffolds in a self-regulated manner according to their own perceived difficulties. Against this background, learners of different ability levels can benefit from the use of this support (Schmidt-Borcherding et al., 2013). Higher-performing learners who do not need guidance on how to work through the task can use the sample solution to compare with their own solution (Schmidt-Weigand et al., 2008). Lower-performing students can use the prompts to support them in creating an answer on their own. These students can then also use the sample solution for comparison (Schmidt-Weigand et al., 2008). The initially differentiating character of incremental scaffolds has already been confirmed in various empirical studies. Großmann and Wilde (2019) showed that both students with a high level of subject-specific prior knowledge and students with little subject-specific prior knowledge could benefit from the use of incremental scaffolds during experimentation in biology lessons.

Incremental scaffolds and interest

In addition to the described positive effects on the students' knowledge acquisition in biology classes (Großmann & Wilde, 2019; Stiller & Wilde, 2021), the use of incremental scaffolds can be associated with an increase in the experience of competence and autonomy (Hänze et al., 2010; Kleinert et al., 2022). In this context, Hänze et al. (2010) describe incremental scaffolds as a compromise between "do it yourself" (p. 71) and "really being able to" (p. 71). According to the self-determination theory of motivation, the experience of competence and autonomy can be described as basic psychological needs. Furthermore, the satisfaction of these basic psychological needs can be related to the development of intrinsic motivation (Ryan & Deci, 2017). Based on these assumptions, empirical studies have already shown positive effects of the use of incremental scaffolds during experimentation in science classes on the students' intrinsic motivation (Kleinert et al., 2022; Schmidt-Borcherding et al., 2013). In addition, the satisfaction of basic psychological needs can be accompanied by an increase in learners' interest (Krapp, 2005). Interest can be defined as a person-object relationship according to Hidi and Harackiewicz (2000). Interest is also characterized by an emotional, intrinsic, value-related, and cognitive component (Krapp, 2010). The *emotional* component of interest includes positive feelings and qualities of experience during engagement with the object of interest. These emotions during an interest-based activity include pleasure and joy, excitement, and engagement (Krapp, 1999, 2007). The *value-related* interest component involves the subjective meaningfulness of an object or action of interest to a person. Personal significance is accompanied by active engagement and identification with the object of interest (Krapp, 1999). The *cognitive* component is based on the close relationship between cognitive processes and interest. Interest in an object or activity results in a pronounced willingness to acquire new knowledge and competencies in the area of interest (Krapp, 2007).

Renninger and Hidi (2016) distinguish between individual and situational interest based on the stability of interest. As a motivational disposition, learners' individual interest can be described as stable and long-lasting, whereas situational interest exhibits less stability (Mitchell, 1993; Renninger & Hidi, 2016). In contrast to individual interest, situational interest can be influenced by external conditions of the learning environment (Hidi & Harackiewicz, 2000; Renninger & Hidi, 2016). To influence situational interest, Mitchell (1993) proposes the implementation of activating work methods in the classroom. Furthermore, interest-promoting learning contexts should foster the experience of the basic psychological needs for autonomy, competence and relatedness (Harackiewicz et al., 2016; Potvin & Hasni, 2014). Interest plays a significant role in successful learning as it is positively related to the use of deep processing learning strategies (Isaak et al., 2022).

However, to our knowledge, there is a lack of empirical studies investigating the effects of the use of incremental scaffolds on learners' situational interest during experimentation in science lessons. Therefore, the aim of the present study is to examine these possible correlations between the use of incremental scaffolds during the experimentation process and the expression of situational interest.

Research questions

Inquiry-based experimentation as a student-oriented form of work could promote students' interest in science classes (Minner et al., 2010). Experimentation as a complex problem-solving process might require the use of instructional support measures. For instructional guidance during experimentation, the described incremental scaffolds could be implemented (Schmidt-Weigand et al., 2008). They encourage students as active learners during the problem solving process (Hänze et al., 2010). This could be accompanied by the promotion on students' interest (Schraw et al., 2001).

> *Research question 1: Does the use of incremental scaffolds during the evaluation of the experiment promote the situational interest of students in biology class?*

Especially during the evaluation and interpretation of an experiment, students show difficulties (Arnold et al., 2014). These deficits can be explained by the learners' lack of mathematical competence (Wellnitz & Mayer, 2013). To address these difficulties, additional incremental scaffolds could be used to support the mathematical evaluation process.

> *Research question 2: Does the use of incremental scaffolds in mathematics class in addition to the use of incremental scaffolds during the evaluation of the experiment additionally promote the situational interest of the students in biology lessons?*

Methods

Sample

75 eleventh-grade students of an experimental grammar school (55.2 % female; M_{age} = 16.50 years, SD_{age} = 0.80 years) participated in the current study. The school's concept is oriented towards a heterogeneous student body. For this reason, the school also accepts students who do not have a qualification for the grammar school (approx. 30 % of the students in the introductory phase). The students were divided into the experimental group I (incremental scaffolds in biology lessons; n = 23), the experimental group II (incremental scaffolds in biology and mathematics lessons; n = 26) and the control group (without incremental scaffolds in biology and math lessons; n = 26).

Test instruments

Individual interest in biology was measured using the PISA questionnaire *Enjoyment and interest in natural sciences* (Frey et al., 2009). The scale consisted of five items. Situational interest in biology was assessed with a self-developed questionnaire consisting of three subscales (*emotional*, *value-related*, *cognitive*). The questionnaire included 15 items. Both scales were measured on a five-point rating scale (0 = *strongly disagree* to 4 = *strongly agree*). To check the factor structure of this questionnaire a major axis analysis was performed. The Kaiser-Meyer-Olkin value (KMO) of the calculated major axis analysis was 0.911. The factor analysis indicated a three-factor structure. 75.76 % of the variance were explained by the three factors (*emotional*, *cognitive*, and *value-related*). The items had factor loadings ranging from .38 to .84. Furthermore, the internal consistencies of the (sub-)scales and the selectivity of the items were in a good range (Table 1).

Table 1: Number of items, example item, and internal consistency for each subscale of situational interest in biology lesson.

Subscale	Number of items	Example item During the biology lesson …	Internal consistency (Cronbach's alpha)	Selectivity of items
Emotional	5	… I enjoyed the subject.	.91	.73 –.85
Value-related	6	… I found the topic personally relevant.	.92	.62 –.88
Cognitive	4	… I wanted to learn more about the topic.	.89	.70 –.84

Test design

The current study followed a quasi-experimental design and was embedded in an interdisciplinary teaching unit between the subjects of biology and mathematics. While the students were taught about osmosis in biology, the mathematic lessons dealt with the subject of linear functions (Kleinert et al., 2020).

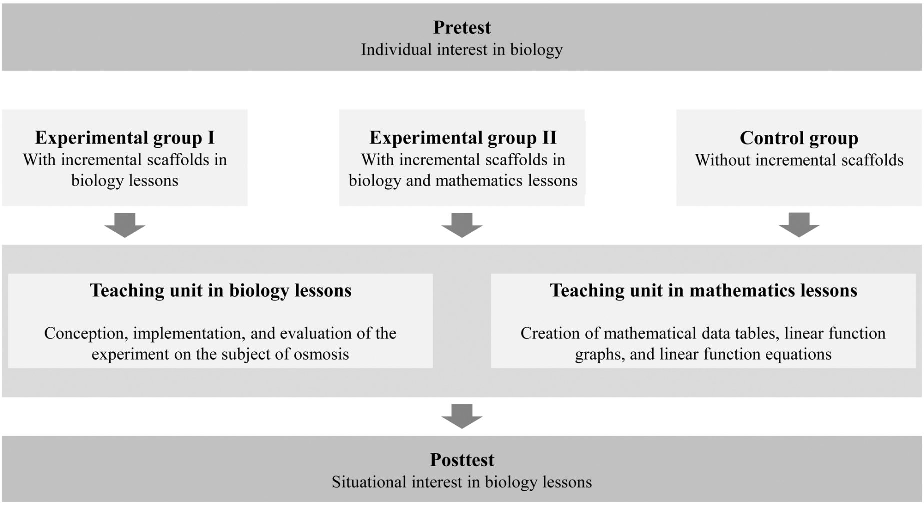

Figure 1: Test design of the current study.

In the pretest at the beginning of the teaching unit, the students' individual interest in biology was assessed. Afterwards, the students participated in the classroom intervention. The teaching unit in biology lessons included the conception, implementation, and evaluation of the experiment "*The osmotic effect of common salt – A student experiment to determine the cell sap concentration in different types of vegetables*" (Schumacher et al., 2020). The students developed their own research questions and hypotheses. These developed research questions and hypotheses were then discussed in the plenary session. The students investigated the following research question "*How high is the cell sap concentration?*" and hypothesis: "*The studied vegetable species have different cell sap concentrations.*". To test this hypothesis, the students planned the experiment. The experiment was then carried out independently in groups. The data obtained from the experiment was used by the students to evaluate the experiment. The students created tables of values, calculated mean values and error measures in order to plot them in a diagram (Schumacher et al., 2020). For the evaluation of the experiment, the students in the experimental groups I and II had the opportunity to use incremental scaffolds (Bekel-Kastrup et al., 2020). The learners in the control group worked without incremental scaffolds. The incremental scaffolds in biology lessons were designed for the following evaluation steps: determination of the relative mass difference, determination of the mean values of the measured values, creation of the diagram, explanation of the diagram with reference to the theory of osmosis, drawing of a compensation line, and determination of the cell sap concentration (Bekel-Kastrup et al., 2020). As an example, the incremental scaffolds for creating a diagram shall be described. In a first step, learners can view a strategic prompt that should stimulate their prior knowledge to design a suitable diagram. In this context, the students can use impulses for axis scaling and axis labeling. In a second step, the learners can receive a possible diagram as a solution (Bekel-Kastrup et al., 2020). At the same time, the students attended a teaching unit on the subject of linear functions in mathematic lessons. This unit includes the creation of mathematical data tables and function graphs. In addition, the students learned how to develop linear function equations from function graphs. The students could use these contents for the creation of function graphs and the formulation of function equations for the evaluation of the experiment in biology class (Kleinert et al., 2020). While the students in experimental group II were able to use incremental scaffolds to create a linear function equation (Hamers et al., 2020), the learners in the control group and experimental group I worked without incremental scaffolds in mathematics lessons. The incremental scaffolds for determining the slope of the function graph are presented here as an example. The students can receive a strategic prompt that is connected to their prior knowledge regarding the creation of slope triangles. In the sample solution of these incremental scaffolds, learners can view a slope triangle constructed for the function graph (Hamers et al., 2020). After the teaching unit, the students' situational interest in biology lessons was assessed in the posttest.

Statistical analysis

A multivariate analysis of covariance (MANCOVA) was conducted to investigate the difference in situational interest in biology lessons between the students in the treatment groups. Since the students' individual interest in biology can be described as predictor for the situational interest, it was applied as covariate. All requirements of the MANCOVA were checked. Normal distribution was fulfilled for the subscales *emotional* ($p = .200$), *value-related* ($p = .185$), and *cognitive* ($p = .197$). The first requirement for including the covariate, i.e., independence of the covariate from the study group, was fulfilled ($F(2,72) = 0.71$, $p = .493$, $\eta^2 = .019$). In addition, the second requirement for inclusion of the covariate (the homogeneity of the regression slopes) was met for each subscale (*emotional*: $F(2,69) = 0.09$, $p = .911$, $\eta^2 = .003$; *value-related*: $F(2,69) = 0.29$, $p = .749$, $\eta^2 = .008$, *cognitive*: $F(2,69) = 0.60$, $p = .551$, $\eta^2 = .017$). If the MANCOVA showed significant effects of the treatment, simple contrasts were performed.

Results

The comparison of the individual interest of the students in the three study groups, as surveyed in the pretest, showed no significant differences (Table 2).

Table 2: Means (*M*) and standard deviations (*SD*) for the individual interest in biology for the students in each treatment group.

Experimental group I *M* ± *SD*	Experimental group II *M* ± *SD*	Control group *M* ± *SD*	Main effect of treatment group
1.74 ± 0.73	1.59 ± 0.77	1.49 ± 0.67	$F(2,72) = 0.71$, $p = .493$, $\eta^2 = .019$

The results of the MANCOVA showed significant effects of the covariate (*individual interest*) on the subscales of situational interest in biology lessons with medium to large effect sizes (Table 3 and 4). For the comparison of the three study groups, significant differences were found in the subscale *value-related* with medium effect size (Table 3 and 4). A contrast analysis revealed significant differences between experimental group I and experimental group II as well as between experimental group I and the control group in favor of the students in experimental group I (Table 3 and 4). Furthermore, significant differences between the control and the experimental group II in benefit for the students in the control group were shown in the contrast analysis (Table 4). For the subscales *cognitive* and *emotional*, descriptive differences in comparison of the treatment groups were found (Table 4). While the learners of experimental group I showed the highest values regarding these subscales, the learners of experimental group II showed the lowest values (Table 3).

Table 3: Means (*M*) and standard deviations (*SD*) for the subscales of situational interest in biology lessons.

	Experimental group I	Experimental group II	Control group
	M ± *SD*	*M* ± *SD*	*M* ± *SD*
Emotional	2.01 ± 0.99	1.51 ± 0.76	1.84 ± 0.61
Value-related	1.74 ± 0.79	1.17 ± 0.77	1.56 ± 0.68
Cognitive	1.64 ± 1.05	1.05 ± 0.70	1.41 ± 0.78

Table 4: Results of the MANCOVA (covariate: individual interest in biology) for the subscales of situational interest in biology lessons as well as the results of the simple contrasts.

	Effects of the covariate	Effects of the treatment	Simple contrasts		
			Experimental group I and control group	Experimental group I and experimental group II	Control group and experimental group II
Emotional	$F(1,71) = 8.70$, $p = .004$, $\eta^2 = .11$	$F(2,71) = 2.52$, $p = .087$, $\eta^2 = .07$	–	–	–
Value-related	$F(1,71) = 7.82$, $p = .007$, $\eta^2 = .10$	$F(2,71) = 3.87$ $p = .025$, $\eta^2 = .10$	$t(47) = 1.92$, $p = .04$, $r = .22$	$t(47) = 2.33$, $p = .024$, $r = .31$	$t(50) = 1.95$, $p = .03$, $r = .26$
Cognitive	$F(1,71) = 11.84$, $p = .001$, $\eta^2 = .14$	$F(2,71) = 3.01$, $p = .055$, $\eta^2 = .08$	–	–	–

Discussion and conclusion

The aim of the study at hand was to investigate possible connections between the use of incremental scaffolds in biology and mathematics lessons and the students' situational interest. With the help of the first research question, it was to be answered whether the use of incremental scaffolds during the evaluation of the osmosis experiment in biology lessons is accompanied by a promotion of learners' situational interest. The results of the MANCOVA showed significant effects of the students' individual interest and the use of incremental scaffolds during the evaluation of the experiment on the learners' situational interest in biology lessons with medium to large effect sizes. With regard to the significant influence of learners' individual interest in biology on the dimensions of situational interest (*emotional*, *value-related* and *cognitive*) the results of the present study support the findings of previous empirical studies. In this context, the investigation of Desch et al. (2016) revealed positive effects of the individual interest on the learners' situational interest in biology classes.

The significant effects of using incremental scaffolds during the evaluation of the experiment on the *value-related* component of situational interest as well as the descriptive highest values regarding the *emotional* and *cognitive* components in favor of experimental group I can be justified by the character of the incremental scaffolds. These elements of scaffolding allow the subdivision of the complex experimental task into different parts. In this way, they structure the learning environment for the learners (Hänze et al., 2010). By presenting the prompts gradually, learners are actively engaged in the learning process throughout the experimentation. Scaffolding elements thus encourage students to be active learners (White & Frederiksen, 1998). According to Schraw et al. (2001), this is accompanied by an increase in situational interest in the classroom. In the context of strategic scaffolding, Rotgansa and Schmidt (2011) have already shown that learners' situational interest can be increased. For the use of worked-examples as a related concept of incremental scaffolds, similar effects were evident (Yaman et al., 2008). By providing step-by-step instructions for problem solving and activating learners in the learning process, situational interest could be promoted (Schraw et al., 2001). In addition to the structuring and activating character of scaffolding elements, incremental scaffolds enable students to connect to prior knowledge through the prompts, which is an essential factor in increasing situational interest in the classroom (Schraw et al., 2001). Furthermore, incremental scaffolds highlight the task relevance to learners. Strategic prompts designed to encourage paraphrasing, focusing, or elaborating on the task can emphasize the relevance of the task to learners (Schmidt-Weigand et al., 2008), which may also be related to promoting situational interest in the classroom (Schraw et al., 2001).

With regard to the specific results on the dimensions of situational interest, the significant differences concerning the subscale *value-related* can be explained in particular by the described function of the incremental scaffolds to focus the task relevance. The descriptive differences regarding the *emotional* and *cognitive* dimensions of interest could be explained by the structuring character of the incremental scaffolds. As means of instructional support, they might equally support students' experience of competence and autonomy during experimentation (Hänze et al., 2010; Kleinert et al., 2022). The experience of competence and autonomy is in turn associated with the *emotional* and *cognitive* dimensions of interest (Krapp, 1999). In this context, Krapp (2005) found a positive relationship between the fulfilment of basic psychological needs and positive *emotional* qualities during an interest activity. Furthermore, it was shown that an autonomy and competence supportive learning environment, as represented by learning environments with incremental scaffolds (Hänze et al., 2010; Kleinert et al., 2022), increases the willingness to acquire knowledge in terms of the *cognitive* interest dimension (Niemiec & Ryan, 2009). Conversely, the lower expressions of situational interest in the control group compared to experimental group I could be explained. It can be assumed that the lack of instructional support in the control group might be associated with an increased cognitive load for the learners during the evaluation of the experiment (Arnold et al., 2014; Germann et al., 1996). In this context, Schmidt et al. (2019) have already shown that open experimentation can lead to an increased extrinsic cognitive load compared to experimentation with incremental scaffolds (Kirschner et al., 2006). An increased cognitive load could restrain the students' learning process and thus decrease the engagement with the learning object (Paas et al., 2003; van de Pol & Elbers, 2013). Against this background, the described results of the control group regarding the situational interest might be explained. In follow-up studies, the influence of cognitive load on the students' situational interest should therefore be investigated.

The second research question was to answer whether the additional use of incremental scaffolds for the topic of linear functions in mathematics lessons, in addition to the use of the incremental scaffolds during the evaluation of the experiment, can additionally promote the learners' situational interest. Contrary to our assumption, the results of the present study indicated that the use of incremental scaffolds in mathematics lessons has no additional effect on the expression of learners' situational interest in biology lessons. This finding might be explained by the design of the incremental scaffolds in mathematics lessons. As part of a pilot study, it could be shown that the learners did not perceive the tasks on the subject of linear functions as difficult and complex enough for working with incremental scaffolds (Hamers et al., 2020). The low complexity of these tasks might have led to students being underchallenged during the mathematics lessons. As a consequence of this lack of complexity, Paas et al. (2004) assume a limitation of the learning process and a decrease of students' experience of competence (van de Pol & Elbers, 2013). It can be assumed that this learning environment, that did not support students' competence, might explain the low level of situational interest of the learners in experimental group II (Harackiewicz et al., 2016; Potvin & Hasni, 2014). Regarding further empirical studies, the task format in mathematics lessons should therefore be adapted. Based on the adapted incremental scaffolds, possible effects of the additional use of the mathematical incremental scaffolds on the learners' situational interest could then be examined.

Despite the described results, some limitations of the current investigation should be addressed. A limitation of the present study is the small sample size. Against the background of the small sample size, a beta error might have been occurred with regard to the subscales *emotional* and *cognitive*. For these subscales, the medium effect sizes might hint that an increase in sample size could lead to significant differences in the comparison of the treatment groups (Field, 2018). Based on the low sample size, the quasi-experimental design could also be described as problematic. Due to the non-randomized assignment of the students to the treatment groups, differences between the groups could already be present before the intervention. However, the comparison of the students in the different study groups did not show any significant differences with regard to their individual interest. Nevertheless, the positive effects of using incremental scaffolds during biological experimentation on the students' situational interest in biology lessons found in the current study should be examined in future studies with an increased sample size. The present study focused on the phase of evaluation during the experimentation process. To what extent the positive effects of the use of incremental scaffolds on the students' situational interest during the evaluation of the experiment can also be transferred to further phases of inquiry-based learning should be investigated in follow-up studies.

The aim of the present study was to investigate possible effects of the use of incremental scaffolds in biology and mathematics lessons on the promotion of students' situational interest. To summarize, the implementation of incremental scaffolds as instructional support during experimentation could contribute to an interest-promoting learning environment. Therefore, the use of incremental scaffolds during inquiry-based experimentation could address the decrease in interest in biology lessons.

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