Protective teaching mechanisms in case of mild perinatal adversity

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Chapter 4

Teacher opinions and beliefs on the effectivity of digital learning material

Introduction: Teacher 'beliefs and expectations' regarding digital interventions predict implementation of such interventions. We explore how these constructs might relate to digital skills of the teacher, and intervention results perceived by the teacher. *Method:* Kindergarten teachers (*N* = 106) filled in the Beliefs and Attitudes towards Digital Educational Material (BADEM) questionnaire. In a series of analyses the four identified core concepts (beliefs and expectations, implementation and involvement, digital use and skill of the teacher, and (perceived) intervention results).were interrelated. *Results:* Significant associations were found between 'implementation and involvement' and '(perceived) results', and between 'digital use and skill' and 'beliefs and expectations'. Associations between 'implementation and involvement' and 'use and skill', and between 'beliefs and expectations' and 'implementation and involvement' were marginally significant. *Conclusion:* Core concepts were strongly associated. Use and skill predicted strongest for other concepts in the model. To promote implementation of digital interventions digital skills of the teacher should be trained.

Digital educational environments offer unique opportunities to adapt the learning environment to the individual needs of students. Recent studies in kindergarten samples show for example that students vulnerable to experiencing learning problems, can thrive when the digital educational environment meets their specific needs (e.g. Van der Kooy-Hofland, Van der Kooy, Bus, Van IJzendoorn, & Bonsel, 2012, Plak, Merkelbach, Kegel, Van IJzendoorn, & Bus, 2016, Merkelbach, Plak, & Rippe, 2018). Under such circumstances, these vulnerable students (can) even outperform their non-vulnerable peers, while in regular learning environments, these children tend to lag behind. Although many questions pertaining to digital educational interventions for kindergartners still need to be addressed, as it currently stands it can be argued that deployment of digital educational programs holds great potential for a considerable number of young children whom are currently falling behind in the regular classroom environment.

In order to effectively implement digital learning material in classrooms, teachers not only need to be capable and equipped to work with digital educational programs, and able to select the right material and effectively integrate it into their curriculum, but they should also be intrinsically supportive of using these materials (Güllbahar, 2007). While teachers seem to generally appreciate the benefits of using technology in their instruction, effective integration of computer programs and other digital material, for which both high levels of involvement and an ICT encouraging school environment are vital (Schiller, 2002), has proven to be often unsuccessful (e.g. Güllbahar, 2007; Vannatta & Nancy, 2014).

This lack of effective use of digital material might be explained by challenges faced by teachers when implementing digital interventions. Such challenges, both internal and external to the teacher, could prevent teachers from (effectively) implementing digital programs in their curriculum, consequentially denying vulnerable children valuable opportunities. External challenges which teachers might encounter include for example a lack of access (e.g. sufficient availability of computers, internet access, etc.), and digital support (e.g. technological support) (Johnson, Jacovina, Russell, & Soto, 2017). However, in primary schools in countries like the Netherlands typically one computer is available for each five pupils and high speed internet access is common (Nationale Onderwijsgids, 2015). Here, it thus seems likely that internal challenges encountered by the teacher are a greater impediment for the implementation of digital learning material than external challenges. Potential internal challenges are negative beliefs and expectations concerning digital programs, lack of digital skills and limited knowledge of computers and digital educational programs, and little involvement and interest in digital programs (Johnson, et al., 2017; Hu, Clark, & Ma, 2003).

The *Technology Acceptance Model* (TAM) (Davis, 1989) describes how internal challenges may hamper effective implementation, by stating that expectations and

beliefs regarding technology are of great predictive value for (effective) implementation. TAM focuses on two constructs that describe these beliefs and expectations: *perceived usefulness* and *perceived ease of use*. Perceived usefulness depends on results of an intervention as perceived by the teacher. If a teacher feels a digital intervention helps pupils to learn, perceived usefulness will be high. Perceived ease of use (from the point of view of the teacher) on the other hand, depends on the complexity of the technology, but also largely on the skill level of the individual working with the technology, in this case thus the teacher. According to TAM, in order to facilitate effective implementation of technology, scores should be relatively high on both perceived usefulness and perceived ease of use.

In line with this reasoning, we might thus expect to predict the teacher's level of implementation of, and involvement in a digital intervention via the model depicted in Figure 1. Because we focus on components internal to the teacher, we did not include complexity of the digital material as a predictor of beliefs and expectations in this model. Because in the current study all teachers worked with the same digital educational material, and thus with the same level of complexity, leaving out this component did not lead to the exclusion of valuable information. The current study aims at testing this mediation model, thereby taking a first step in identifying which (teacher) constructs could serve as an anchor for intervention in order to further promote effective use of digital material in classrooms.

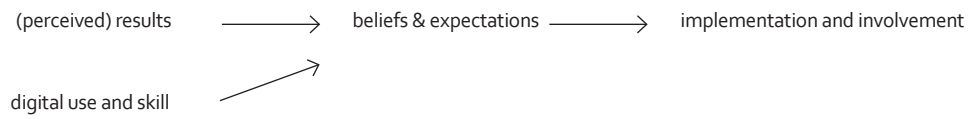

Figure 1. Expected model predicting active deployment of digital material in the classroom, based on the TAM.

Method

Design

In the school years 2013/2014 and 2014/2015 a total of 183 schools participated in the research project *What Works for Whom*, a large scale study on the (differential) effects of digital educational programs in kindergarten (e.g. Plak et al., 2016). In two consecutive research waves kindergarten teachers participating in this study implemented digital literacy- and numeracy interventions over the course of two to three months. After completing the intervention, teachers of the 139 schools participating in the second research wave (N = 106) were asked to complete a survey about their beliefs and

expectations about digital educational material and the use of such material in their curriculum, their personal computer use and digital skills, their current use of computers and digital material in the classroom, and their opinions on participation in the *What Works for Whom*-project and on the interventions used in this study. The *What Works for Whom*- project is described in more detail in Plak et al. (2016) and Merkelbach et al. (2018).

Participants

We surveyed only those teachers whom had participated in the second wave of the *What Works for Whom*-project, in which 139 schools participated. Questionnaires were send out to all participating schools, of 95 schools at least one teacher responded. From most schools, one teacher filled in the questionnaire. Of five schools two teachers answered the questions, while of three schools three teachers filled in the questionnaire. Schools were located across The Netherlands, in both rural and urban areas. The mean age of teachers was 43.90 (SD = 11.94) years. 91.5% of teachers was female, one teacher was male (.9%) and for eight teachers their gender was not reported. Part-time work was indicated by 67.0% of teachers and they thus share their teaching responsibilities with another teacher.

Measures

Questionnaire

The questionnaire on Beliefs and Attitudes towards Digital Educational Material (BADEM) was developed by the researchers and digitally distributed. Questions regard background information of teachers, beliefs and expectations towards the use of computer programs in the curriculum, computer use and skills, appreciation of participation in the *What Works for Whom*-project, and use of the computer in the classroom (both as part of, and outside of the research project). Filling out took between 10 and 15 minutes. For a complete overview of questions and respective answers, see Supplementary Table 1 (gray boxes identify the answers given most frequently by teachers). Overall, teachers displayed a moderately positive attitude towards working with digital material. It must be noted however, that this questionnaire was sent out only to teachers who had already agreed to participate in a study into the effects of a digital learning intervention, most likely resulting in some bias. We probably reached teachers with a more than average positive attitude towards digital material, while missing teachers with a critical stance. However also in most other studies, teacher opinions towards digital material turn out to be nuanced and predominantly positive (e.g. Lam, 2000, Chen, 2008). Also in this study, answers were sufficiently spread, and teachers did not exclusively feel positive towards digital programs: for example, only 19.1% of teachers did not believe that children with literacy delays would benefit more from individual teacher attention than from working with computer programs.

Data analysis

Items were grouped per construct of the mediation model based on TAM, as depicted in Figure 1: 'use and skill' (item 7 and item 8), '(perceived) results'(item 9, item 14, item 15), 'beliefs and expectations' (item 1 to item 6), and 'implementation and involvement'(item 9 and item 21). Items describing the same construct were combined into one empirically weighted score by performing a principal component analysis (PCA). We chose to this approach, instead of deploying a SEM with latent constructs, because we wanted those constructs included in the analysis to match constructs described in the model depicted in Figure 1 as closely as possible, and because this approach would minimize the number of parameters included in the model. After defining these constructs, the mediation analysis depicted in Figure 1 was tested using structural equation modelling (SEM).

Results

Components

The component describing digital 'use and skill' explained 77.66% of variance, both items showed loadings of .88. A high score indicated a high level of computer skills and use. The component describing '(perceived) results' explained 78.09% of variance, both items showed loadings of .88. A high score indicated positive (perceived) results. The component describing 'beliefs and expectations' of teachers explained 42.15% of variance, loadings varied from -.48 (item 1) to .83 (item 6). A high score indicated negative beliefs and expectations towards digital material. Since the other component identified so far describe positive feelings and associations, this scale was reversed, so that a higher score now indicated more positive beliefs. Lastly, the component describing 'implementation and involvement' explained 65.91% of variance, both items showed loadings of .81. A high score indicated a high level of implementation by and involvement of the teacher.

Mediation analysis

The overall mediation model proved significant (F (2, 91) = 10.52, p <.001), and explained 19% of variance (R^2= .19) of the 'implementation and involvement' construct. Not all of the expected paths proved significant. Figure 2 shows which paths could be confirmed and which could not, dashed lines indicate non-significant relations.

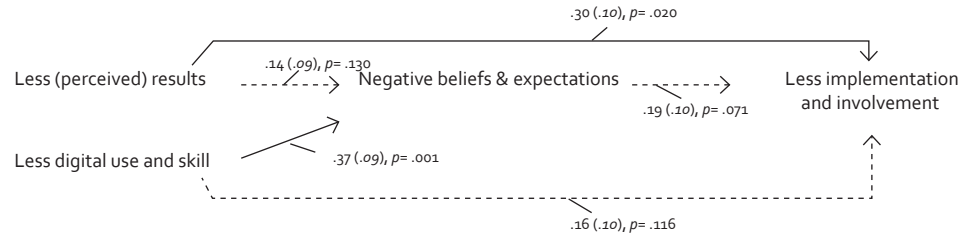

Figure 2. Results mediation model including estimates (*SE*) and *p*-values (continued lines = significant, dashed lines = not significant)

'(Perceived) results' was directly associated with 'implementation and involvement' (p = .020), however no association was found between '(perceived) results' and 'beliefs and expectations' (p = .130). Digital 'use and skill' was also not associated with 'implementation and involvement' (p = .116), however a direct effect on 'beliefs and expectations' was found for digital 'use and skill' (p = .001). There was however no mediation, since the association between 'beliefs and expectations' and 'implementation and involvement' just failed to reach significance (p= .071). In conclusion, this set of associations between these four constructs, does not indicate mediation of the association between '(perceived) results' and/or digital 'use and skill', and 'implementation and involvement' through 'beliefs and expectations' of the teacher.

These results do not align with our expectations. Surprisingly absent is an association between teacher 'beliefs and expectations' regarding digital material and level of 'implementation and involvement', a link which was however firmly established in TAM-based literature.

Secondary explorative analysis

One possible explanation for these unexpected results is that the tested mediation model is an oversimplification of true connections between the concepts in the model, because the model suggests one-directional causality. For example, it might not be reasonable to assume that 'implementation and involvement' is the final stage in this model, consequently not influencing the other constructs. Instead, teachers who do not make use of digital material (in their teaching; i.e. thus scoring low on implementation and involvement) could be expected to not train their digital skills sufficiently. This suggested additional association is supported by the finding that under promoted digital implementation and involvement of kindergarten teachers (by providing them with laptops and digital material to work with), teacher skill level with educational technology increases (Donovan, Green, & Hansen, 2011). Additionally, since digital material has been shown to have the possibility to stimulate a broad range of (academic) skills in kindergartners (e.g. Lieberman, Bates, & So, 2009), less (effective) implementation of

such materials would evidently lead to less (perceived) results. Because 'implementation and involvement' thus can influence both digital 'use and skill', and level of '(perceived) results', we extended the initial mediation model with associations A and B, as depicted in Figure 3. Additionally, digital 'use and skill' of the teachers might not only be predictive for 'beliefs and expectations', but also for '(perceived) results' since technology will most likely have little effect if teachers are not adequately trained to use this technology or have a too low digital skill level to do so (Savage , Erten, Abrami, Hipps, Comaskey, & Van Lierop, 2010). Teachers with low levels of digital 'use and skill' will have more trouble selecting appropriate interventions and will encounter more (technical) difficulties while implementing interventions, which in turn could lead to lower '(perceived) results. To account for this, association C (as depicted in Figure 3) was added to the model.

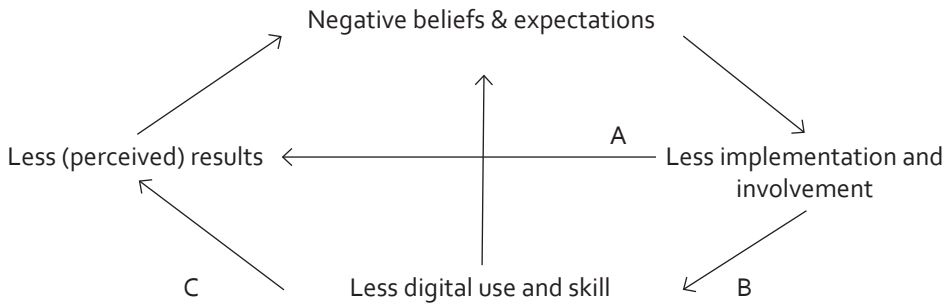

Figure 3. Proposed extended model of teacher influences on use of digital material in the classroom.

Results of this analysis are depicted in Figure 4. Connections between '(perceived) results' and 'digital use and skill' (p = .543) and between '(perceived) results' and 'beliefs and expectations' (p = .880) did not reach significance. However the association between 'implementation and involvement' and '(perceived) results' reached significance (p <.001), as did the association between digital 'use and skill' and 'beliefs and expectations' (p <.001). The associations between 'implementation and involvement' and 'use and skill' (p = .068), and between 'beliefs and expectations' and 'implementation and involvement' (p = .054) were marginally significant.

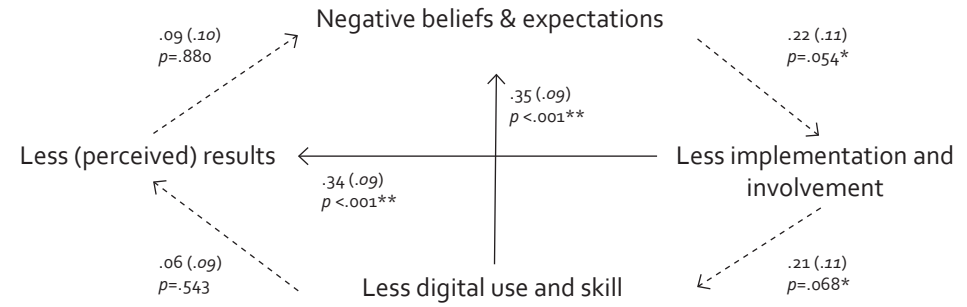

Figure 4. Results of the expanded model circular model (solid lines = significant, dashed lines = marginally significant, grey dashed lines = not significant)

As was seen in the original mediation results, 'digital use and skill' is a significant predictor of 'beliefs and expectations', while '(perceived) results' is not predictive. Also, as was the case in the mediation model, the expected association between 'beliefs and expectations' and 'implementation and involvement' was not convincingly detected, however the association was now marginally significant (p= .054). The association between 'implementation and involvement' and '(perceived) results' was significant, as it was in the original model, however in the current model the direction is converted. The added association between 'implementation and involvement' and 'digital use and skill' reached a marginal significance level (p = .068).

To assess sensitivity and stability of the just-described results, we repeated the analysis under exclusion of the one male teacher, since he might be considered conceptually different from the other respondents. Results (depicted in Supplementary Figure 1) were highly comparable to those presented in Figure 4.

Discussion

Digital educational material can offer children unique learning opportunities (e.g. Van der Kooy-Hofland et al., 2012, Plak et al., 2016, Merkelbach et al., 2018). However, both external and internal challenges can prevent teachers from effectively implementing digital interventions in the classroom (Johnson et al., 2017). In this study, we focused on internal teacher challenges, assuming that influence of internal challenges outweighs that of external challenges (such as availability of digital material and hardware) in a modern western society. Based on the TAM (Davis, 1989) we expected 'beliefs and expectations' of the teacher about the utility of digital material (i.e. perceived ease of use and usefulness of such material) to mediate the relation between teacher's digital 'use and skill' of and 'implementation of and involvement' in such digital programs, as

well as the relation between '(perceived) results' of digital intervention by the teacher and 'implementation and involvement' (Figure 1). We were however not able to confirm the proposed mediation (Figure 2). While some of the associations reached significance, most associations could not be confirmed.

Additional, exploratory analyses were run, in which we tested a circular model of the implementation of digital material by the teacher (Figure 3). Here, too, not all proposed associations could be confirmed. However, four (66.67%) of the proposed associations proved (marginally) significant, all depicted in Figure 5.

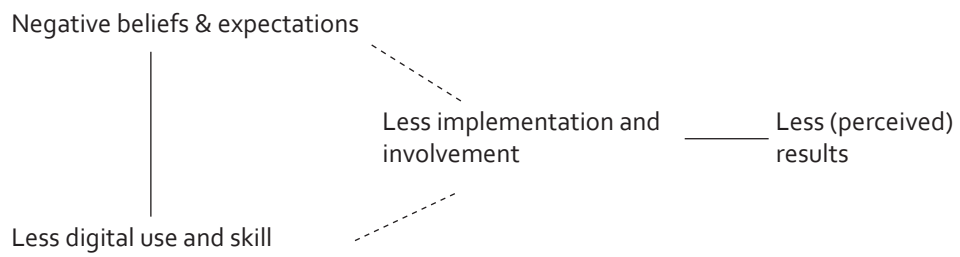

Figure 5. *Confirmed associations of the circular model of the implementation of digital educational by the teacher (solid lines = significant, dashed lines = marginally significant)*

This model suggests that 'implementation and involvement' are key ingredients for achieving and perceiving intervention results. Additionally, whether or not digital material will be implemented can be predicted by both the 'beliefs and expectations' of the teacher towards digital material and the level of digital 'use and skill' of the teacher, while digital 'use and skill' of the teacher also predicts for 'beliefs and expectations'. The level of digital 'use and skill' of the teacher thus seem to be the base of the current model. Additionally, recent case studies show that promoting digital 'use and skill' of kindergarten teachers by offering ICT training can positively influence teachers' perceptions and practices, as well as reduce obstacles teachers encounter while implementing digital material (Ihmeideh & Al-Maadadi, 2018). Therefore digital 'use and skill' is expected to be the aspect that could best be intervened on in order to promote the integration of digital material in standard curricula. Developers of digital material should thus not only focus on developing effective digital interventions and programs, they should also secure ease of use of such material for the teacher, and offer clear instructions on how to use and implement digital material. Additionally teacher training should include courses in which using digital material in the classroom is discussed and trained in a professional manner (Instefjord & Munthe, 2017).

In the current model no causal relations can be revealed and we cannot be sure of the direction of associations. Additionally, concepts are broadly defined, future research should

focus on carrying out dedicated experiments to establish a predictive association between promoting digital skills of teachers and a) changes in their 'beliefs and expectations', b) in their level of 'implementation and involvement', and eventually and most importantly c) in achieved results. Additionally, further specification of teacher training requirements is needed. For example, should teachers be trained to use specific digital interventions, should we focus on improving the general use of digital technology, or are both concepts equally important? By both broadening and specifying our understanding of how internal characteristics of the teacher might influence the implementation of digital interventions and thereby eventually the results of such programs, we can more precisely identify which steps could be taken in order to stimulate the use of digital material in the classroom.

In summary, digital interventions have the possibility to help children learn, but internal challenges of the teacher might prevent the effective implementation of such digital programs as standard part of the curriculum. The current study reveals that teacher 'implementation of and involvement' in digital material might form the link between the relation between teacher digital 'use and skill', and the teacher's '(perceived) results' of digital learning material. Additionally, the association between teacher 'beliefs and expectations' regarding digital material and '(perceived) results' is also connected by 'implementation and involvement' of the teacher. Lastly, 'beliefs and expectations' can be predicted from the level of digital 'use and skill'. These findings suggest that improving digital dexterity of teachers might be the most effective way to promote the implementation of digital material in classrooms, eventually leading to better academic results. The current study is however explorative and non-experimental, therefore causality and direction of associations between core concepts cannot be established. More research, for example RCT's which intervene on digital skills of the teacher or by promoting 'beliefs and expectations', are needed to specify current findings and to establish if found relations are causal.

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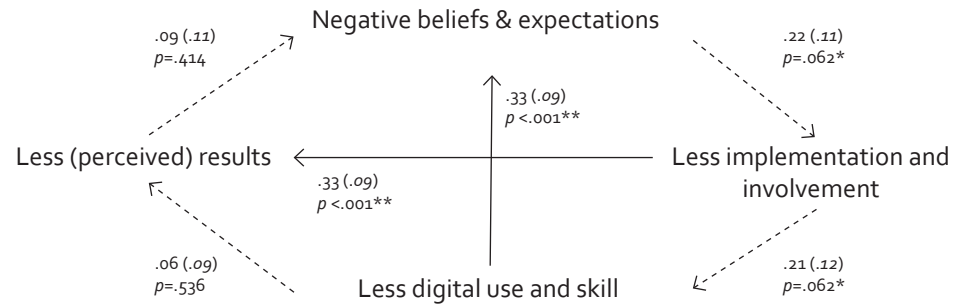

Supplementary Figure 1. Results expanded circular model tested in a sample without the male teacher

Supplementary Table 1. *Kindergarten teacher survey on computer use*

Teacher report on use of digital educational programs					
Teacher opinions and beliefs regarding the use of digital material in instruction					
	Totally disagree	**Disagree**	**Neutral**	**Agree**	**Totally agree**
1.Computer programs can help children to catch up literacy delays	n = 0 (0%)	n = 0 (0%)	n = 20 (21.3%)	n = 60 (63.8%)	n = 14 (14.9%)
2.Children with literacy delays benefit more from individual teacher attention than from computer programs	n = 0 (0%)	n = 18 (19.1%)	n = 43 (43.6%)	n = 31 (33.0%)	n = 4 (4.3%)
3.Computers offer a valuable contribution to language education	n = 0 (0%)	n = 1 (1.0%)	n = 5 (4.8%)	n = 51 (48.6%)	n = 48 (45.7%)
4.Working with computer programs takes the teacher a lot of effort	n = 15 (14.4%)	n = 61 (58.7%)	n = 22 (21.2%)	n = 5 (4.8%)	n = 5 (4.8%)
5.Working with computer programs takes the teacher a lot of time	n = 11 (10.6%)	n = 47 (45.2%)	n = 29 (27.9%)	n = 16 (15.4%)	n = 1 (1.0%)
6.The time/effort it takes the teacher to work with computer programs is better spend on other activities	n = 21 (20.2%)	n = 62 (59.6%)	n = 19 (18.3%)	n = 2 (1.9%)	n = 0 (0%)
Computer use and -skills					
	Mean (*SD*)	**Range**			
7.How do you judge your computer skills on a scale from zero to ten? Zero meaning you have no computer skills, ten meaning you have excellent computer skills	7.40 (1.21)	2 - 10			
	Never	Sometimes	Regularly	Frequently	Always
8.I often make private use of computers	n = 0 (0%)	n = 4 (3.8%)	n = 5 (4.7%)	n = 30 (28.6%)	n = 66 (62.9%)
9.Do you - outside of the What Works for Whom project - use computer programs in your instructions?	n = 8 (8.5%)	n = 6 (6.4%)	n = 27 (28.7%)	n = 29 (30.9%)	n = 24 (25.5%)
Opinions on participation in What Works for Whom					
	Totally disagree	**Disagree**	**Neutral**	**Agree**	**Totally agree**
10.The instructions provided by the researchers during What Works for Whom were satisfactory	n = 1 (1.0%)	n = 18 (17.8%)	n = 28 (27.7%)	n = 52 (51.5%)	n = 2 (2%)

Continued Supplementary Table 1. *Kindergarten teacher survey on computer use*

11.The logging in procedure during What Works for Whom was satisfactory	n = 8 (7.9%)	n = 24 (23.8%)	n = 25 (24.8%)	n = 42 (41.6%)	n = 2 (2%)
12.The accessibility of the programs used during What Works for Whom was satisfactory	n = 7 (6.9%)	n = 18 (17.8%)	n = 28 (27.7%)	n = 46 (45.5%)	n = 2 (2%)
13.Participating in What Works for Whom took little time	n = 6 (6.4%)	n = 26 (27.7%)	n = 15 (16%)	n = 39 (41.5%)	n = 8 (8.5%)
14.Children benefitted from participating in What Works for Whom	n = 0 (0%)	n = 3 (3.2%)	n = 40 (42.6%)	n = 45 (47.9%)	n = 6 (6.4%)
15.What Works for Whom offers valuable support for delayed children	n = 0 (0%)	n = 2 (2.1%)	n = 41 (43.6%)	n = 45 (47.9%)	n = 6 (6.4%)
16.What Works for Whom offers a good addition to the regular curriculum	n = 0 (0%)	n = 6 (6.4%)	n = 37 (39.4%)	n = 43 (45.7%)	n = 8 (8.5%)
	No	**Maybe**	**Yes**		
17.Would you have participated in What Works for Whom if you would have known what the research project encompasses in advance?	n = 12 (12.8%)	n = 28 (29.8%)	n = 54 (57.4%)		
Digital classroom practices (in- and outside the research period)					
	No	**Yes**			
18.Did children work with the computer inside de classroom?	n = 22 (21.2%)	n = 82 (78.8%)			
19.Did children wear headphones while working with the computer programs ?	n = 7 (6.7%)	n = 97 (93.2%)			
20.Did you sit beside the child the first time he/she worked with What Works for Whom?	n = 31 (30.7%)	n = 70 (69.3%)			
	Totally disagree	**Disagree**	**Neutral**	**Agree**	**Totally agree**
21.I have a clear image of what the programs of What Works for Whom encompass	n = 6 (6.4%)	n = 19 (20.2%)	n = 23 (24.5%)	n = 42 (44.7%)	n = 4 (4.3%)
22.I provided children with help while interacting with the programs	n = 25 (24.8%)	n = 50 (49.5%)	n = 22 (21.8%)	n = 3 (3.0%)	n = 1 (1.0%)