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Research Article

The Effect of Incremental Scaffolds in Experimentation on Cognitive Load

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Abstract

Experimentation provides a suitable way for students to gain an understanding of scientific inquiry since it is one of its main methods to develop scientific knowledge. However, it is assumed that experimentation can lead to cognitive overload when students experience little support during experimentation, which, in turn, might hinder effective learning. Extraneous cognitive load describes the load caused by inefficient instructional designs such as unguided problem-solving or the way information is presented and thus can be influenced by appropriate instructions. In order to prevent students from cognitive overload and assist them during experimentation, they can be provided with incremental scaffolds, which are sequential written solution instructions. The present study investigates the extent to which the use of incremental scaffolds affects learners' cognitive load during experimentation in biology classes. The students in the *Incremental Scaffolds Group* (IncrS; $n = 54$) used incremental scaffolds in two self-conducted experiments while students of the *No-Incremental Scaffolds Group* (No-IncrS; n = 74) experimented openly without such a support. Both groups were provided with a pre-structured researcher protocol including the steps of experimentation and received the same lessons. Extraneous cognitive load was assessed after both experiments using a self-developed questionnaire consisting of two items. These were designed to assess how cognitive load was affected by the learning materials. The findings only revealed a significant main effect of time between the two conducted experiments, but no significant interaction effect with the treatment. Consequently, the results show that repeated experimentation reduces cognitive load during experimentation, regardless of the provision of incremental scaffolds. The positive effects of incremental scaffolds, thus possibly also concerning cognitive load, are assumed to occur only after multiple applications; hence, they might need to be applied more frequently and regularly to really become practiced. Two sessions of experimenting with incremental scaffolds seem to be insufficient for providing learners with substantial support, as students may need more time to fully adjust to utilizing the incremental scaffolds. Furthermore, a brief reflection phase on the use of incremental scaffolds at the end of each lesson in which they were used appears to be helpful. If incremental scaffolds can free up working memory, it may also be useful to consider the relation between incremental scaffolds, cognitive load, and knowledge acquisition.

Keywords

Cognitive Load, Learning Support, Incremental Scaffolds, Experimentation, Problem-Solving Tasks, Biology Lessons

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1. Introduction

Scientific inquiry plays a crucial role regarding scientific thinking and is considered a significant element of science education [1]. The term scientific inquiry is associated with the requirement that schools provide students with scientific knowledge and the competencies that enable them to apply this knowledge [2]. These requirements are reflected in the pertinent international curricula [2] and the German national curriculum [3]. As one form of scientific problem-solving [4-6], experimentation provides a suitable way for students to gain an understanding of scientific inquiry since it is one of its main methods to develop scientific knowledge [7]. However, students often perceive experimentation as a very complex process [8] and may need guidance, especially novices [9]. Complex tasks such as scientific problem-solving tasks can quickly overwhelm students cognitively [10]. To prevent students from cognitive overload, complex learning situations should be designed according to the principles of cognitive load theory [11].

1.1. Cognitive Load Theory

Cognitive Load Theory (CLT) assumes that working memory is a cognitive structure that is responsible for consciously processing incoming information and is limited in time and capacity [9]. Working memory is only limited to sensory memory, which only focuses on incoming information and not information already stored in long-term memory [12]. Working memory can therefore only process a limited number of elements at a time. In CLT, elements are characteristic schemata [13]. A schema consists of several single elements which initially also need to be processed individually in working memory. Only after these individual pieces of information are integrated into an overall schema in one's long-term memory can the schema constructed in this way be treated as a single element in working memory [13]. While experts can handle associated elements as a single entity based on existing schemata and thereby expand the capacity of their working memory, novices are unable to do so [14]. Hence, schema construction reduces the amount of simultaneous information that needs to be processed at the same time and thus frees up working memory. For this reason, learning can be defined as schema construction [15]. Besides schema construction, schema automation also plays an equally important role in learning processes. This involves automating access to previously learned schemata. Access can be automated if previously learned schemata have been consolidated and deepened learned schemata have been consolidated and deepened through repeated practice [15]. Therefore, it appears to be advantageous to take schema construction and automation into account in lesson design and the forms of support offered in the learning process since they are, for the reasons stated above, assumed to facilitate learning.

According to recent publications [16-18] that have revised CLT, there are two different types of cognitive load straining working memory: intrinsic and extraneous load. The former describes the cognitive load that is directly relevant for performing and learning the task [16]. It cannot be altered by didactic interventions because it is determined by the nature of the content itself and the expertise of the learners [12]. By contrast, extraneous cognitive load is caused by inefficient instructional designs such as unguided problem-solving [11] or the way information is presented [12, 18] and thus plays a significant role since it can be influenced by didactic interventions and considerations within a task. Extraneous cognitive load is not needed for the acquisition of schemata and is therefore considered ineffective for learning [16]. If cognitive load arises from mental activities that interfere with the construction or automation of schemata, this might have negative effects on learning [20]. Since both types of cognitive load are additive [13, 18], extraneous load should be kept to a minimum in order to prevent working memory from overload. Free working memory capacity might "permit an increase in the working memory resources devoted to [...] germane processing" [16] (p. 395), which is relevant for the construction of schemata and therefore learning [17]. As a result, the need for appropriate instructional designs and task formats that minimize extraneous cognitive load by facilitating the overall cognitive processing of knowledge in working memory and thus providing sufficient resources for the actual desired increase in knowledge and skills also becomes evident. By reducing extraneous cognitive load, sufficient cognitive resources are left for the actual learning process to take place [17]. The need for reducing extraneous cognitive load becomes even more evident in complex learning situations such as experimentation [8].

1.2. Experimentation

Experimentation requires several problem-solving activities [4] that students need to consider when experimenting in biology lessons. Competent learners must know, understand, and be able to apply different steps when experimenting such as formulating questions, generating hypotheses, planning and conducting experiments, interpreting the data, and coming to a final conclusion [4, 6]. Experimentation is often perceived as a very complex process by students [8]. In various studies, learners have been shown to have deficits with regard to the different dimensions of process skills in scientific inquiry [21-23]. Thus, learners show difficulties in hypothesizing, systematically planning and conducting experiments, and interpreting data [21]. Therefore, very open experimental situations can overburden students because they place too high metacognitive demands on them [24] and thus lead to cognitive overload if students receive little or no support during experimentation [9]. Accordingly, students' learning processes could be supported if they receive instructions during inquiry learning [9]. For this purpose, strongly pre-structured experiment instructions are often used in science classes; however, these have been found to be less suitable for promoting scientific methodological skills, especially in the sense of scientific thinking [25]. One reason for this may be that this type of structuring does not focus on an understanding of the experimental procedure [26-27].

Hence, in order to implement scientific problem-solving activities such as experimentation in science education, it is not sufficient to merely conduct experiments in a recipe-like manner, as it is often done in the classroom [28-29]. Rather, students must be given the opportunity to follow the scientific steps in conducting experiments [27, 30]. However, this is hardly successful if experiments are simply conducted according to the narrow guidelines of an instruction manual, as studies on experimentation in schools show [8, 28, 31-33]. As a combination between open and fully structured experimentation, guided experimentation can counteract the above-mentioned issue [34]. To implement this guidance and to harness the potential of experiments for the students' own learning, the implementation of adequate instructional support is suggested [24, 34]. This kind of support might then also affect cognitive load during experimentation [35]. One possible way of reducing cognitive load is to provide students with supports, e.g., in form of scaffolds, during a learning situation [36].

1.3. Incremental Scaffolds

The research [37] distinguishes between two basic types of supports: hard scaffolds and soft scaffolds. Soft scaffolds are seen as dynamic support measures that require situational diagnostic competence on the part of the teacher [35]. Hard scaffolds and according to [38] also tool scaffolds, in turn, are static supports that anticipate potential problems of learners and can thus be prepared in advance [37] such as the use of incremental scaffolds [10]. Incremental scaffolds are sequential written solution instructions [10, 39] that learners can access as needed. These aids can be structured in such a way that learners are provided with prompts in the first part to perform a cognitive action relevant to learning and a sample solution in the second part [10, 35, 40].

Learning supports such as prompts can help learners experiment when they are provided to the learners throughout the learning process [41]. Prompts are cues or questions to which the learners can refer back to during the learning process to activate their knowledge, strategies, or skills [42]. Prompts provide some form of structuring cues and background information (e.g., data, formulas, laws) to encourage solving a subtask by, for example, paraphrasing, focusing, activating prior knowledge, elaborating sub-goals, and/or visualizing [10]. The activation of prior knowledge, for example, may reduce the likelihood of cognitive overload [19]. The prompts can be designed in different ways, but they should always include learning strategies or methodological and content-related support [43].

During experimentation, prompts can be used to structure students' thinking [44], potentially breaking the experiment into smaller, cognitively accessible, parts. Furthermore, the use of prompts allows students to work on the tasks given to them with a high degree of autonomy [45] and to achieve a fit between task and individual abilities [46]. Prompts can be provided to students in the form of incremental scaffolds that can also affect the learners' cognitive load during experimentation [35, 36]. In accordance with the researcher [47], who originally designed these learning supports, other authors [10] suggest using incremental scaffolds to mediate between completely open and strongly pre-structured problem-solving tasks. With incremental scaffolds, the learners' processing of complex problem-solving tasks can be supported [47], and they enable learners to work independently on these complex tasks [48]. In addition to the prompts in the first part, the second part of the incremental scaffold contains an example (partial) solution of the respective sub-step and serves as feedback for the learners [10, 39].

Incremental scaffolds, which allow an activation of prior knowledge and thus recourse to previously learned schemata, may also have a positive effect on students' cognitive load. These positive effects may occur only after the repeated use of the incremental scaffolds [10, 46].

1.4. State of Research

There has been a limited amount of research exploring the efficacy of incremental scaffolds so far. Furthermore, the results regarding various types of scientific problem-solving tasks lack clarity. Compared to more open learning environments, research has demonstrated that incremental scaffolds have a positive impact on procedural knowledge [49], conceptual knowledge [50], scientific reasoning [35], and performance in science problem-solving tasks [39, 40]. Still, the positive effects of incremental scaffolds are not consistent across the board. For example, the study in reference [51] found no positive effect of incremental scaffolds on conceptual knowledge, reference [35] did not discover any positive impacts of incremental scaffolds on procedural and conceptual knowledge, and reference [50] only reported a positive impact on one of the two measures of conceptual knowledge.

Compared to worked-out examples, incremental scaffolds were associated with higher levels of motivation and competence perception, but not with an increase in knowledge [39, 52]. However, studies indicate that the use of incremental scaffolds does not lead to greater perceived competence [40, 49], procedural knowledge [53], problem-solving task performance [40] or motivation [49] compared with students who worked with strongly pre-structured experiment instructions. By contrast, the study in reference [40] demonstrated that incremental scaffolds have a positive effect on motivational factors, such as social relatedness, interest, and engagement.

Regarding cognitive load, few studies to date have investigated the impact of incremental scaffolds on cognitive load during problem-solving tasks. Research has demonstrated that the use of incremental scaffolds was associated with lower cognitive load compared to the use of worked-out examples [39] and open-ended experimentation [35]. In a separate study, incremental scaffolds were accompanied by higher extraneous cognitive load compared to learning environments with strongly pre-structured experiment instructions [53].

2. Research Question and Hypotheses

This study aims to narrow the knowledge gap concerning the effects of using of incremental scaffolds on cognitive load by conducting a study that investigates the impact of incremental scaffolds on extraneous cognitive load and its reduction over time in the context of problem-solving tasks. Consequently, it seeks to determine the effect of incremental scaffolds by comparing their impact on extraneous cognitive load experienced by participants to open experimentation without such support.

As stated above, independent or open experimentation can be cognitively stressful and thus often lead to cognitive overload [54]. At this point, incremental scaffolds can serve as a measure of support. However, learning aids such as incremental scaffolds can also have a negative impact on cognitive load to the extent that the extraneous load caused by the learning materials might increase [35]. Learners can be overwhelmed by an overabundance of materials as well as unfamiliar lesson design. The extraneous load may be increased due to the gathering of relevant information from different sources [15]. Thus, it can be hypothesized:

Hypothesis 1 (H1): In a first open experiment, students who experiment with incremental scaffolds report a higher degree of extraneous cognitive load than students who experiment without incremental scaffolds.

It can be assumed, however, that this potential cognitive overload caused by the complexity of the learning materials can be reduced if the usage of the materials has been learned. In other words, over time the students may no longer perceive the incremental scaffolds as a new schema to be learned, but have already integrated them as such and can draw on them automatically [15]. A reduction in extraneous load can possibly occur only after repeated use of the incremental scaffolds [10, 46]. Therefore, the following hypothesis can be assumed:

Hypothesis 2 (H2): In repeated open experiments, students who experiment with incremental scaffolds report a lower degree of extraneous cognitive load than students who experiment without incremental scaffolds.

3. Method

3.1. Sample and Study Design

The study was conducted with 128 students (48% female; M_{age} = 11.88 years, SD_{age} = 0.68) in the sixth grade of two comprehensive schools (“Gesamtschule”). 51% of the students speak German as their first language, 27% speak German and another language at home, and 22% speak mainly another language. The study used a quasi-experimental pretest-posttest-control group design (see Figure 1) and was embedded in a four-lesson teaching unit on animal adaptation to cold. The ‘incremental scaffolds group’ (IncrS; n = 54) received support during experimentation in the form of researcher-tips (incremental scaffolds), while the ‘no-incremental scaffolds group’ (No-IncrS, n = 74) experimented without researcher-tips. The five classes were randomly assigned to the two conditions, meaning that it was determined by chance which class would receive the respective treatment. During the lesson, the students conducted two model experiments, each dealing with an animal ́s survival strategy in the cold. Students in both treatment conditions received the same lesson but with the difference that students in the IncrS-group had access to the researcher-tips during experimentation, whereas students in the No-IncrS-group did not receive the researcher-tips and experimented openly without any further support. After each experiment (at the end of the second and third lesson), extraneous cognitive load was assessed.

Student teaching was conducted by two student teachers in their final semester who also implemented the questionnaire survey.

3.2. Teaching Unit

The first lesson aimed to introduce scientific inquiry and experimentation to the students. They were initially presented with the basic steps of a scientific experiment in general, and these experimental steps were theoretically explained through an illustrative sample experiment comparing isopod preference for wet versus dry substrates. Similar to the sample experiment presented, the students theoretically worked through another sample experiment that examined the preference of isopods for light versus dark habitats. At the beginning of every sample experiment, the students were provided with background information in the form of a fictional research report outlining the research problem. Subsequently, the students were able to deduce the research question based on the report. Each experimental step was first discussed in groups of two students before a class discussion was held to ensure that all students had the uniform level of understanding. The students in the IncrS-group also used researcher-tips in form of incremental scaffolds to discuss the procedure. This was intended to provide the students with the opportunity to familiarize with the use of the researcher-tips. At this point, students were also introduced to the experimental protocol. Additionally, the differences between model and real experiments were discussed at the end of the first lesson.

In the two following lessons, the students conducted two experiments. Again, they were given a research report from which they derived a research question. After that, they planned and performed an experiment on their own. The students in both groups received a protocol sheet that basically structured the experimentation through work tasks. The IncrS-group was supported by researcher-tips, while the No-IncrS -group received no support other than a protocol sheet. The protocol sheets of the two groups differed in that the protocol sheet of the IncrS -group contained a notation at the places where a researcher-tip could be used.

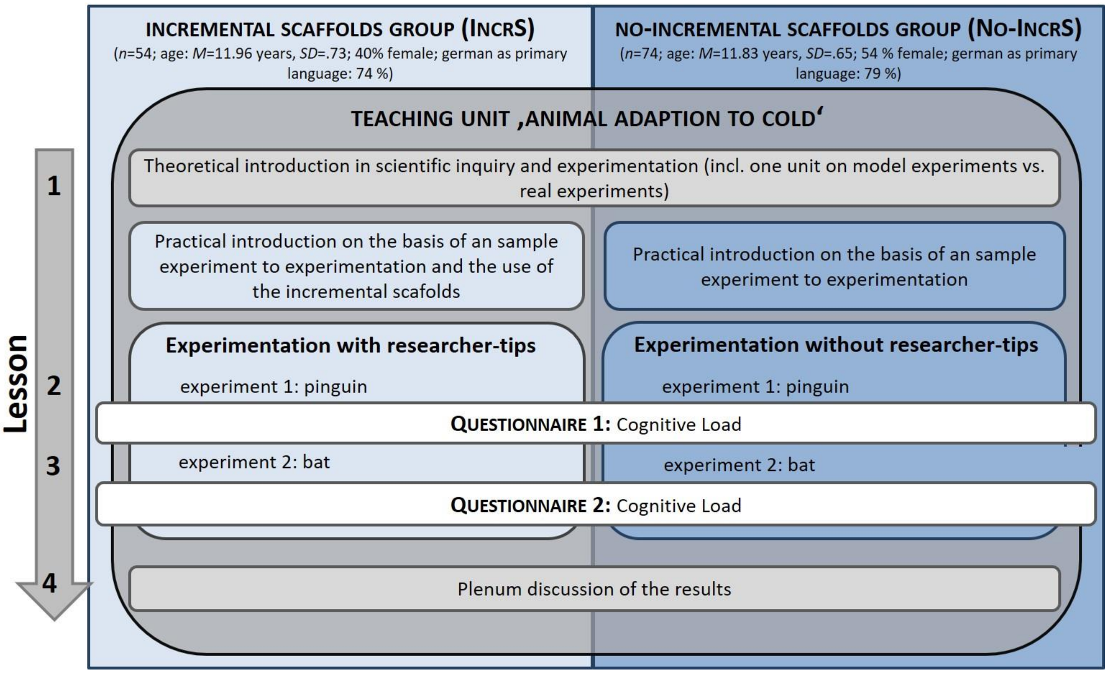

Figure 1. *Study design and teaching unit.*

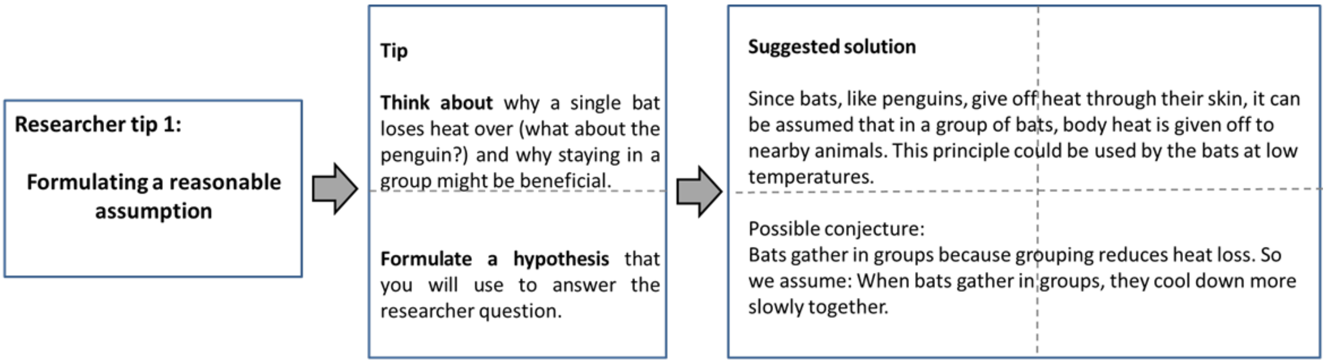

Figure 2. *Example of an incremental scaffold.*

3.3. Incremental Scaffolds

In the study, the students of the IncrS-group could use researcher-tips that provided incremental scaffolds [10, 39] for each step of the experimentation. The researcher-tips (see Figure 2 for an example) were folded pieces of paper that the students could unfold step by step in order to use the support. They were designed in such a way that after being opened once, structuring hints and background information (e.g., structural or content-related tips) were given, which encouraged the solution of the sub-task. After unfolding again, a possible example solution was presented, which was intended to prevent the students from opening all researcher tips at once. For the first experiment, the students were instructed by the teacher to use the researcher-tips. For the second experiment, the students were reminded of the availability of researcher-tips in case they experienced any difficulties. However, the decision to utilize these tips was left to the participants.

3.4. Measuring Instruments and Statistical Analyses

The students' *extraneous cognitive load* was assessed using a self-developed questionnaire. The items are designed to evaluate how the learning materials affect cognitive load. The students were asked to rate their agreement with two statements ("I found today's materials were easy to comprehend." and "I clearly understood what was expected of me in the task.") on a scale of 0 (strongly disagree) to 4 (strongly agree). The reliability of the scale was in an acceptable range, with a Spearman-Brown coefficient [55] of .69 for the first measurement point and .70 for the second measurement point [56].

To investigate the hypotheses, we conducted a mixed-ANOVA.

4. Results

The results showed no significant effect of the treatment ($F_{1, 126}$ = 1,10, p =.296, η_p^2 = 0.009). The students in the experimental group did not differ significantly in terms of extraneous cognitive load from students in the control group (Figure 3). The first hypothesis could therefore not be confirmed.

In both treatments, there were significant differences in extraneous cognitive load between the first and the second time of measurement ($F_{1, 126}$ = 17,45, p <.001, η_p^2 = 0.122). The students reported a significantly lower extraneous cognitive load in the second experiment than in the first experiment (Figure 3).

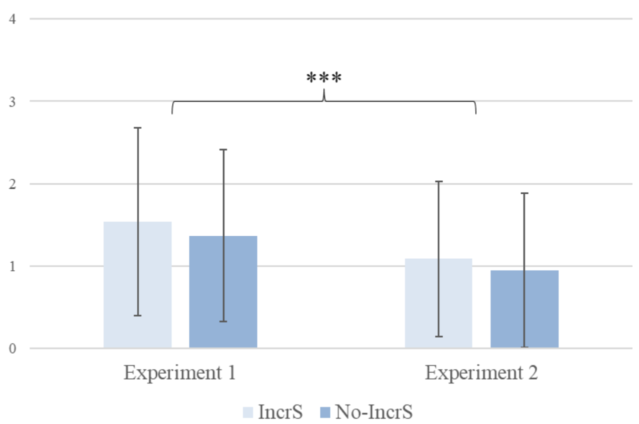

Figure 3. *Extraneous cognitive load at the first and second measurement points. Mean values and standard deviations are shown. *** <.001.*

Nevertheless, there was no significant interaction effect ($F_{1, 126}$ = 0.01, p =.93, η_p^2 < 0.001). Accordingly, their extraneous cognitive load decreased from the first to the second experiment, regardless of the treatment (IncrS: M_{Exp1} =1.54, SD_{Exp1} = 1.14, M_{Exp2} =1.09, SD_{Exp2} = 0.94; no-IncrS: M_{Exp1} =1.37, SD_{Exp1} = 1.04, M_{Exp2} =0.95, SD_{Exp2} = 0.94). Consequently, the results reveal that repeated experimentation reduces the cognitive load during experimentation regardless of the provision of incremental scaffolds. Thus, no support for the second hypothesis could be found in this study.

5. Discussion

The purpose of the present study was to investigate the effects of incremental scaffolds in experimentation on students' cognitive load compared to open experimentation without such support. The first hypothesis assumed that the students who experiment with incremental scaffolds (*IncrS*) would report a degree of higher extraneous cognitive load than those who experiment openly (*No-IncrS*) without such support. Due to the new unfamiliar format of support, it could be assumed that the incremental scaffolds could initially result in a higher level of extraneous load for the students. The analysis showed that the two treatments "Incremental Scaffolds" (*IncrS*) and "No Incremental Scaffolds" (*No-IncrS*) did not differ significantly. Accordingly, the incremental scaffolds had neither positive nor negative effects on extraneous load. Although the incremental scaffolds may have been perceived as additional learning materials by the students, they did not lead to a higher degree of extraneous cognitive load. The extraneous load's potential increase due to the additional gathering of relevant information [15] was not observed. Thus, contrary to our initial assumption, the incremental scaffolds did not demonstrate a higher level of cognitive demand compared to open experimentation without additional support. Based on the descriptive data, the mean values revealed a relatively low degree of extraneous cognitive load in both groups. Therefore, the design of the learning materials, including the use of incremental scaffolds, did not seem to overtax working memory. This available working memory capacity could enable an expansion of the working memory resources dedicated to intrinsic load (also known as germane processing) [16] relevant for schema construction. The use of these free capacities, in turn, depends on the students' motivation [12]. Therefore, in further studies it seems reasonable to consider and measure motivational variables in order to exploit the potential of germane processing, which is relevant for schema construction and thus learning.

The investigation of the second hypothesis that the students who repeatedly experiment with incremental scaffolds would report a lower degree of extraneous cognitive load compared to the students who experiment without incremental scaffolds revealed a significant decrease in both groups between the two measurements. Accordingly, the students might not only have become familiar with the incremental scaffolds, but the students of both groups could have become familiar with experimenting according to the scientific problem-solving process. Therefore, schema construction and automation might probably have taken place rather regarding scientific inquiry than in terms of automatizing the use of incremental scaffolds. It is desirable that students no longer perceive the incremental scaffolds as a new schema to be learned because they have already integrated them as such and can draw on them automatically [15]. The positive effects of incremental scaffolds, thus possibly also concerning cognitive load, are assumed to only occur after multiple applications [10]. Therefore, incremental scaffolds might need to be applied frequently and regularly to really become practiced. Furthermore, it might be helpful to include a brief reflection phase on the use of incremental scaffolds at the end of each lesson in which they were used. That way, students can explain their usage to their fellow students in order to share different ways of meaningfully using an incremental scaffold with its various sub-steps.

Another potential reason for the absence of significant differences in the students' self-reported cognitive load values between the two groups could be ascribed to the age of the participants. The students surveyed in this study were approximately 12 years old. The low mean values of extraneous load, in general, may have prevented further measurable reduction in the IncrS-group. Here, it is questionable whether the students actually perceived low extraneous cognitive load or simply reported it due to social desirability when answering the questionnaire. Social desirability is particularly relevant among younger respondents, especially when they are being assessed or interviewed by adults or in the presence of adults (e.g., in a classroom setting). In these situations, children tend to answer in a manner that pleases the teachers, as they are dependent on them and, consequently, reliant on their goodwill [57]. The used items might distort the students' response behavior concerning social desirability. This is reflected in the under-reporting of "bad" behaviors [58], in this case admitting the actually perceived cognitive load during experimentation.

Another factor that may have influenced the effectiveness of the incremental scaffolds is linguistic barriers within the respondents. As the sociodemographic data show, only half of the students speak German as their first language at home and about a quarter reported speaking mainly another language than German. This indicates a large linguistic heterogeneity, which might also be a reason why the incremental scaffolds could not develop their full potential in this study. The linguistic barriers encompass various language-related factors that can impede language acquisition or hinder effective communication and understanding, particularly in educational settings [59]. To address this issue, the design of incremental scaffolds may need to consider linguistic simplification, include more intermediate steps, and focus more on non-verbal elements, such as illustrations.

Lastly, the measurement of cognitive load should be considered in more detail. The recorded values of extraneous cognitive load were widely scattered, as illustrated by the high standard deviation, which must be taken into account when interpreting the results. The present study investigates extraneous cognitive load with a two-item scale, which might not be optimal for identifying an underlying construct [55] such as cognitive load. In the present study, test economic constraints necessitated the use of a restricted number of items. Nonetheless, the acceptable reliability of the measurement indicates its quality. In addition, the retrospective measurement of cognitive load only once at the end of an entire learning period may also be considered. This kind of measurement requires students to give a retrospective evaluation of the cognitive load caused by a series of (sub-)tasks, which possibly has to be recalled from long-term memory [60] that especially younger students might have difficulties with. However, using subjective measurement instruments for self-assessment remains a widely accepted method for evaluating CL in the context of a learning task [61-65]. Furthermore, such subjective instruments have the advantage of an easy use via paper-pencil questionnaires that can easily be established within the intervention [66].

6. Conclusion and Outlook

The present study found the impact of incremental scaffolds on cognitive load was different to our initial assumptions. Extraneous cognitive load decreased between the two times of measurement regardless of the treatment. As discussed above, future research might focus on older students to explore whether the same result can be found there. It is also conceivable to expand the sample at other types of schools. To extend the research findings on the usefulness of incremental scaffolds, their actual use should be recorded, especially when their use is voluntary as in this study.

In addition to cognitive load, motivation, which is related to the use of potentially free working memory capacity [12] should be considered. Since cognitive load is assumed to be a motivational cost for learners [67], these two constructs might be considered together in further research to reach a more holistic understanding of the relationships. In terms of knowledge acquisition, it may also be useful to consider the relation between incremental scaffolds, cognitive load, and knowledge acquisition. Students with little prior knowledge may benefit from the use of incremental scaffolds [68]. Therefore, it may be interesting to investigate how the use of incremental scaffolds affects the cognitive load of these students. In addition, it may be of interest to investigate the use of incremental scaffolds in biology lessons in other instructional and content settings that require a particular procedure with various sub-steps similar to the scientific problem-solving process (e.g., analyzing family trees).

In summary, the simultaneous lowering of extraneous cognitive load during experimentation despite the use of the incremental scaffolds, which were initially assumed to increase cognitive load, can nevertheless be interpreted positively. The use of incremental scaffolds seems to address other relevant areas of learning. In a qualitative study, Kleinert et al. [69] found that incremental scaffolds can positively influence metacognitive action planning, reflective behavior, and the activation of prior knowledge. In addition, further studies have shown that the use of incremental scaffolds during experimentation can also positively influence learning success in terms of knowledge acquisition [51] and scientific thinking [35]. It becomes clear that incremental scaffolds can achieve several positive effects regardless of cognitive load and further research on this seems worthwhile.

Conflicts of Interest

The authors declare no conflicts of interest.

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