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Five Years of Construction Kits in Primary Schools: Evaluating the Current State of a Project to Facilitate Technology Education

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Abstract

In March 2018, metal construction kits were distributed to all elementary schools in Rhineland-Palatinate as part of the project called "Technikkiste" [translation from German: technology box] to promote STEM education. At the end of the year 2018, three more expansion sets followed. So far, no requests have been made to schools, even after five years of the project's start as to how and whether they use this material. Therefore, an evaluation study was carried out in 2023, which was intended to find out the current usage behaviour with the kits as well as to get an impression of the teachers regarding the in-service training that took place as part of the project. For that 921 elementary schools were asked to participate in an online survey. 69 answered the questionnaire some more gave informal feedback. The results from the survey already show that only about 70% of the responders are even aware of the metal construction kits. Around 30% stated, that they were not familiar with the metal construction kits. In addition, only about 43% of the participants indicated that the kits have ever been used in the classroom at their school. One of the main reasons why they do not use the constructions kits is that the school has allegedly not received a kit or has too few for classroom use. This brief excerpt from the survey results already shows that the promotion project is not showing the success that the Ministry of Education had hoped for.

Keywords

Construction kits, Primary schools

Introduction

Against the lack of technology education in schools and the resulting consequences, projects are occasionally initiated to combat these resulting consequences (VDMA, 2019), which at least give the impression that education policy wants to change this. So this is was what was done by the Ministry of Education of the federal state of Rhineland-Palatinate in Germany. With the aim of stimulating more interest in STEM topics at elementary schools it initiated a support program named "Technikkiste". It was based on the findings from socialization research, according to which construction kits and other technical toys were often among the decisive motives for a technophile career and subject choices in previous generations (acatech, 2009).

However, despite the associated financial and logistical effort and individual accompanying measures such as further in-service training, no evaluation has taken place even five years after the start of the project. But, because such an evaluation study can provide a wide range of insights and consequences for teacher training, everyday school life and future support programs, this study was intended to investigate whether and, if so, how the metal

construction kits are still being used in schools. Consequently, questions arose as to what has become of the metal construction kits in the meantime and how teachers reflect on them? Specifically, the aim is to find out whether the construction kits are still being used and, if so, to what extent and in what settings? Another aim was to find out whether all schools have received these kits at all and how satisfied the teachers are with the materials and the training opportunities.

In 2018, the Ministry of Education in Rhineland-Palatinate launched the "Technikkiste" project to promote STEM education in a classical way. For this purpose, a metal construction kit (see Figure 2) was sent to each elementary school together with prepared didactic recommendations for use and one more kit if at least one teacher participated in an in-service training (Tschiedel, 2023). A total of 355 teachers decided to participate in this in-service training. Five years later, the question arose: how are these boxes being used today and what feedback can teachers provide to the ministry? For this reason, a study was developed in July 2023 and all 921 elementary schools in Rhineland-Palatinate were invited to participate. In addition, recommendations for future support programs were to be derived from this.

Related Work

For a study that deals with the use and retention of construction kits as a means of promoting STEM interests in a project, it is obvious to consider research that is focused on construction kits as such, deal with their basic mechanisms of action on the target group and, on the other hand, include results that examined the STEM promotion projects themselves.

While a lot of historical and cultural driven research about construction kits like those of Leinweber (1999) and Noschka and Knerr (1986) is available, those about their use as educational tool is slightly limited. However, Sachs and Fies (1977); Fast (2006, 2008) and Plickat (2006) have already elaborated the possibilities of construction kits used in the German classrooms for technology education. Continuing that, Fislake (2022) summarized the history of construction kits as educational tools at all, beginning with Fröbel's Spielgaben. He outlined that these Spielgaben are one of the first known construction kits and still used as educational tools in Kindergardens. Later, MECCANO and other construction kits conquered family homes in western cultures before they first entered classrooms in the nineteenth century (Jaffé, 2006). One of their characteristics was the causal relationships between the effects of teaching and playing scenarios appears to be self-evident on the basis of assumptions, experience and plausibility.

Today, scientific evidence of connections between interventions with construction kits, socialization processes, habitus acquisition and career entry is sought on the basis of empirical data. According to van Tuijl and van der Molen (2016), retrospective life course research plays a significant role here due to the time spans to be considered, as Helwig (2003) did in his longitudinal study with children aged 7 to 17. Accordingly, van Tuijl & van der Molen (2016) characterize professional development as a lifelong process and childhood as an important formative time for this. Papadakis et al. (2021) emphasizes it and rate early childhood (from birth to age eight) as a crucial period for children's development and rate positive key experiences as one of the most prevalent factors, to initiate interests towards technology. Acatech (2009) further shows that early technical socialization is one of the decisive factors for a later orientation towards STEM professions.

Pfenning et al. (2002) and Ziefle et al. (2009) extend this approach and refer to studies from empirical social research, according to which successful engagement with scientific and technical topics requires a combination of interest, motivational dispositions and cognitive abilities. As a result, technology socialization is considered as an important prerequisite for choosing a corresponding STEM occupation.

In addition to these aspects acatech also studied the effects of projects to promote technology-related topics. It was supplemented by an inventory of all school and extracurricular STEM promotion projects, of which only 21.2% were aimed at children of primary school age (acatech, 2008). As one of the projects analysed, the private project "Denzlinger Cleverle" has the particularity that the children are very motivated to participate and even enjoyed gaining new experiences with technical devices in their free time. Two reasons for this success could be the close mentoring and the open-ended tasks. Because this project is not based on a well-designed pedagogical concept, but has a high practical component, it can be categorized as autodidactic self-education from a didactic perspective. In addition, children in a fear-free environment are cognitively and motorically able to use electrical and technical devices with caution, which makes the low number of STEM promotion projects for elementary school children unfounded. In the final report, the project is described as a "very inspiring, ambitious model project" that operates "at a high level for support and equipment" (acatech, 2010).

Another project is called “KiTec - Kinder entdecken Technik” [translation from German: KiTec - Children discover technology] and aims to encourage children to work independently and in a solution-oriented manner on their own ideas. The aim is for them to get in touch with their technical skills and experience the importance of technology (Wissensfabrik Deutschland, 2023). The “Wissensfabrik” (transl.: Knowledge Factory) provides the appropriate course materials needed and offers suggestions for embedding the teaching units. Each of the material sets consists of three boxes containing tools and construction materials.

However, the acatech study was just as critical of the teachers' limited experience with tools as it was of the children's "increasing lack of manual experience in handling traditional technical instruments and construction materials" (acatech, 2011). In addition, free experimentation and the associated need for assistance was identified as a reason why some teachers were deterred from using the boxes.

Project ‘Technikkiste’ to Facilitate Technology Education

With the aim of stimulating more interest in STEM topics at elementary schools, the "Technikkiste" program was initiated by the Ministry of Education of the federal state of Rhineland-Palatinate, Germany. The project is based on findings from socialization research, according to which construction kits and other technical toys were often among the decisive motives for a technophile career and choice of field of study in previous generations. According to Tschiedel (2023), at the start of the project in March 2018, one construction kit was sent to each of the 961 elementary school in Rhineland-Palatinate, which could be supplemented with a further kit for each school if a teacher took part in further teacher training. In November 2018, additional extension sets were also sent to all elementary school (Tschiedel, 2023), resulting in the distribution of over 4,000 metal construction kits worth €263,000, including the 131 schools for children with learning difficulties and a spare parts service. During the preparations, a five-page teaching handout was drawn up and sent digitally to the schools at

the end of February 2018 (Hubig, 2018). Above all, it was intended to provide information about the various possible uses and applications.

Figure 1. Training locations together with the number of schools in each school district. (Schumacher, 2021)

In addition to a didactic and methodological classification, the handout also shows possible applications for lessons in the morning, as well as in the afternoon programs of all-day schools. A separate chapter describes the initiation of technology-specific ways of thinking and acting and highlights their advantages.

Between March 2018 and March 2019, accompanying training courses were offered at 14 dates and twelve different locations (see Figure 1) to support the teachers. In order to achieve an

equal regional distribution, the training locations were offered in as many regions as possible and attended by a total of 355 teachers, as Holder (2023) explained.

The content of the training included an introduction to the topic and the link to the curriculum, as well as various application and possible teaching methods. In addition, the participating teachers were given specific closed and open tasks to try out the metal construction kits. Finally, a link to practice was established by the participants developing a word memory with technical terms, cognitively activating task formats and a meaningful structure for the workplace (Holder, 2023).

The basic construction kit is called type C166 (see Figure 2) and comes from the eitech company. It consists of 527 small parts mostly metal, a few made of plastic and is contained in robust wooden boxes (eitech, 2023). The electric and solar expansion set contains additional 135 components, the gear set another 250 parts. Suitable tools such as screwdrivers and illustrated step-by-step building instructions that show how to build eleven different models of varying degrees of difficulty were also included (Tschiedel, 2023).

Figure 2. Basic construction kit type C166 von eitech (eitech, 2018)

One of the main arguments for choosing and using the eitech construction kit was the positive experience from the 'Kleine Konstrukteure' (transl.: little constructors) as part of the extracurricular summer school called technikcamps (transl.: technology camps) which is based on basics on the training of pre-service teachers for technology education and is distributed by the University of Koblenz (Fislake, 2022). In the vacation courses offered there, children from the age of 6 can gain their first experience of technology in a playful and independent way.

The enclosed building instructions make it easier to get started, offer a systematic approach and encourage spatial imagination. The necessary handling of the tools train fine motor skills and the assembly of the components requires patience and perseverance. In addition, the construction kits offer the freedom to realize one's own creative ideas, as the fire engine shown in Figure 3 demonstrates. It was designed and built by a 7-year-old without instructions. It is remarkable how the boy installed the light on top of the vehicle, with a functioning electrical circuit, independently by trial and error.

Figure 3. Fire engine of a second grader. Built with the basic and extension kit. (Schumacher, 2023)

Research method

An online questionnaire was selected and developed as the evaluation instrument for the planned full survey of all 921 public elementary school in Rhineland-Palatinate. The decision was made because it appeared to be an efficient means and at the same time offered the possibility of achieving results that were as representative as possible (Aeppli, Gasser, Gutzwiller, & Tettenborn, 2016). The people who accepted the invitation were able to take part in the survey anonymously and in compliance with data protection regulations in summer 2023. Although topic-centred interviews with a smaller sample were discussed as a supplement or as an alternative type of survey, they were rejected.

The questionnaire contains 29 questions (items) with single and multiple possible answers as well as free text fields. It is divided into six thematically different dimensions, each containing two to five items. As the questions build on each other and partly follow an if-then scheme, not all participants had to response to every question. In addition, due to administrative requirements, participants were free to decide whether they wanted to answer any of the questions at all. As a result, the items without an answer were scored differently than those with the answer "no answer".

Results

Of the 921 invitations sent out, 69 people completed the questionnaire. This corresponds to a response rate of 7.5%. In addition, five schools submitted written feedback by email. Around

70% of participants stated that they were familiar with the metal construction kits. Only 1% selected neither yes nor no and therefore left the field unanswered.

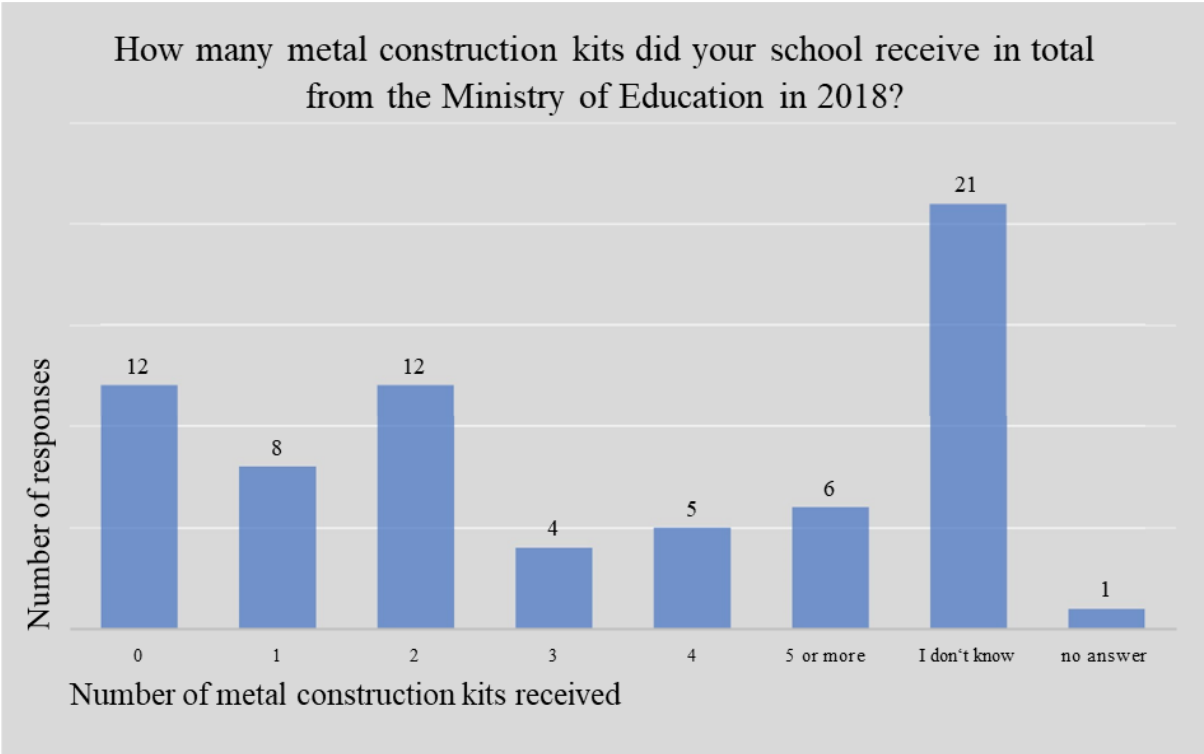

Figure 4. results of item 2

When asked about the number of kits received, 30% stated they did not know the number. One did not answer, while 17.39% responded 0 or 2 kits. 12% received one kit, while 8.7%, reported 5 or more, 7.2% got 4 and only 5.8% got 3 kits (see Figure 4).

When asked how many extension sets were received, around 38% responded "I don't know". 32% said that their school had not received any extension sets, while five participants said that they had received one extension set each. For 2 sets there are three people, for 3 and 4 sets there are four responses each. Two respondents left their answer option unanswered.

For question 4, the number of metal construction kits currently available could be estimated if the number was not known. With 30.2% the largest proportion stated that their school currently had two complete sets. 25.4% responded that there was no basic construction kit at their institution, which is illustrated in

Figure 5.

Figure 5. results of question 4

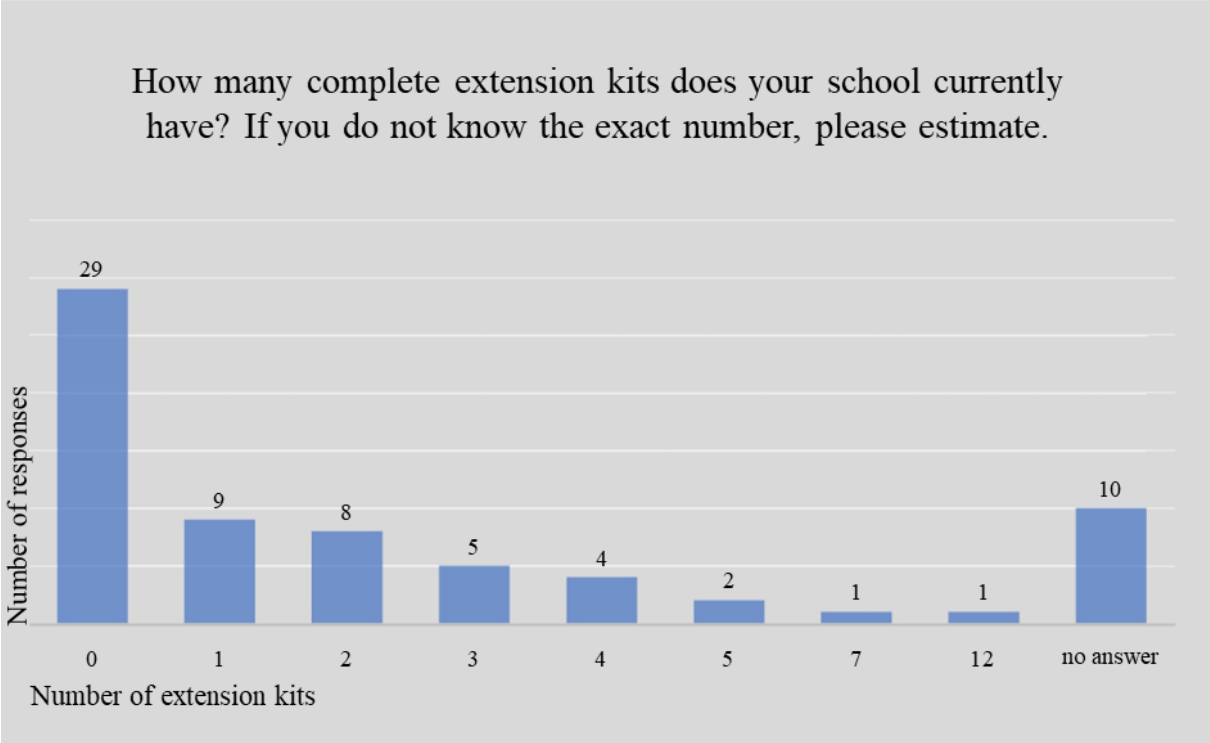

Figure 6. results of item 5

As can be seen in Figure 6 question 5 revealed that the schools currently have an average of 1.2 complete sets in use, although on average each elementary school should have 2.8 complete metal construction kits. Around 42% stated that their institution does not have any additional kits.

Furthermore, around 37% of respondents reported to question number 6 that the kits they received never have been used in lessons at their school. For the same question, 30 out of 69 people answered "yes" and 13 people said "no answer".

Around 34% did not react to question 7, placing them in the "unanswered" group. Around 18% use the metal construction kits once or twice a year. Eleven out of 69 resondents described their usage behaviour as "sporadic". Around 11.6% never use the construction kits, as illustrated in Figure 7.

Around 11.6% selected the "no response" option, while four opted for the frequency of use "every 2-3 months", which corresponds to around 6%. One stated that they use the metal construction boxes weekly. None of the participating teachers use the technology box on a daily basis.

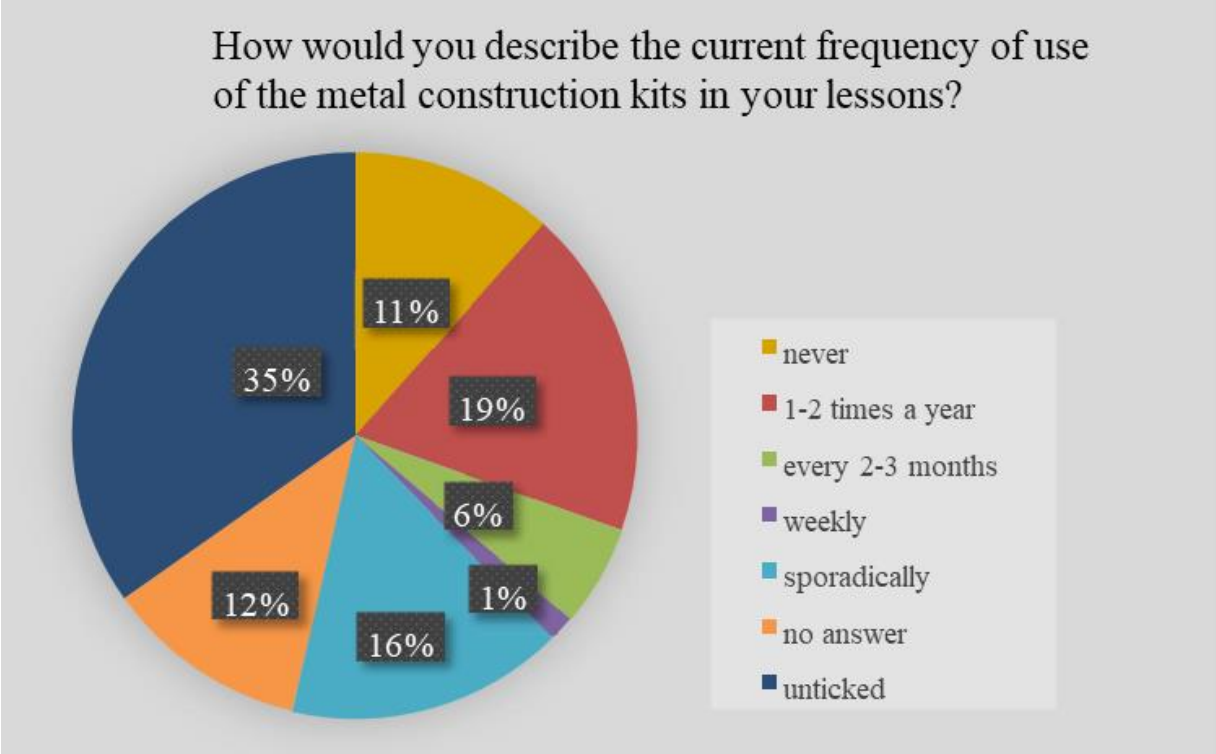

Figure 7. results of question 7

The reasons for not using the kits can be summarized as follows: 20.3% had not received any boxes. Another 20.3% stated that they had too few boxes for optimal use and that the school budget for additions was often insufficient. 13% cited lack of time as a reason for not using them or argued that it was more important to promote basic skills. Six people gave this reason. Four teachers mentioned a lack of teachers as the reason, as a second teacher would be needed for use in lessons. Four participants responded that the boxes were not usable due to incompleteness. A similar argument is that the number of boxes is not compatible with the group size in their classes. Two people emphasized that the number of children in their classes were too high or that the school had too few boxes. Three people also stated that the instructions were too complex for children and that they could only be used without problems from K 4 onwards.

Two teachers criticized the usability of the metal construction kits, as the following description shows: "It is a problem to keep the kits complete. When working with a class, it is difficult to keep an overview. Children also bend the flat bars very quickly - they are also very unstable." (translated by authors). Other individuals provide arguments such as (translated by authors):

- "The purchase came top down and was not supported by anyone in the school. Like so many ideas that come from the Ministry of Education."
- "No instruction. No personal interest."
- "Hygiene measures in Corona time. Use in first and second school year does not seem promising. One colleague has the boxes permanently in her classroom for free construction."
- “Lack of willingness on the part of teachers to deal with the topic.”
- "It takes a long time for the children to build a model."

- "Our textbooks are not tailored to this. I therefore forgot about the boxes and think it's good to be reminded by this survey. There were so many other important and interesting topics. As a teacher, it's easy to stay on familiar tracks."

Nevertheless, a third of the surveyed completely agreed with the statement of question 9: "I consider the use of the metal construction kits during lessons to be useful." Almost as many voted "somewhat agree" and around 13% responded "somewhat disagree". Just under 6% did not agree with the statement at all, while 11 respondents did not provide any information.

When asked to assess the use of the metal construction kits as a self-learning object, a third of the participating teachers tended to agree. In contrast to question 9, only 23% fully agreed with the statement in question 10. 13% responded that they somewhat disagreed with the statement. One person did not agree with the statement at all. Ten out of 69 participants selected "no answer". Question 11 asked for feedback about the usefulness of the kits as a simple activity material. 31.8%, or almost a third tended to agree with the statement "I consider the use of the metal construction kits as an activity material to be useful". 18 people agreed while 23.2% rather disagreed with the statement. Five teachers did not consider the kits to be useful as an activity material at all, while around 12% chose the "no answer" option.

A third of all respondents stated (see Figure 8) that they had neither received nor read the five-page teaching handout for action entitled “Technikkiste – Unterrichtsmaterial zur Förderung des naturwissenschaftlich-technischen Lernens in der Grundschule“ (transl.: "Technology box - teaching material to promote scientific and technical learning in elementary school". In contrast 26% answered that they had received and read the recommendations for teaching. The same number of people did not wish to answer this question. Around 15% of the participating teachers chose the answer option that they had received the handout but had not read it.

Around 30% did not want to answer question number 13 on whether they had received ideas from the handout regarding the use of the construction kits. A further 34% left this question unanswered. In each case, around 13% received no or only partial ideas for the use of the metal construction kits from the handout. However, six people answered "yes" to this question.

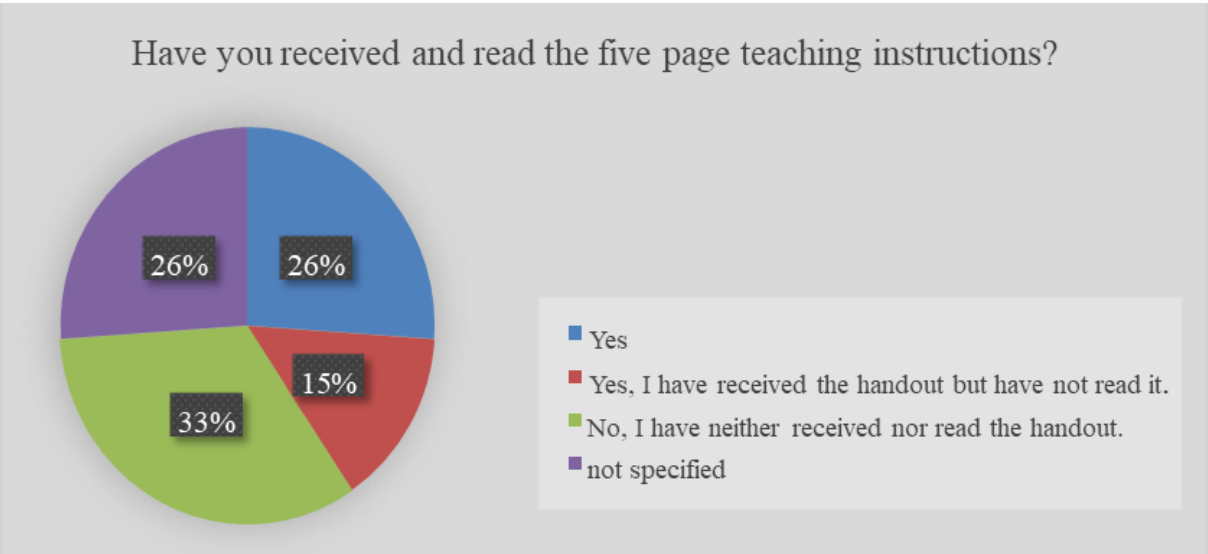

Figure 8. results of question 12

In question 14, the following ideas for using the metal construction kits were collected, with nine out of 69 participants giving the following answers (translated by authors):

- "As a study group in afternoon classes"
- "Our technology kits are used exclusively in a "construction" study group one afternoon a week. Here we still build with old fischertechnik construction sets, but also with materials such as wood, cardboard and paper."
- "Building vehicles and using small tools. Topic is covered as a compulsory subject in subject lessons in year 3 or 4 for project days/project weeks/study groups" (Answer was given twice.)
- "Individual electricity projects"
- "I was only able to try out the kits on a Discovery Day. There, the children built various vehicles according to a plan."
- "Within the topic of energy generation, stability and balance, etc., these construction kits deepen certain technical knowledge."
- "Installation in science lessons with experiments on propulsion and movement"

Only 19% out of 69 people took part in the teacher training offered. 8.7% did not give a reason. In contrast, 41 persons gave reasons for not taking part in the training, which corresponds to 59.4%. The most common reason was lack of time due to family circumstances, such as childcare or staff shortages, as described by the following answers (translated by authors):

- "Too little time, as there was a lot of additional work due to teacher absences"
- "As a head teacher and class teacher, I often don't have enough time. As we are a small, single-form entry elementary school without a reserve of substitutes, we can't guarantee further training without lessons being cancelled."

Nine people reported that they had not received any information about the training program. In addition, six people stated that they considered other topics or other training courses to be more important to them and had not taken part for this reason. Four participants explained they were not yet in the teaching profession at the time of the training. Two people made already their own experiences with the kits and did not consider it to be very practicable and therefore did not take part. Only one other teacher said that she was familiar with the boxes and did not need further training to use them.

For question 17, 13 respondents explained their reasons in writing, with similar statements being summarized below. Eight people described that their personal interest in technology, science or STEM education in general had motivated them to register. Only two people wrote that receiving another kit would have motivated them to take part. Two other people argued that they hoped the training would give them more ideas for using the construction kits in the classroom. Other reasons that were occasionally given were (translated by authors):

- "Interest and own inclination to work with haptic technology and to encourage the children in things like problem-solving skills and creativity."
- "I'm a counsellor myself and conducted the training at school."
- "Proximity and cooperation"
- "- wanted to try something new"

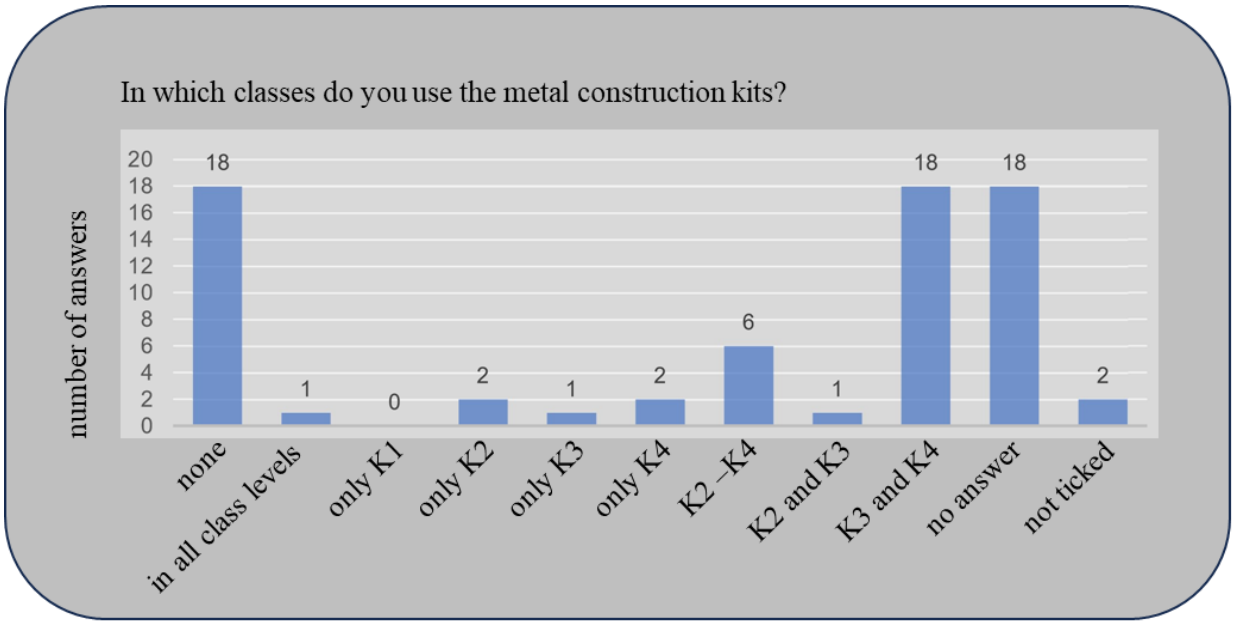

Figure 9. results of question 18

Question 18 was used to record the class levels in which the construction kits were used. According to this, 26% do not use the metal construction kits at any grade level. Just as many use the construction kits in 3rd and 4th grade. A further 26% did not specify. Six people selected grades 2 to 4. Only one teacher uses the technology box in all grades. No one uses the technology box only in first grade, as can be seen in Figure 9.

The exclusive use in the second class is the case for two teachers. Another person stated that they only use the box in year 3. Another teacher combines grades 2 and 3. Two respondents stated that they only use the construction kits in grade 4. The question was also left without an answer by two people. Around 26% declared that they do not use the kits in any setting while 30% responded only use the metal construction kits in the mornings during lessons. One teacher stated that they were used exclusively in the after-school care program. The kits are also used in the afternoon, but in the form of a working group at an all-day school, by 7.25% of respondents. Three people selected the combination of "in the morning" and "after-school care". Four teachers stated a variation of "mornings" and "working group" while two used them in the after-school care program and in a working group. Some 20% selected "no answer" and one person left the question unanswered. About 30% only use the engineering construction kits in subject-specific lessons, which means that for the majority of respondents it is the sole area of use. Three people use the construction kits in both mathematics lessons and Sachunterricht [Translation from German: general science].

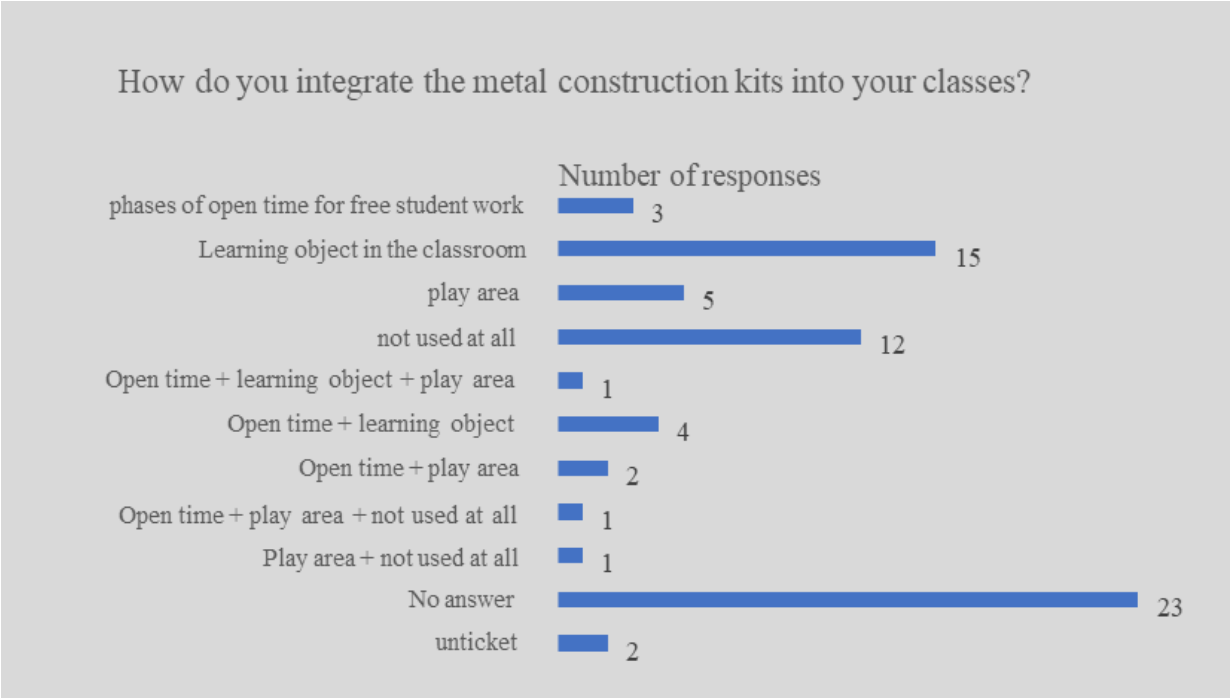

Figure 10. results of item number 21

Two participants use the kits in a combination of art and general science lessons. One person stated that they would use the metal construction kits as part of German, math, art and general science lessons. The subjects English, music, religion and sport were not selected individually or in any combination. However, three people left this question unanswered and 56.52% chose "no answer".

Regarding question number 21 (see Figure 10) 21.74% of the participating teachers use the technology kit exclusively as a learning object in the classroom. 17.39% responded they do not integrate the metal construction kits into their classroom at all. For 7.25%, the construction kits are only used in the area of free play of the classroom. Three teachers stated that they only integrate the technology kit in phases of open time for free student work. Four people chose the combination of open time for free student work and use as a learning object in the classroom. One teacher uses the box both in free work phases and as a learning object and otherwise stores it in the area of free play in the classroom.

Two teachers store the kits in their classroom that way, that the children can easy access them both during phases of open time for free student work and during play breaks. One person stated that although the kit is in the area of free play, it is not used. Another teacher expanded the combination of answers to include the option of use in free work phases. A third of respondents selected the "no answer" option to question 21 and two people left this question without responding.

In question 22, participants were able to provide further options for using the technology box, with seven out of 69 people providing the following answers (translated by authors):

- "During Corona, the construction kit was used for single children only."
- "Teaching with high gifted students"

- "The material is stored in drawers on a cupboard and is used as support material in addition to the working group."
- "Training of fine motor skills."
- „During additional childcare services at elementary schools”
- "Project days" (Cited by two people.)

Approximately 51% did not wish to provide any information on their satisfaction with the services offered as part of the support program. 26% stated that they were only partially satisfied. Nine teachers responded that they were satisfied with the offers. Three were not satisfied and four left the question open. 28 teachers selected that receiving more metal construction kits would help them to use them more frequently. The suggestion to publish specific teaching instructions received almost as many votes. Explanatory video clips were voted into third place as another useful offer with 20 votes. 17 considered pre-structured teaching units to be a helpful way of increasing the use of the construction kits. Eleven teachers thought that further in-person training would be helpful. Twelve participants considered online training to be useful. 16 people did not want to give a response and seven left the question without an answer.

Question 24 (outlined in Figure 11) was designed for collecting suggestions that would help teachers when using the construction kits. Nine people stated that there was a lack of resources in particular, as there was a demand for more material such as replacement boxes or additional extension sets, as well as for more time and staff or more teaching hours per week. The quality of the tools provided was also criticized. Others reflected that a study day and examples of best practice would help them. In addition, "it would be great if textbooks suggested specific tasks so that it will not be forgotten" (response from one participant, translated by authors).

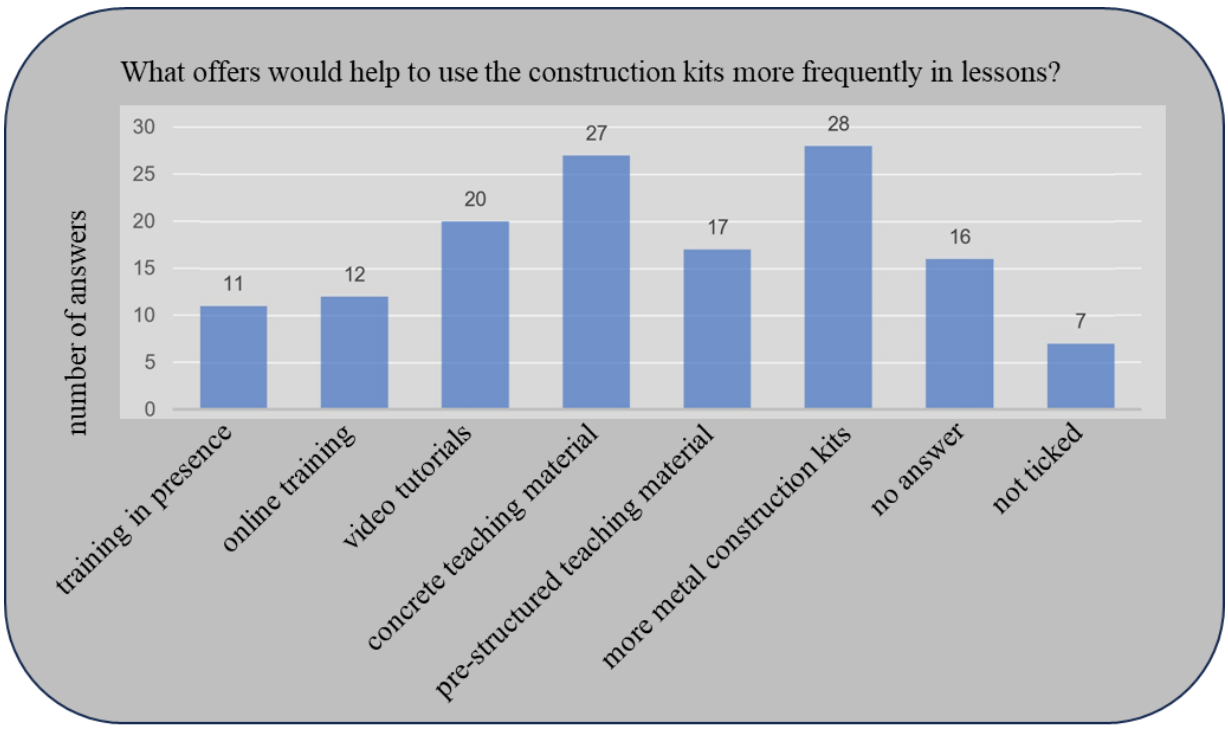

Figure 11. number of responses to item 24

26% of respondents to question number 26 made suggestions as to what they would have liked the Ministry of Education to do in the run-up to the start of the project in order to be able to work optimally with the kits. The following is an excerpt of some of the responses (translated by authors):

- "The problem is that the ministry regularly throws something new into the schools for implementation, but consistently ignores the fundamental problems such as teacher shortages, overworking school management etc."
- "A larger number of kits so that they can also be used in a classroom."
- "More staff, less actionism in clumsy acquisition and throwing it at the schools' feet."

In particular, there were calls for human resources and more free material. In addition, the suggestion was made several times that schools should be asked in advance whether they would like to take part in such a project in order to provide interested schools with a larger number of materials instead of just supplying them all with an insufficient quantity. Furthermore, an increased desire for more information and an introduction to the topic and advertising for such projects aroused. Isolated calls for schools to be involved in the selection of teaching materials were also proposed. In addition, one teacher commented that (translated by authors) "[one] could have done without the training that was provided [...] it was superfluous". Another person suggested that online training should be offered in the afternoons.

Almost half of the respondents were satisfied with the quality of the metal construction kits. As can be seen in Figure 12 only 3% answered they were not satisfaction, while 46% of ticked "no answer" and 2% left the question unanswered.

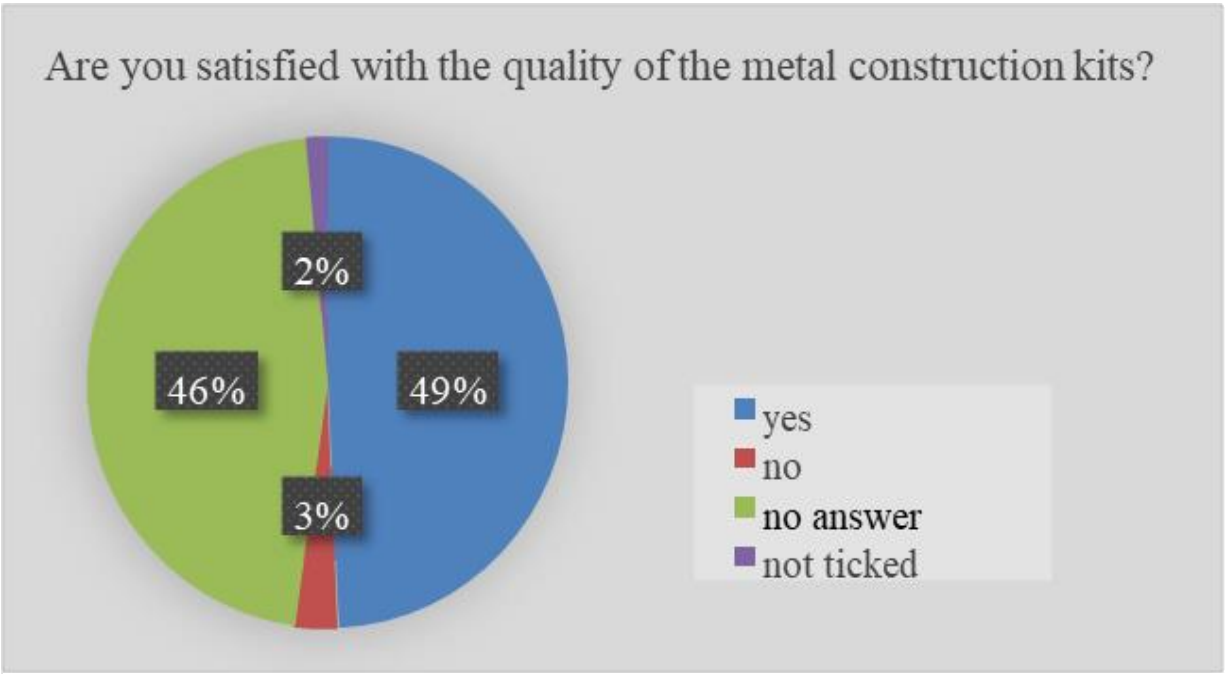

Figure 12. results of item 27

As illustrated in Figure 14 (item 28) 62% of all answers would accept more basic construction kits for their school if they had the opportunity. 7% would not accept any more metal construction kits. Around 28% gave no indication and just under 3% didn’t answer.

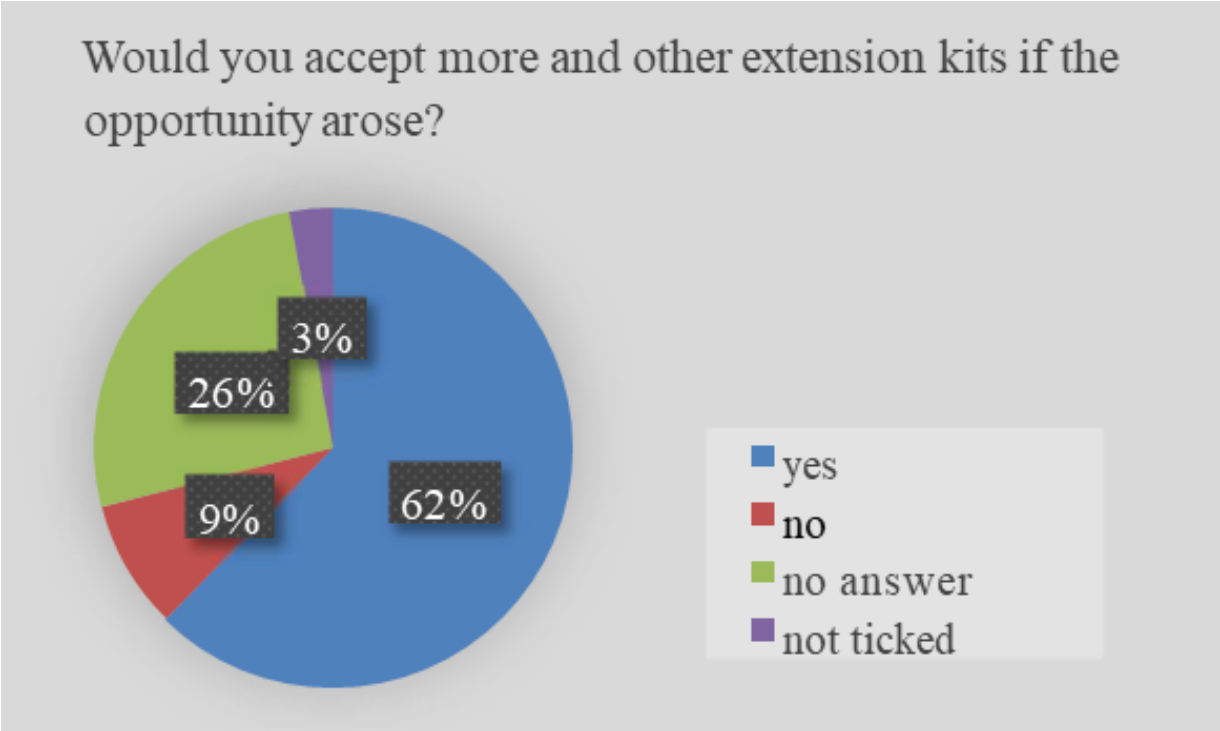

Figure 13. feedback to item 29

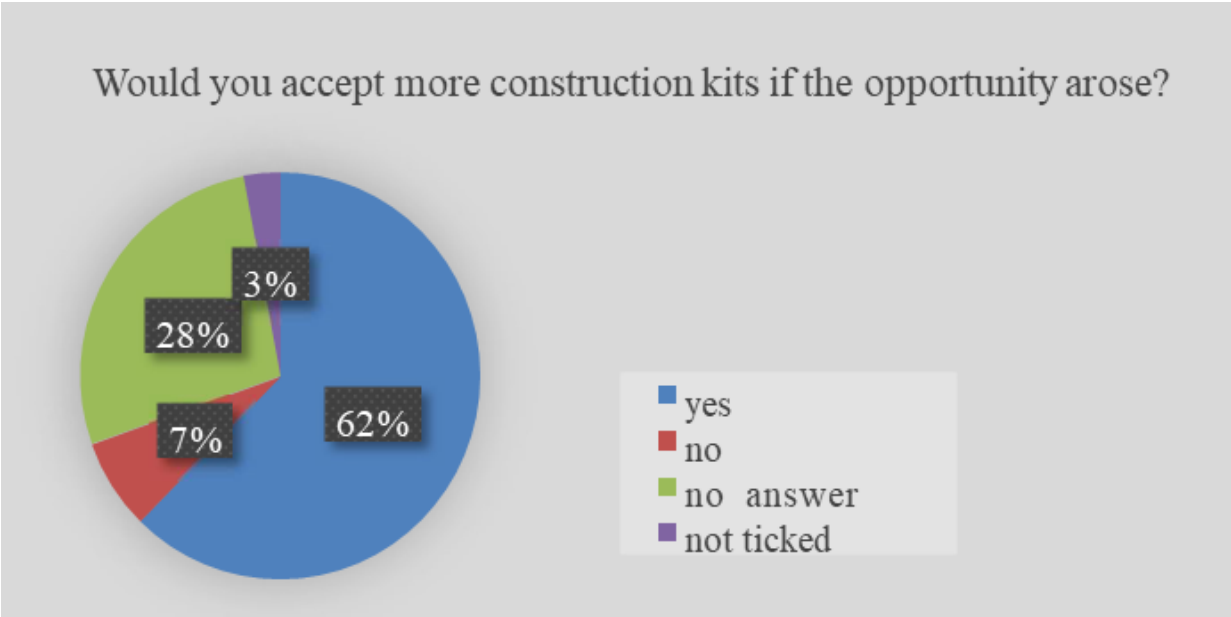

Figure 13. responses to question 28

Likewise, 62% of the teachers would accept additional extension sets of a different type for their school if they had the opportunity to do so (see Figure 14). However, 9% stated that they would decline this offer. 26% of respondents did not give a response and, as with question 28, 3% left this question without an answer.

Correlations between the questions

Only three of the 13 people who declared that they had taken part in the training were of the opinion that they were satisfied with the training offered. Seven of the 13 training participants

were only partially satisfied, while one was dissatisfied. The others did not state how satisfied they were with the program. Only one of the participants of the training indicated that he did not use the metal construction box. For the other twelve, the boxes were either used in lessons or in the afternoon. 25 teachers who had not taken part in the training stated that their school would use the boxes either in the mornings in lessons or in the afternoons as part of a supervision program or in the form of an afternoon working group. Of these 25 people, eleven reported they were only partially satisfied with the technology box. Six of them were satisfied with the offers, despite not taking part in the training. Two of the 25 non-participants were dissatisfied. The remaining six non-training participants, who do use the technology box, did not state how satisfied they were.

Informal feedback

Based on the invitation email to participate in the survey that was sent to the schools, five schools expressed their interest in the survey. However, they did not want to take part in the survey as they either did not use the construction kits or had not received any. Of these, three schools reported back that they had not received any boxes but would be happy to take some if the opportunity arose. The other two schools did not use the delivered kits at all.

Discussion

The planned full survey revealed errors in the provided addresses and discrepancies in the available data sets from different sources. As a result, six emails could not be delivered, and it was not possible to ensure that all 921 elementary school received the invitation to the survey. Targeted follow-up campaigns were prevented by administrative requirements and the General Data Protection Regulation. In addition, it was not possible to determine whether several participants from the same school responded, which could lead to distortions in school-related questions. In question 4, for example, it can be assumed that the two people who stated that their schools each have a total of twelve metal construction kits are from the same school, as this answer stands out from the other responses. Otherwise, it can be assumed that at least one of the two participants made a typing error, as this field is a free text field.

Another assumption is that the participants originally wanted to give the answer "1-2", but the hyphen was not displayed in this field (only numbers permitted), resulting in the number 12. However, if there were no input errors, the assumption that the two people who each gave 12 complete basic construction sets are from the same school can be invalidated by the fact that the two teachers entered different numbers in the subsequent question on how many extensions sets the respective school has.

One reason for the large number of people who selected "I don't know" for questions 2 and 3 could be that, after 5 years of the project, they no longer remember how many boxes they received at the beginning. The statement that around 30% do not know the number of boxes at all and 38% stated that they have not yet worked with them suggests that they have not yet had any contact with the metal construction kits. Another assumption regarding the results for questions 4 and 5 is that in contrast to question number 1, where a picture of the basic set was included to avoid misunderstandings, a picture of the extension sets was not provided to understand the exact difference between the basic kit and the extension set.

It can be assumed that the majority of participants did not know which construction set belonged to which question and therefore already included the extension sets in question 4. For example, one person stated that their school currently had 26 complete basic construction sets, but no extension sets. With this information, it can be assumed, among other things, that the assignment of the boxes with the terms “basic” and “extension” was not entirely clear.

For questions 7 and 13, it is noticeable that 35% of respondents did not answer in each case. One reason for this could be that the previous question in each case breaks down an if-then structure and participants are therefore asked with their answer in question 6 or 12 to continue with another question and thus skip questions 7 and 13. In the case of question 7, all respondents did it and followed the intended flow chart. In contrast, seven participants gave a different answer to question 13 and did not continue with question 15 as requested. The reason for this behaviour could be that the participants did not read the description carefully and thought that they also had to answer the next question.

The large proportion of those who did not wish to provide any information, such as in question 20, could be explained by the fact that towards the end of the survey there was no more time or motivation to read the question-and-answer options carefully and the participants therefore ticked a neutral answer option.

Conclusions and Implications

As the results have shown, the metal construction kits are hardly used or not used at all. Almost 30% of participants were not even aware of the kits, while one in five survey participants stated that their school had not received a metal construction kit at the start of the project. This situation means that one of the most frequently cited reasons why schools do not use the metal construction kits in their lessons is that they have too little or no learning material.

On the other hand, the study shows that the majority of teachers consider the opportunities to use metal construction kits in lessons to be useful. In addition, it was expressed several times to accept more boxes in order to increase the number of metal construction kits. It can be assumed that only a limited number of kits were given to the schools in order to initiate additional purchases by schools, while the interviewees almost universally stated that the budget provided by the school authorities was insufficient for the purchase of additional kits. With regard to the overall costs of the project, the question therefore arises as to whether the funds spent by the Ministry represented a sensible investment.

One of the main reasons why teachers did not take part in the training is that they were unable to find the time or capacity to do so due to staff shortages at school. It can be assumed that the training locations are also linked to this, as the 12 training locations, in contrast to the school locations, tended to be on the outer edge of the federal state. Even if the training provider considers the location to be balanced (Holder, 2023), teachers from the centre of the state in particular complained about the long journey.

Another problem highlighted by the results of the study is internal school communication. The fact that 30% of participants were unaware of a statewide STEM support project and that teachers repeatedly reported in the course of the survey that they had not received any information about the kits gave cause for concern. One reason for this could be that there is not enough advertising for such projects or that they are not communicated to the teachers. It

is important to question whether all emails that primarily concern teachers should be sent exclusively to the school management or whether a different system could be established to inform teachers in the best possible way.

Furthermore, future studies should consider examining the school's internal communications in order to identify the source of the information block between the ministry and the teacher and to develop possible suggestions for improvement.

Recommendations and Future Research

In conclusion, it can be said that schools are generally interested in support programs and also consider the use of the metal construction kits to be useful but would like to be asked in advance whether they would like to participate in such a project. Teachers hope that this will enable them to receive a larger number of materials from the Ministry of Education, as funds would then only have to be spent on interested schools.

In addition, the passing on of information appears to be a fundamental problem. In future studies, it would be interesting to find out whether the school management received the information but did not pass it on to the teachers or whether the school management did not receive any information about the project or the training dates for various other reasons. In order to circumvent the information, stop by the school management, it should be considered whether in future, with such cost-intensive projects as this one, the information should be sent directly to the teachers in order to advertise the use and further training opportunities.

In addition, the choice of training dates and locations should be reconsidered, as there were no training opportunities in many districts, which meant long journeys and a great deal of time. Online training courses or asynchronous explanatory videos should therefore also be considered for future projects in order to reach a larger number of people on the one hand and to act in a more economically and ecologically conscious manner on the other. Teachers would also like specific teaching materials to support and guide the use of the boxes in the classroom.

Another way to increase publicity for a STEM funding project of this size is to visit as many schools as possible in different districts at the start of the project and organize a morning together with the children using the new material to whet their appetite for more. The aim of such a day would be to arouse the children's interest in continuing to work with the boxes and for the teachers to experience a best-practice example in a direct teaching situation, thus reducing the inhibition threshold to try something new.

Another aspect that could increase the use is the inclusion of the metal construction kits in the existing loan range of the training courses offered by the “Pädagogisches Landesinstitut“ (transl.: pedagogical institute of the state). One argument in favour of including the kits in the range would be that schools could borrow exactly the number of boxes they need, as smaller classes need fewer boxes than larger ones in order to be able to work optimally. This could also save costs and resources by not purchasing boxes that are not used.

Another idea that could increase the use of the kits in schools would be to launch a follow-up campaign after five years of the project launch, giving schools the opportunity to register for a new collective order at favourable conditions in order to obtain the quantity of boxes needed for optimal use.

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