Behavioural Intention of Teachers for Teaching Computational Thinking in Primary Education

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Abstract

Teachers are challenged with the task of teaching Computational Thinking (CT) to their students. This study seeks to identify factors and their influence that initiate teachers to implement CT in their teaching programs. The Theory of Planned Behaviour (TPB) is used to gain insight into factors that influence people's intention to perform behaviour. The influence of policies and a shared vision on school level was also taken into account. A questionnaire was used and spread among teachers (n = 73) of schools who were interested in implementing CT in their education. Structural equation modelling was used to see if the independent variables (1) attitude; (2) subjective norm; (3) perceived control; (4) policy & vision, influenced the dependent variable "intention to use CT". The relationship among the independent variables was also measured. Subjective norm and perceived control seemed to significantly influence the teachers' intention to implement CT in teaching programs. Correlations were found between all independent variables, these variables influence each other and might suggest indirect effects of both attitude and policy & vision on the intention of teachers to implement CT in teaching programs.

Keywords: Computational Thinking, Theory of Planned Behaviour, Structural Equation Modelling, 21st century skills

Introduction

Teachers are expected to teach students the knowledge, skills and attitude needed to be successful in work and life. But the society around students seems to ask for different knowledge and skills than most schools are currently teaching, thus creating a gap (21st century skills NL, n.d.; Bower et al., 2017; Saavedra & Opfer, 2012). To bridge the gap, certain *21st century skills* came up as necessary components to be successful 'these days' (Rotherham & Willingham, 2010). The 21st century skills consist of multiple soft skills, but there is some disturbance in the literature on how they are named and how they are divided. For this study, the skills suggested by Kennisnet and Slo (Pijpers, 2017; Slo, 2018) were hold in mind, as they are the leading model in the Netherlands. While the newness of 21st century skills can be questioned (Rotherham & Willingham, 2010), they did raise awareness in the educational sector.

To be able to bridge the gap between educational offer and societal demand, teachers are expected to teach their students the 21st century skills within learning activities. Research has been done to investigate the way teachers should deal with teaching the 21st century skills. Saavedra and Opfer (2012) took scientific theory and proposed nine points of advice for teachers that allow them to support 21st-centrury learning. In their article, Saavedra and Opfer (2012) intend to give advice on teaching styles that influence the 21st century skills, but they do not go in depth on how to support implementing them. Bower et al. (2017) noticed the lack in literature on teacher support within one of the 21st century skills, *Computational Thinking* (CT), and tried to identify the experienced demand of teachers for professional development within the skill, by using surveys before and after a workshop on CT. They did find some influencing factors. Where trainings, peer learning, and available resources are named as influencing factors on CT (Bower et al., 2017), they seem to be more of a possible practical solution, but they do not go into detail on what influences a teacher to use CT in

practice. Bower et al. (2017) only name self-efficacy improvement as a possible influencing factor. However, in their study it remains a suggestion and it is unknown how factors like self-efficacy relate to CT and other factors that might be influential. Due to this limitation, it remains unknown if these factors directly or indirectly influence the implementation of CT in teaching. The relatedness of these factors could be interesting as their connection could show how different factors influence each other when compared to the use of CT as part of a teaching program. Bower et al. (2017) point out that the preparation of CT-teachers in education might currently be the biggest challenge. Inefficient teaching will have consequences for students' CT skills and their perception of them (Guo, Piasta, Justice & Kaderavek, 2010; Israel, Pearson, Tapia, Wherfel & Reese, 2015). Because of these insights, it seems important to know what factors influence teachers' behavioural intentions to use CT in their education. In this study a focus will be applied on CT, because the idea of CT as a skill and universal competence which every person should possess emerged over the past years (Bower et al., 2017). With this in mind, the aim of this study is to add theoretical insights, to find out which factors influence the intention to teach CT by teachers. Only a few studies focus on the teacher in CT, and in the case factors are found, their relatedness is not tested. This relatedness could be important, as factors could also influence each other and the intention to teaching CT.

Theoretical framework

21st century skills

The 21st century skills are an innovative skill set that are essential for future societal demands (Qian & Clark, 2016). In the Netherlands the leading model of 21st century skills is made by Kennisnet and slo (Pijpers, 2017; slo, 2018). They suggested the following skills: creative thinking; problem solving; computational thinking; information skills; information and communication technology skills; using media responsibly; communicating;

collaboration; social & cultural skills; self-regulation, and critical thinking. While each skill is important on its own, it would be too broad for this study. Wing (2008) points out that CT influences a lot of fields in the society. With rapid technological advancements in a lot of fields, and the growing affordances that come with them, people are challenged more to think computational. Due to this insight CT was chosen as the focus point of this study.

Computational thinking

CT can be defined as a thought process involving the formulation of problems and solutions in a way which you could solve with computer technology (Grover & Pea, 2013). It is a collect activity of thinking processes, in which problem definition, data organization, analysis and representation are used to solve problems, possibly with the help of ICT-techniques and tools (Slo, 2015). CT is proposed to serve as an effective vehicle that helps learning other subjects (Bower et al. 2017). The use of information technology is linked to CT, but it should be noted that CT can go beyond the usage of information technology. An example of CT is being able to break a problem into smaller comprehensible parts. So, if a team of teachers discovers their students are performing below expectations, they need to find a solution. The teachers will have to look at different parts within their education, like didactics, teaching styles, motivation of students or tests used, in order to analyse the problem and find a suitable and sustainable solution. If wanted, these factors could even be tested using different kinds of analysis. This example shows that a small part of CT, namely "decomposing" can help to solve problems. The example could even be expanded, as teachers might look for patterns by comparing the results to those of previous years. In summary, CT is a problem-solving method that is originally derived from computer sciences and has since be used in non-computer contexts (Mohaghegh & McCauley, 2016).

Teacher development concerning CT

To identify the integration of CT in teaching programs by teachers, knowing what moves people to change behaviour offers great insights. A theory that investigates behavioural control factors and factors that influence people's intention to perform behaviour is the Theory of Planned Behaviour (TPB) (Ajzen, 1991; Montano & Kasprzyk, 2015). The TPB has three main factors that influence behavioural control and intention: (1) attitude, (2) subjective norm, and (3) perceived control. (1) A person's attitude is formed by their beliefs on outcomes and attributes that are bound to the behaviour. A person then evaluates the outcomes and attributes to determine their weighting (Ajzen, 1991; Montano & Kasprzyk, 2015). For example, if a teacher has heard about the positive effects of CT in education, he might evaluate it as useful for his own classroom, as a result his attitude towards using CT becomes more positive. Thus, either positive or negative beliefs on behaviour towards the outcome, will lead to a corresponding attitude towards the behaviour. (2) Subjective norm is the combination of normative beliefs and motivation to comply. Normative beliefs have to do with the approval or disapproval of other, often important, people concerning the behaviour. These normative beliefs are weighted against a person’s own motivation to comply with these individuals (Ajzen, 1991; Montano & Kasprzyk, 2015). For example, if a colleague of a teacher shows her approval of teaching CT, the teacher will evaluate the belief of her colleague. The teacher respects the colleagues work and is motivated to go along with the set norm. So, if a certain behaviour is valued by others, and the person who has to initiate the behaviour is motivated to live up to these values, the person who has to initiate the behaviour has a positive subjective norm and will be inclined to exhibit that behaviour. Both attitude and subjective norm are factors that focus on intention to perform behaviour. However, (3) perceived control focusses more on the believed ability. Perceived control is the combination of the beliefs a person has concerning the amount of control one has and the perceived power one has to be able to change their behaviour (Ajzen, 1991; Montano & Kasprzyk, 2015). For example, if a teacher

gets a lot of freedom to use the teaching style that suits him best, he might perceive a lot of control to change his own teaching behaviour. Kalogiannakis and Papadakis (2017) suggest that self-efficacy is an influencing factor on CT. Self-efficacy has been defined by Bandura (1991) as “people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives” (p. 257). Overlap between the findings on self-efficacy in CT studies and perceived control in TPB can be found. Ajzen (2002) notes that self-efficacy is part of perceived control as it concerns believed capacities to exercise control. This means that measuring self-efficacy is an essential part in measuring perceived control.

Beside the teachers’ own behavioural aspects, the environment in which a teacher works also influences the way CT is included in education. Barr and Stephenson (2011) state that a change towards CT is not a natural process. They call for policies, shared vision, inspiration and preparation among teachers school wide. This indicates that a need for communal goals, targets and believes, influence the acceptance and implementation of CT. When looking at the TPB, environmental influence is included. Ajzen (1991) states that subjective norm is formed by normative beliefs on behaviour. However, there is a difference. Where the subjective norm is the product of normative beliefs and one's own motivation (Ajzen, 1991; Montano & Kasprzyk, 2015), having policies and being aware of a shared vision is an observation that influences CT without looking at one's motivation. This means that if a school has a shared goal on implementing CT it could influence the intention of teachers to integrate CT in teaching programs. For this reason, it has been chosen to use "policy & vision" as a different variable. In summary the following factors seem to affect the intention of using CT: (1) attitude; (2) subjective norm; (3) perceived control; (4) policy & vision.

Correlations between factors

Concerning the relation among the factors in the research question, theory was examined to see if any relationships can be found between the different factors. Within the TPB, a few studies find and suggest a relation between the independent variables attitude, subjective norm and perceived control (Armitage & Conner, 2001; Lai, 2017; Teo & Lee, 2010). Teo and Lee (2010) point out that these relations can be found, but the meanings should be further investigated to acquire greater insights. When looking at studies on norms and behaviour, it is also known that group norms can influence the attitude of a person (Terry & Hogg, 1996). Based on this finding it is expected that subjective norm and attitude relate to each other. The relation between attitude and perceived control can be examined by looking into the study of Ward and Barnes (2001). Ward and Barnes (2001) found that consumers who perceive a higher amount of control, have an increased positive attitude towards the environment. Attitude towards an environment and attitude towards the intended use of CT might not be directly transferable, but it seems interesting to see if the same relationship exists.

Sheppard and Brown (2009) performed a case study and viewed the effect of organizational vision on teaching and learning of teachers within schools. They note that shared vision also comes with a shared culture in an organisation. In different cultures, different norms are taken into account. How another person approves or disapproves behaviour, and a person's own motivation to comply, might be influenced by this culture. With the same idea in mind, it might also be the case that policies and a shared vision on organizational level influence a person's attitude and the experienced subjective norm. When looking at the relation between "policy & vision" and "perceived control", the study of Zimmerman and Zahniser (1991) offers some insight. Zimmerman and Zahniser (1991) found that organisational policies influence a person's feeling of empowerment. Empowerment is

based on competence, perceived control, and the desire to have control. Thus "policy & vision" and "perceived control" might be related.

In summary, there might be a relationship between the independent variables in the TPB (Armitage & Conner, 2001; Lai, 2017; Teo & Lee, 2010). Concerning these relationships found in the TPB and in results of studies related to the "policy & vision" variable, the relationships between the independent variables will be checked.

Present study

In this study, the following research question will be answered:
"What factors influence teachers' intention to use CT in teaching programs and how do these factors relate to each other?" Concerning the factors mentioned in the research question, the following hypotheses were formed:

Hypothesis 1: There is a positive relation between attitude and intention to teach CT.

Hypothesis 2: There is a positive relation between subjective norm and intention to teach CT.

Hypothesis 3: There is a positive relation between perceived control and intention to teach CT.

Hypothesis 4: The awareness of shared policy & vision relates to increased intention to teach CT.

As mentioned before, there might be correlations between the independent variables, that will be checked in this study. For the variables "attitude", "subjective norm" and "perceived control" the relationship was found in past studies (Armitage & Conner, 2001; Lai, 2017; Teo & Lee, 2010) but the exact meaning of this relationship remains unclear. Based on the findings of Terry and Hogg (1996) hypothesis 5 was formed and based on the findings of Ward and Barnes (2001) hypothesis 6 was formed.

Hypothesis 5: Subjective norm correlates positively with a person's attitude.

Hypothesis 6: Perceived control correlates positively with a person's attitude.

To see how a school level view on CT usage influences the variables within the TPB, three hypotheses were formed. Hypotheses 7 and 8 were based on the findings by Sheppard and Brown (2009), hypothesis 9 was based on the findings by Zimmerman and Zahniser (1991).

Hypothesis 7: policy & vision of a school correlates positively with subjective norm.

Hypothesis 8: policy & vision of a school correlates positively with a person's attitude.

Hypothesis 9: policy & vision of a school correlates positively with perceived control.

Beside the acknowledgement of a relation existing between subjective norm and perceived control in past studies (Armitage & Conner, 2001; Lai, 2017; Teo & Lee, 2010), no clear meaning of this relationship was found within literature. But to be able to examine the relationship and interpreted results, hypothesis 10 was formed.

Hypothesis 10: Subjective norm and perceived control correlate with each other.

Based on these hypotheses the model in figure 1 was constructed.

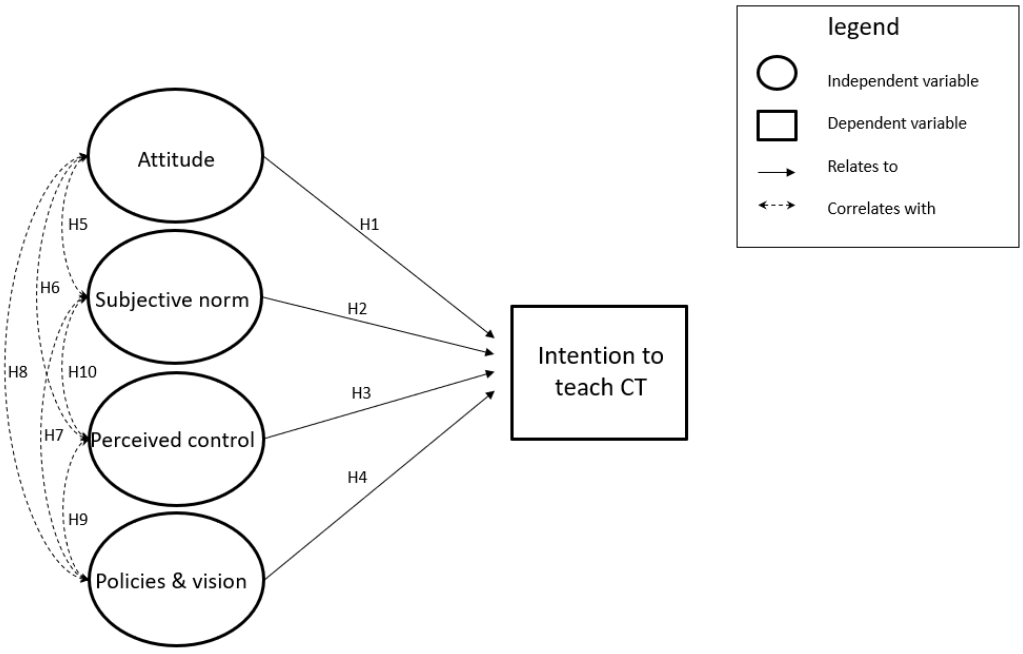

Figure 1: hypothetical model intention to teach CT. *Note.* The meaning of the squares and circles in this figure differs from AMOS. All variables in this figure are latent variables.

Method

Design

This study has a quantitative design, as it examines the relationship between different factors measured with questions that were rated on a scale. Due to this design choice, only one moment of measurement was needed, as it was a measurement among factors, not over time or the influence of an intervention. The dependent variable in this study is intention to teach CT. The independent variables are: attitude, subjective norm; perceived control; policy & vision. The number of teachers needed to create enough power was calculated by using the program *G*Power* version 3.1.9.2 (Erdfelder, Faul, & Buchner, 2014). The essence of the used analysis is mostly comparable with multiple regression, and an a priori test using f^2, α, power and predictors was used. As no effect size was known, both medium ($f^2 = 0.15$) and large ($f^2 = 0.35$) effect sizes were tested, using an α of 0.05, a power of 0.8, and with 4 predictors. From the analysis, it was concluded that between 40 (large) and 85 (medium) people needed to participate to create enough power.

Participants

The participants in this study were teachers in primary education from which their board of the school was interested in working on the development of CT in their education. As not every school in the Netherlands is working on CT. Schools were found through the ‘academic workplace computational thinking’ of Iselinge Hogeschool. In this academic workplace, a few schools with interest in CT have assigned one or more teachers to participate in developing materials and to transfer knowledge towards their school. Teachers who participated in this study received an informed consent form (see Appendix A) which

explained the purpose of the study. In total, 80 people filled in the questionnaire. Out of the 80 participants who agreed to participate in this study, the data of 73 teachers in primary education were used for analyses. Of the 73 teachers 14 were male (19.18%), and 59 were female (80,82%). The youngest participant was 21 years old, the oldest 64 years old (M = 39.53, SD = 13.03). The difference in service years at the school the teachers were working at during the period of the study varied between 0 and 44 years (M = 10.20, SD = 11.02).

Instrumentation

A questionnaire (see Appendix B) was used to allow the measurement of the independent variables by a 7-point scale. The 7-point scale was used as it was the scale size used in the study of Knabe (2012) from which the questions for the TPB variables were derived. This scale was not altered as Dawes (2008) notes that the usage of either a 5-, 7- or 10-point scale does not affect a significant difference in results. The distribution of independent variables in the questionnaire was as follows: attitude (5 questions); subjective norm (4 questions); perceived control (4 questions); policy & vision (4 questions). The dependent variable on the questionnaire was "intention to use CT in teaching programs" (3 questions) and was also measured using a 7-point scale. The variables, gender, age and years of employment at the school were added as demographic variables, and all measured using 1 question per variable. For the measurement of attitude, subjective norm, perceived control, and intention, the questions made by Knabe (2012) were taken as an example, adjusted to the subject of CT and translated to Dutch. For the measurement of policy & vision a new scale was created. The questionnaire contains a total of 25 questions. Examples of questions for the dependent and independent variables are provided in table 1. In table 2 the division of questions among the different constructs can be found. It should be noted that the constructs "use of CT in the past" and "feeling of competence" were used in the questionnaire because

the academic workshop CT and an overarching school organisation were interested in these variables.

Table 1

Example questions per dependent and independent variable

Construct	Example questions
Attitude	Ik denk dat computational thinking zinvol is voor mijn onderwijs.
Subjective norm	Collega's die gebruik maken van computational thinking motiveren mij om zelf ook met computational thinking aan de slag te gaan.
Perceived control	Hoe vrij voel jij je om op je eigen manier met computational thinking bezig te zijn?
Policy & vision	Mijn school heeft een duidelijk doel wanneer het aankomt op het gebruiken van computational thinking.
Intention to use CT	Ik heb de intentie om komend schooljaar computational thinking te gebruiken in mijn lessen.

Note. The questions are in Dutch as the questionnaire was used in the Netherlands.

Table 2

Division of questions among constructs

Dependent and independent variables	
Intention	2, 3, 4
Attitude	5, 6, 7, 8, 9
Subjective norm	10, 11, 12, 13
Perceived control	14, 15, 16, 17
Policy & vision	18, 19, 20, 21

Demographic variables	
Gender	23
Age	24
Years active at current school	25
Additional variables	
Use of CT in the past	1
Feeling of competence	22

To verify if the questionnaire would measure variables that influence CT and whether they were suited for teachers in primary education, an expert check was performed. In cooperation with an expert on CT from the academic workshop CT, the original questionnaire by Knabe (2012) and the first version of the questionnaire in this study were examined to see how they could be adjusted to measure variables that influence CT. For “intention” it was advised to change the first question, as “I would like to” (ik zou graag) was experienced as vague by the expert. Instead, it was changed to “I have the intention to” (ik heb de intentie om). For “attitude” Knabe (2012) uses one question with multiple answer scales (good-bad, pleasant-unpleasant etc.). At first the way of questioning did not seem right to use for questioning CT, so questions were altered. After the expert took a look at the questions, she pointed out that the original questions by Knabe (2012) could be used, but separated into multiple questions, so it would be clearer to the teachers what they were asked. The expert also advised to alter the questions a bit, so the perspective of the teachers in using CT would be clearer. So, the questions started with a personal view like: “I think”; “I view”; “I am”. For questions concerning “subjective norm” and “perceived control”, the expert pointed out she thought the questions were fine. However, she pointed out that the questions should not be asked as if teachers were already applying CT in their teaching programs, as this might not be

the case for every teacher. So, statement like “other teachers approve when I use…”, turned into “other teachers approve when I want to use…”. Finally, as “policy & vision” was a newly created scale, the expert suggested to add a question about the school facilitating teaching in CT. So this question was added.

In order to check whether the questionnaire has been translated correctly from English to Dutch, a researcher with a PhD in English language and culture, who also teaches the English language was asked to check the original scale by Knabe (2012) and compare it with the questions in this study. The most notable results were in the translation of the attitude scale. Where the word “wise” translates directly to the Dutch word “wijs”, it would be better translated into “verstandig”. Another example is the translation of the word desirable, which translates to “wenselijk”. However, in the context of the question it would be better to write it down as “ervaren als gewenst”. For the questions concerning intention, subjective norm, perceived control, she pointed out they were adequately translated.

Procedure

Teachers from different schools who are planning on integrating CT in their education were asked to participate by filling in the questionnaire. The aim of the study was made clear to the schools, so they could inform their teachers at least a week in advance. Before teachers participated, they were informed by the researcher via an information letter (see Appendix C). A total of nine schools were visited on different days. These visits were planned after the students were send home and teachers were done with the teaching part of their job. Teachers were gathered in the coffee room and collectively participated. Before handing out the survey, it was checked if the teachers at least heard of CT and asked if they had the slightest idea of what it is. Teachers signed an informed consent form before participating. The questionnaire and the informed consent were printed on paper. Participants signed the informed consent just before they participated and were free to step out at any moment. Teachers were asked for 10

minutes of their time. As teachers were sitting together in the coffee room, it was asked of them to fill in the questionnaire individually. Teachers were allowed to ask the researcher for clarification if a question was not clear to them, the researcher would then point out what the question deemed to ask of the teacher. After a teacher was done filling in the questionnaire, the papers would be handed back to the researcher and put in a bag so no one could see the data of other participants. Questionnaires were stored in a locked box until all data was gathered. After that the data was digitalised in SPSS and saved on YoDa. Questionnaires and informed consents were scanned and placed separately in different YoDa folders.

Data inspection

Missing data

Missing data was found within the surveys of 6 participants. Every kind of missing values was analysed thoroughly. Three participants did not answer on questions concerning colleagues using CT in their education. These missing data points did appear to have a reason as two participants wrote down “not applicable” (Dutch: n.v.t.) instead of rating the scale and one participant added the comment “substitute teacher”. To test all missingness in the data file, Little’s MCAR (missing completely at random) test was conducted. Little’s test showed a non-significant result (chi^2 = 50,825, df = 46, p = .289). This means that the data is missing completely at random, and no imputation method should be used (IBM, 2019). According to the guide of IBM (2019) listwise deletion of cases would be the correct way to handle the missingness. As a result, 6 participants were deleted from the data set.

Beside missingness, two participants decided to circle two answers on a question, one of them leaving an arrow in between the numbers. As these numbers were next to each other the mean of both numbers was taken. For example: if a participant chose to circle both 4 and 5 as an answer, then 4.5 was put into the SPSS datafile.

Data analysis plan

For the data-analysis *Structural Equation Modelling* (SEM) was used. An example was taken by the study of Bourgonjon, Grove, Smet, Looy, Soetaert, and Valcke (2013). The first step was a confirmative factor analysis to determine whether the data would fit the suggested model. Based on the exploratory factor analysis and a reliability analysis some changes were made to the model so the fit measures would increase. The second step is a path analysis, showing the regression coefficients between dependent and independent variable. The path analysis showed also the coefficients between independent variables. Based on these results hypotheses were either accepted or rejected.

Testing assumptions

Normal distribution was checked to see if the assumption of normality for SEM was violated and to check for outliers. One outlier was found and deleted from the dataset. To determine normality, the Shapiro-Wilk test must be insignificant ($p > .05$). Total scores were used and calculated by adding up all item scores of a variable. Intention ($p = .001$), attitude ($p < .001$), perceived control ($p = .031$) and policy & vision ($p = .002$) were all significant, which means the data on these variables is not distributed normally. Only the data of subjective norm was found to be normally distributed ($p = .249$). However, as SEM is a kind of regression analysis, normality of residuals is more important. By examining a P-P plot and scatterplot (Appendix D), the standardised residuals were hold against the standardised predicted values. As the points in the P-P plot clustered reasonably tight along the line of predicted values, normality of residuals can be assumed. When looking at the scatterplot, there were no patterns found in the distribution, which also assumes normality of residuals. To recognise troublesome patterns, the described patterns by Allen, Bennett and Heritage (2014) were used as frame of reference. As the residuals seemed to be normally distributed, no alternative form of SEM needed to be used.

Confirmative factor analysis

A Confirmative factor analysis (CFA) was conducted in IBM AMOS 24 to see if the data would fit the proposed model. Within the CFA it was checked whether the observed items would fit the prescribed latent independent variables as well as the prescribed latent dependent model. The model showed that the data did not have an ideal fit with the model (see "result measurement model" in table 3). To identify what measures "good fit" a statistics consultant at the Utrecht University pointed out that the fit measures of TLI (Tucker-Lewis index), CFI (comparative fit index) and RMSEA (root mean square error of approximation) should be used. The norm as advised by the consultant as well as the results of the CFA are shown in table 3. The norms for CFI and TLI were confirmed in literature by O'Rourke and Hatcher (2013). The norms for RMSEA, the *p*-value of Chi^2 and CMIN/df (CMIN = minimal function of Chi^2) were confirmed by Hu and Bentler (1999) and Hoe (2008). Normally, a significant *p*-value of Chi^2 would mean that the data does not fit the model (Schermelleh-Engel, Moosbrugger, & Müller, 2003). However, in advanced statistics it is known that using Chi^2 is not flawless (Schermelleh-Engel et al., 2003). Using other fit indexes that compare the data to a best or worst possible model could give multiple points of insight. Schermelleh-Engel et al. (2003) point out that every fit measure has advantages and disadvantages. Looking at multiple fit indexes might counter these flaws.

Table 3

Norm of fit measures and fit measures of the first measurement model

Fit index	*p of* Chi^2	CMIN/df	TLI	CFI	RMSEA
Norm	>.05	< 3	> 0.90 (acceptable) > 0.95 (good)	> 0.90 (acceptable) > 0.95 (good)	<0.08 (acceptable) <0.05 (good)

Results measurement model	$p < .001$	2,158	0.815	0.844	0.127

Reliability analysis

In order to measure the reliability of the data, Cronbach's alpha was calculated per construct. Cronbach's alpha for the three items that measure intention was .899. Closer examination of the questionnaire item-total statistics pointed out Cronbach's alpha could increase to .968 if "int1" was deleted. Even though the Cronbach's alpha would increase a lot, it was decided not to drop "int1". Intention is only measured by three questions and the first question does not seem to measure anything other than intention. For "attitude" the Cronbach's alpha of the original five items was .945. For the four items that form subjective norm a Cronbach's alpha was found of .799. However, when "subn1" would be dropped, Cronbach's alpha would increase to .850. After looking into the question, no reason was found to drop it. The question does not seem to differ extremely from the other questions concerning subjective norm, so "subn1" was not dropped. The four items forming perceived control showed a Cronbach's alpha of .667, which is a bit questionable, as ideally it should be above .700 (Allen et al., 2014). Dropping items will not increase Cronbach's alpha, so the measurement of the construct perceived control seemed to be a bit off. The 4 items measuring policy & vision showed a Cronbach's alpha of .804, removing "povi3" would increase Cronbach's alpha to .838. After close examination on the item "povi3", it was found that it could possibly measure trust in school instead of the policies and vision on school level. Because of this distinction and the negative effects on Cronbach's alphas it was chosen to drop "povi3" from the questionnaire.

Exploratory factor analysis

The first measurement model did not fit the set norms. Based on the reliability analysis "povi3" was deleted from the model, creating measurement model 2. For the fit measures of model 2, see table 4. In order to increase the fit, the CFA turned into an exploratory factor analysis (EFA). AMOS can show factor loadings and modification indices. A factor loading under .30 was seen as "low" (Iacobucci, 2009). No item seemed to have a factor loading under .30.

Looking at the modification indices (*MI*), a covariance between the measurement errors of "subn1" and "perc1" was suggested (*MI* = 26.731). Looking at the questions it was found that the content of the questions can be interpreted in a way which causes overlap. Where "subn1" is about "approval of CT usage by important people within the school" "perc1" was about "the feeling of being allowed to use CT". Because of the high *MI* and the possible overlap, covariance between the errors of the items was drawn resulting in measurement model 3 (table 4).

After measurement model 3 was adjusted, a few other options were examined. Looking at the MI's, a few covariances were still suggested by AMOS. Some covariances between error terms cannot be explained by looking into the items themselves and were not applied to the model. The covariance suggested between "povi1" and "povi4" (*MI* = 8.624) was accepted, as the questions concern "familiarity within the school on the possibilities of CT" and "facilitation of using CT" which could be linked in a way as familiarity with possibilities of CT might be linked to the facilitation. This modification created measurement model 4 (table 4). Options for alternative measurement models by looking at modification indices as suggested by AMOS were considered. But the remaining options by AMOS were illogical or simply not applicable.

Table 4

Improvement of fit through the measurement models

Measurement model	*p* of Chi^2	CMIN / df	TLI	CFI	RMSEA
1	< .001	2.158	0.815	0.844	0.127
2	< .001	1.970	0.854	0.878	0.116
3	< .001	1.725	0.891	0.910	0.100
4	< .001	1.621	0.906	0.923	0,093

Depending on the fit index the data either does or does not fit the model in the expected way. CFI (0.923) and TLI (0.906) point out the data fits, as both should be 0.900 or higher in order to show an acceptable fit. RMSEA compares the measurement model to the worst possible model and should be .080 or lower in order to show an acceptable fit. The significant *p*-value of Chi^2 is also a sign that the data does not fit the model. So according to the value of RMSEA (0.093) and the *p*-value of Chi^2 the data does not fit. As no other changes were made, measurement model 4 turned out to be the best fitting model and was used as the structure model (figure 2).

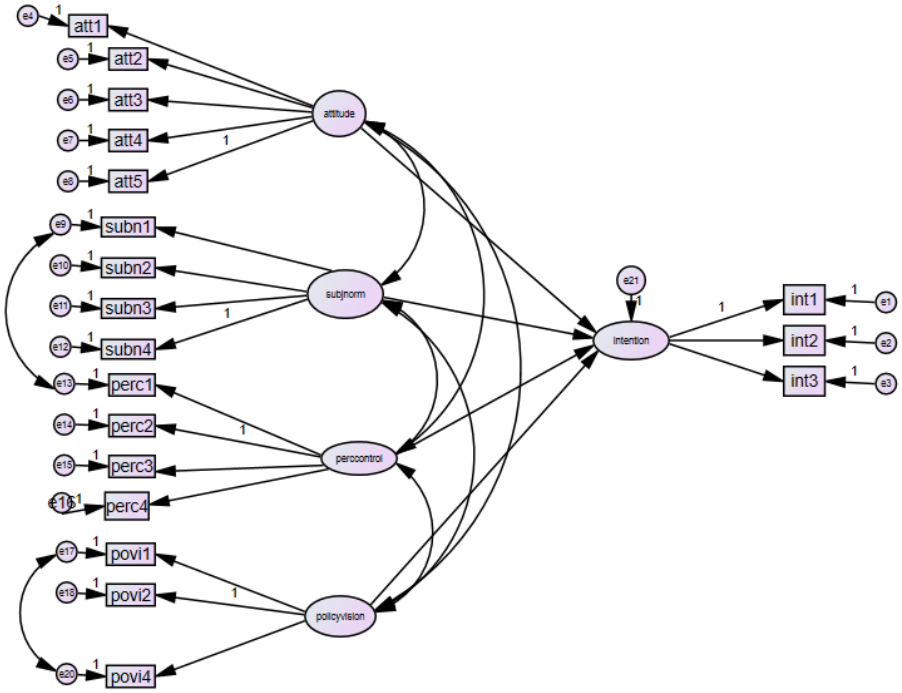

Figure 2. Measurement model 4 / structure model

The final model has a good fit according to the fit measures TLI and CFI. RMSEA is still a bit high, and the *p*-value of Chi^2 remains significant. The fit of the model is only partially accepted.

Results

Path analysis

A path analysis was conducted on the structure model. In this analysis, the hypotheses as mentioned before were tested in order to see which independent variable would influence the intention to use CT in education and how the independent variables would relate to each other. The model with standardised regression weights is shown in figure 3.

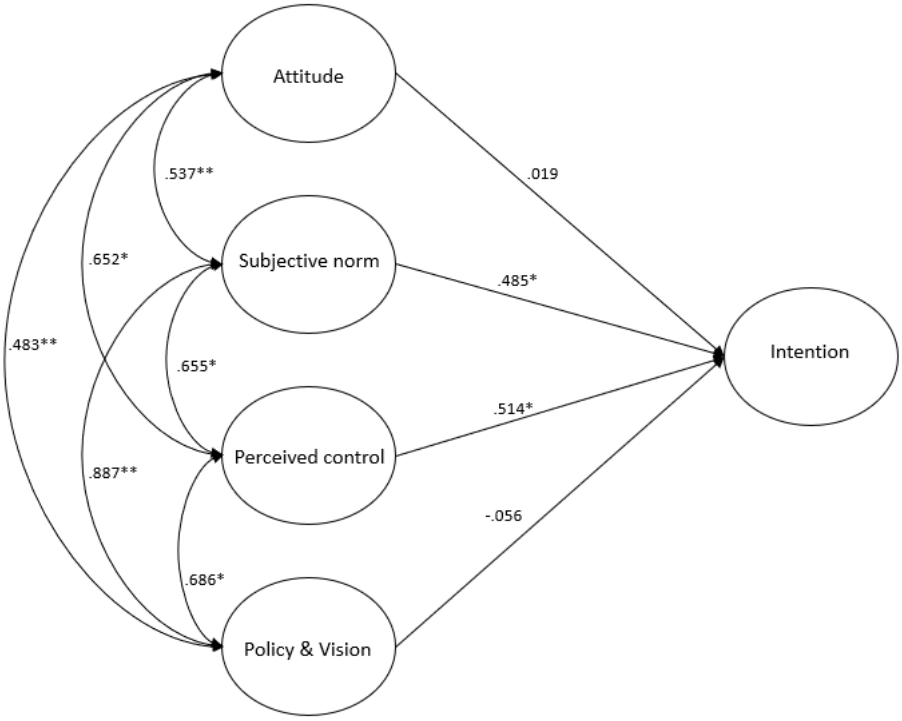

Figure 3: structure model with standardised regression weights. *$p < .05$, **$p < .001$.

From the ten hypotheses, eight were found to be accepted. Perceived control was found to have a significant effect on intention (H3, $\beta = .514$, $p = .038$), thus confirming hypothesis 3. Subjective norm was also found to have a significant effect on intention (H2, $\beta = .485$, $p =$

.038). There were no effects found that confirm hypotheses 1 and 4, as the results were not significant. So, in this study attitude (H1, β = .019, *p* = .876), and policy & vision (H4, β = -.056, *p* = .799) showed no effect on intention to use CT in education. However, correlations between independent variables were found to be significant. Perceived control seemed to correlate with attitude (H6, β = .652, *p* = .018), subjective norm (H10, β = .655, *p* = .022), and policy & vision (H9, β = .686, *p* = .017). Besides that, correlation between policy & vision, and subjective norm (H7, β = .887, *p* < .001), policy & vision, and attitude (H8, β = .483, *p* < .001), and attitude and subjective norm (H5, β = .537, *p* < .001) were found to be significant.

Conclusion and Discussion

The goal of this study was to find an answer to the research question: "What factors influence teachers' intention to use CT in teaching programs and how do these factors relate to each other?". Supposed factors were found by searching the literature and tested within this study. Six correlations between independent variables and two direct effects on intention were found to be significant, but there remains a lot to discuss.

Interpretation of results

In this study, the expected influence of subjective norm and perceived control on intention were found (hypotheses 2 and 3). However, according to the theory of planned behaviour attitude should also influence intention (Ajzen, 1991; Montano & Kasprzyk, 2015). In their studies, Ling, Saibin, Labadin, and Aziz (2017, 2019) found a significant effect of attitude towards CT on the intention to use CT in teaching programs, which differs from this study. However, the questions meant to measure attitude used in the study of Ling et al. (2017) are more based on willingness to implement CT in their current teaching, while attitude measured in this study is towards the concept of CT itself. This difference may cause a difference in results. In this study it appears that the direct influence of attitude does not mean teachers are more intended to use CT in their teaching. The correlation of attitude with

subjective norm and perceived control might suggest an indirect effect. Subjective norm is a combination of a person's motivation and the normative belief of others (Ajzen, 1991; Montano & Kasprzyk, 2015). A person's motivation and attitude may be linked, which would explain the correlation. When looking at the correlation between attitude and perceived control, it might be explained by looking into the Technology Acceptance Model (TAM). In the TAM attitude is affected by perceived usability and perceived ease of use (Davis, Bagozzi, & Warshaw, 1989). The perceived ease of use was found by Ling et al. (2019) to influence attitude towards CT. Perceived ease of use might affect the amount of control and power a person feels to implement CT. Thus, the found correlation could suggest an indirect effect of attitude via perceived control.

A "policy & vision" variable was added to this study as it was suggested by Barr and Stephenson (2011) that policies and a shared vision towards the implementation of CT would be necessary for the implementation of CT in education. No past studies were found that take a variable like "policy & vision" as a separate variable to determine intention. In this study, "policy & vision" as a variable measures the schoolwide orientation on CT, and facilitation of implementing CT. No direct effect on intention was found, but correlations with attitude, subjective norm and perceived control were significant. When looking into the variables, it could be that the way a school facilitates CT can influence the control and power a person feels to implement CT. Where subjective norm is about a person's motivation against the norm of other people who are deemed important to that person (Ajzen, 1991; Montano & Kasprzyk, 2015), a schoolwide view on CT might influence what norms are acceptable. Thus, policies and a shared vision on school level might affect the subjective norm and perceived control, causing an indirect effect.

Theoretical implications

Studies like the one of Kreijns, van Acker, Vermeulen and Buuren (2013) try to find out what stimulates teachers to integrate information technologies. However, for CT, which is not bound to technology, these kind of studies are limited. This study is contributing to the current knowledge on factors that predict behavioural intention on implementing CT. It examined the influence between the independent variables within the TPB, which offered new insights in the relationships of the independent variables. This means relationships among independent variables within the TPB should be checked more, as they could influence each other as well. This study also took the influence of policies and a shared vision on a school level, to see whether they would influence intention of teachers. As it turns out, in this study this direct effect was not found, but seemed to influence the other variables within the TPB that predict intention. Meaning that the possible organisational influence should also be checked when trying to predict intention. Only a few studies investigate the intention of teachers to integrate CT in their teaching programmes. Ling et al. (2017, 2019) tried to investigate the intention of teachers to integrate CT in their teaching programmes, but focus more on the technology side, by examining the intention with the TAM. This study investigates the intention to integrate CT in teaching programmes focussing more on the "problem solving" aspect, which it essentially is. This study gives food for thought when it comes to applying and altering models that predict intention when it comes to the implementation of CT in education.

Practical implications

If we understand which factors influence the intention of teachers to use CT in teaching programs, then schools can adjust to facilitate them. Now that we can carefully say that perceived control and subjective norm influence the intention to use CT in teaching, schools can think of ways to facilitate them. As perceived control is about the feeling of control and the feeling of power to change actions (Ajzen, 1991; Montano & Kasprzyk,

2015), schools could try to give teachers the time, space and resources to experiment with CT. This way teachers have the opportunity to work with CT and are capable of changing their CT practices if they want. At the same time subjective norm could mean that schools could invest in teachers that have an interest in CT, so they can share it among the team. As motivation to comply plays a major role in subjective norm (Ajzen, 1991; Montano & Kasprzyk, 2015). As seen in this study, subjective norm does correlate with attitude, perceived control and policy & vision. So maybe if teachers are made enthusiastic about CT (attitude), get enough space to experiment (perceived control) and are supported by their school (policy & vision), then the subjective norm might increase.

Limitations

This study has a few limitations. Conclusions drawn from the results in the structure model should be done with care. Due to a non-acceptable fit in the first measurement model, it was found that the data did not fit the proposed model. By altering the model based on suggestions by AMOS and a reliability analysis the data was found to fit better, reaching a partly acceptable fit. This means that the alterations should be hold in mind when interpreting the results and conclusion of this study.

Beside assumptions, SEM works best with large numbers of participants. In the ideal situation there would have been enough teachers and time to perform a pilot. This would have allowed for a final measurement model to be tested, using an altered version of the questionnaire and new data to confirm the proposed factors and fit. However, the amount of schools who are currently interested in using CT is limited. Teachers in this study had to have heard of CT as the questions were aimed at people knowing what CT is. Due to this, teachers who had not heard of CT or worked at a school that was not currently interested in CT had no chance of participating in this study. The lack of a pilot also made that the new made “policy

& vision" variable could not be tested beforehand. This meant that the construct validity was based on the expert check but could not be checked with statistics.

The teachers asked to participate in this study worked at schools of which the board had interest in implementing CT among their schools. But the progression of the implementation of CT seemed to differ per school. In the TAM "perceived ease of use" and "perceived usefulness" are factors that influence attitude (Davis, et al., 1989). Having heard of CT does not necessarily mean teachers are competent in using CT and know exactly how to use it and whether it is perceived as useful. The data might have been gathered too early for teachers. Attitude was probably based on the idea of CT, rather than past experience of experimenting with CT. as more experience with applying CT in their education might have helped forming attitude towards CT.

Suggestions for future research

Firstly, during the data gathering, it was noticed that the idea of CT differed between teachers. The differences were noticed when asking teachers if they wanted to participate and if they were familiar with CT. This often resulted in teachers trying to check their knowledge on CT with the researcher. These checks often laid a lot of focus on the information technology side. The researcher pointed them towards the description at the start of the questionnaire so teachers could check whether their idea of CT was correct. As teaching in CT does not necessarily require information technology, this might indicate a misconception. As CT is basically a problem-solving method in which using computer technology is optional, there might be a link between the intention to use CT in teaching and the acceptance or competence in the use of technology in education. The link between CT and the use of information technology is found in literature as well. CT is often referred to as "thinking like a computer" to solve problems (Günbatar, 2019). CT originated from computer science, but the approach to problem solving started being used in non-computer contexts (Mohaghegh &

McCauley, 2016). CT can be used in all kinds of contexts, but the name and its origin seem to suggest the misconception that computers are needed. This study did not investigate the technological side. Future research could investigate this matter, combining the TPB with models for technology acceptance like the TAM or the unified theory of acceptance and use of technology (UTAUT). The combination of different models like TPB, TAM or UTAUT has been used in the past, like in the study of Attuquayefio and Addo (2014). In their study they use the UTAUT as a base model and add parts of TPB and TAM in their model to measure intention to use information and communication technology. A similar design could be used to measure the intention of teachers to use CT in teaching programs.

Secondly, concerning the "policy & vision" variable, a different measurement level could be applied. In this study "policy & vision" was measured in the situation the schools were currently in, but future research could also look into the effects of a change in policies and a shared vision over time on the intention to use CT in teaching or look at it from a national perspective.

Lastly, the indirect effects mentioned in this paper are based on the fact that correlations were found, but no direct effects. The possible indirect effects could be tested in another study, to see if they indeed exist.

Conclusion

In summary, this study showed that subjective norm and perceived control might influence the intention to integrate CT in teaching programs. It also showed that attitude and policy & vision do not influence intention directly, but that they might have an indirect effect. It adds to the current knowledge on how to deal with implementing CT in education from a teacher perspective.

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Appendix A: informed consent

Beste docent,

Met wie heeft u te maken?
Ik ben Bas Bruggink, student in de master onderwijswetenschappen aan de Universiteit Utrecht. Momenteel ben ik bezig met het uitvoeren van mijn masterthesis. In dit proces word ik begeleid door dr. Pieter Wouters.

Wat is het doel van het onderzoek?
Ik doe onderzoek naar factoren die het aanzetten tot lesgeven in computational thinking beïnvloeden. Door dit onderzoek uit te voeren hoop ik bij te dragen aan meer inzicht in de onderliggende processen die docenten aanzetten tot het gebruiken van computational thinking in hun lesgeven.

Wat houdt het onderzoek in?
Voor dit onderzoek vraag ik u een vragenlijst in te vullen. Deze vragenlijst zal ongeveer … minuten van uw tijd in beslag nemen. Na het invullen van de vragenlijst zal ik deze graag weer van u ontvangen.
U heeft op ieder moment het recht om u terug te trekken uit dit onderzoek.

Privacy en vertrouwelijkheid
Alle gegevens worden vertrouwelijk behandeld en anoniem verwerkt. Uw antwoorden worden niet teruggekoppeld naar uw school. De gegevens worden alleen voor opleidings- en onderzoeksdoeleinden gebruikt.

Mogelijkheid tot vragen, informatie en toestemming
Als u nog vragen heeft over het onderzoek of als u op de hoogte gehouden wilt worden over dit onderzoek, stuur dan een mail aan: Bas Bruggink, b.bruggink@students.uu.nl. Voor verdere vragen over de masterthesis onderwijswetenschappen kunt u contact opnemen met: Pieter Wouters p.j.m.wouters@uu.nl.

Met vriendelijke groet,
Bas Bruggink BSc en dr. Pieter Wouters

Indien u besluit wel mee te doen aan het onderzoek, wordt ervan uit gegaan dat u goed heeft nagedacht over deelname aan het onderzoek. Daarnaast bent u zich ervan bewust dat u op ieder moment uw deelname mag beëindigen. U hoeft geen uitleg of reden te geven voor het stoppen met het onderzoek.

☐ Ik doe wel mee aan het onderzoek.

☐ Ik doe niet mee aan het onderzoek

Uw naam:	Datum:	Handtekening:
_____	_____	_____

Appendix B: questionnaire

Wat is computational thinking?

Computational thinking valt onder digitale geletterdheid. Het gaat bij computational thinking niet enkel om het gebruiken van ICT, computers of programmeren. Het gaat om het procesmatig (her)formuleren van problemen zodat je deze eventueel met behulp van technologie kunt oplossen. Computational thinking wordt vaak onderverdeeld in: het ontleden van problemen; vereenvoudiging van ingewikkelde zaken; het herkennen van patronen en het bedenken van algoritmes. Het betreft vaardigheden die essentieel zijn voor het oplossen van problemen in de huidige tijd en in de toekomst. Computers zijn in de basis dus niet nodig voor computational thinking. Toch worden ze vaak genoemd omdat deze manier van werken gepaard gaat met veel informatie en variabelen. Om deze grote hoeveelheid informatie en variabelen te verwerken, worden computers en ICT ingezet.

Omcirkel wat van toepassing is:

---

1. Heb je computational thinking al eens toegepast tijdens je lessen?

   Ja Nee

---

2. Ik heb de intentie om komend schooljaar computational thinking te gebruiken in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

3. Ik heb besloten om komend schooljaar computational thinking te gebruiken in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

4. Ik ben vastbesloten om komend schooljaar computational thinking te gebruiken in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

5. Ik denk dat computational thinking zinvol is voor mijn onderwijs.

Oneens 1 2 3 4 5 6 7 Eens

---

6. Ik beschouw het toepassen van computational thinking in mijn onderwijs als gewenst.

Oneens 1 2 3 4 5 6 7 Eens

---

7. Ik vind het verstandig om aandacht te besteden aan computational thinking in mijn onderwijs.

Oneens 1 2 3 4 5 6 7 Eens

---

8. Ik zou het prettig vinden om computational thinking toe te passen in mijn onderwijs.

Oneens 1 2 3 4 5 6 7 Eens

---

9. Het is belangrijk om les te geven in computational thinking.

Oneens 1 2 3 4 5 6 7 Eens

---

10. Mensen binnen de school die voor mij belangrijk zijn, keuren het goed wanneer ik computational thinking wil gebruiken in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

11. Mensen binnen de school die voor mij belangrijk zijn, verwachten van mij dat ik computational thinking ga gebruiken in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

12. Ik heb het idee dat collega's gebruik maken van computational thinking of dat graag willen doen.

Oneens 1 2 3 4 5 6 7 Eens

---

13. Collega's die gebruik maken van computational thinking motiveren mij om zelf ook met computational thinking aan de slag te gaan.

Oneens 1 2 3 4 5 6 7 Eens

---

14. Ik heb het idee dat ik computational thinking mag toepassen in mijn lessen.

Oneens 1 2 3 4 5 6 7 Eens

---

15. Hoe vrij voel jij je om op je eigen manier met computational thinking bezig te zijn?

Helemaal niet vrij 1 2 3 4 5 6 7 Helemaal wel vrij

---

16. Als ik volgende week computational thinking moet toepassen in een les, dan zie ik dit als:

Onmogelijk 1 2 3 4 5 6 7 Zeker mogelijk

---

17. Ik bepaal zelf of ik computational thinking toepas in mijn lessen of niet.

Oneens 1 2 3 4 5 6 7 Eens

---

18. Op mijn school is bekend wat je met computational thinking kunt bereiken.

Oneens 1 2 3 4 5 6 7 Eens

---

19. Mijn school heeft een duidelijk doel wanneer het aankomt op het gebruiken van computational thinking.

Oneens 1 2 3 4 5 6 7 Eens

---

20. Ik heb er vertrouwen in dat op mijn school computational thinking te integreren is in het onderwijs.

Oneens 1 2 3 4 5 6 7 Eens

---

21. Mijn school faciliteert het lesgeven in computational thinking.

Oneens 1 2 3 4 5 6 7 Eens

---

22. Hoe competent voel jij je in het omzetten van computational thinking naar lessen of activiteiten in je eigen onderwijs?

Totaal niet competent 1 2 3 4 5 6 7 Geheel competent

---

23. Met welk geslacht identificeer jij je het meest?
- Man
- Vrouw
- Anders
- Ik wil hier liever geen antwoord op geven

---

24. Wat is je leeftijd?

_____

---

25. Hoeveel jaar ben je al werkzaam als leerkracht op jouw school?

_____

Je hebt het einde van de vragenlijst bereikt.
Bedankt voor het invullen.

Ik wil je vragen om deze vragenlijst samen met het *informed consent* weer in te leveren bij de onderzoeker.

Appendix C: information letter

Beste docent,

Met wie heeft u te maken?
Ik ben Bas Bruggink, ik studeer onderwijswetenschappen aan de Universiteit Utrecht.
Momenteel ben ik bezig met het uitvoeren van mijn masterthesis. In dit proces word ik begeleid door dr. Pieter Wouters.

Wat is het doel van het onderzoek?
Ik doe onderzoek naar factoren die het aanzetten tot lesgeven in computational thinking beïnvloeden. Door dit onderzoek uit te voeren hoop ik bij te dragen aan meer inzicht in de onderliggende processen die docenten aanzetten tot het gebruiken van computational thinking in hun lesgeven.

Wat is computational thinking?
Computational thinking valt onder digitale geletterdheid. Het gaat bij computational thinking in essentie niet om het gebruiken van ICT, computers of programmeren. Het gaat om het procesmatig (her)formuleren van problemen zodat je deze eventueel met behulp van technologie kunt oplossen. Het betreft vaardigheden die essentieel zijn voor het oplossen van problemen in de huidige tijd en in de toekomst. Computers zijn in de basis dus niet nodig voor computational thinking. Toch worden ze vaak genoemd omdat deze manier van werken gepaard gaat met veel informatie en variabelen. Om deze hoeveelheid informatie en variabelen te verwerken worden computers en ICT ingezet. Computational thinking is belangrijk, aangezien we als gevolg van de groeiende digitalisering nieuwe problemen tegenkomen die we op een logische wijze moeten benaderen en verwerken.

Wat houdt deelname aan het onderzoek in?
Voor dit onderzoek vraag ik u een vragenlijst in te vullen. Deze vragenlijst zal ongeveer 5 tot 10 minuten van uw tijd in beslag nemen. Na het invullen van de vragenlijst zal ik deze graag weer van u ontvangen. U heeft op ieder moment het recht om u terug te trekken uit dit onderzoek.

Privacy en vertrouwelijkheid
Alle gegevens worden vertrouwelijk behandeld en anoniem verwerkt. Uw specifieke antwoorden worden niet teruggekoppeld naar uw school. De gegevens worden alleen voor opleidings- en onderzoeksdoeleinden gebruikt.

Wat kan dit onderzoek voor jou betekenen?
Het resultaat van dit onderzoek (niet de data) wordt teruggekoppeld naar de scholen waar leerkrachten hebben meegedaan aan dit onderzoek. Op deze manier kunnen u en uw school inzicht krijgen in het gebruik en bevorderen van computational thinking.

Mogelijkheid tot vragen, informatie en toestemming
Als u nog vragen heeft over het onderzoek of als u op de hoogte gehouden wilt worden over dit onderzoek, stuur dan een mail aan: Bas Bruggink, b.bruggink@students.uu.nl. Voor verdere vragen over de masterthesis onderwijswetenschappen kunt u contact opnemen met: Pieter Wouters p.j.m.wouters@uu.nl.

Met vriendelijke groet,
Bas Bruggink BSc en dr. Pieter Wouters

Appendix D: P-P plot and Scatterplot – normality of residuals

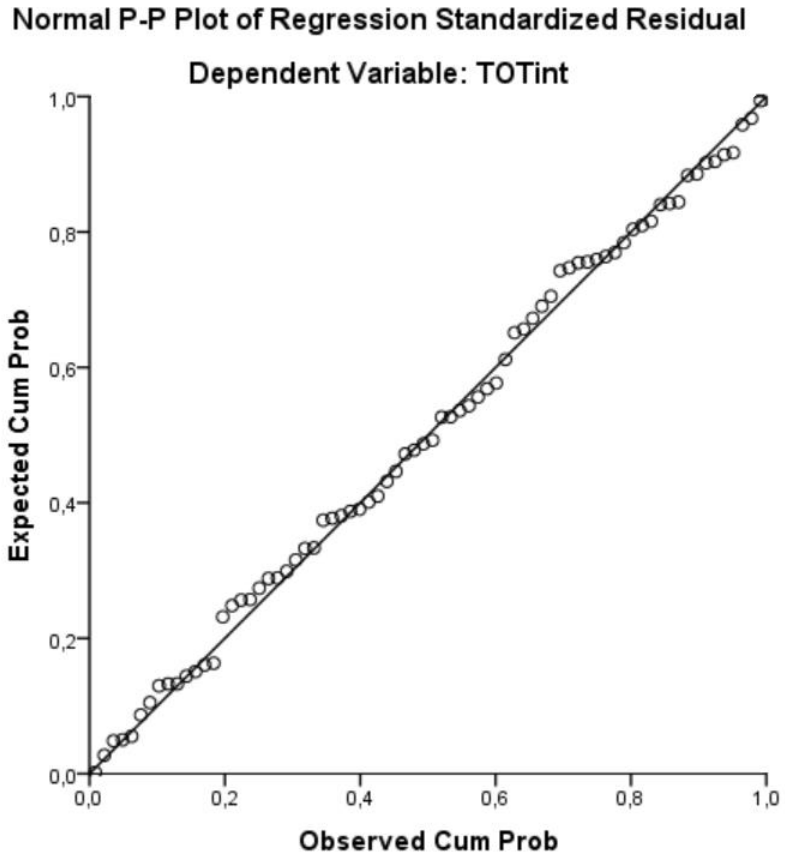

Figure 4. P-P plot of regression standardized residuals

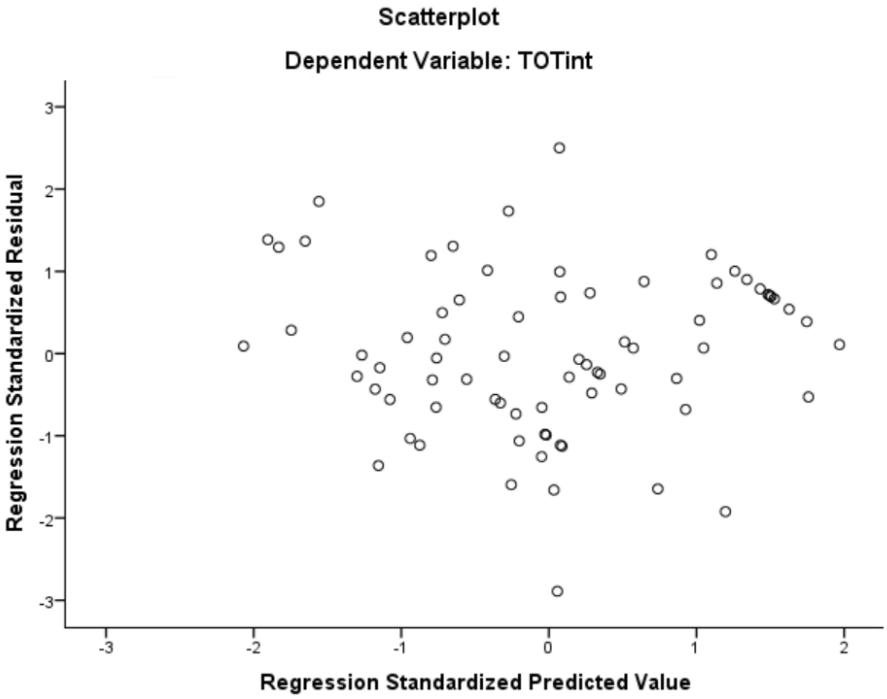

Figure 5. Scatterplot standardised residuals against standardised predicted values of intention

Appendix E: Risk analysis

Possible risks within this design can be found within the pilot study. The pilot will need participants who are not going to participate in the main data gathering. As the number of teachers available might be scarce, it might become harder to get enough participants in the main data collection. A second risk is that schools are not willing to participate. This will cause for some extra recruitment when the minimum number of participants is not met.

In the case, the recruitment of teachers willing to participate is causing too much trouble, there is an option of switching to teachers in training, but this will have consequences throughout the entire paper. Possibly the pilot can be executed with third- and fourth-year pre-service teachers who are currently working on a minor in computational thinking.

A third risk is illness. The chance exist that the researcher becomes ill. By planning broad, in terms of months, small periods of illness should not form a problem. Finally, loss of data is a possible risk. In case this happens, the supervisor will be consulted to see what the best course of action is. The researcher has to prove it was not done on purpose and form a new plan on gathering the data.

Appendix F: FETC form

APPLICATION FORM FOR THE ASSESSMENT OF A RESEARCH PROTOCOL BY THE FACULTY ETHICS REVIEW BOARD (FERB) OF THE FACULTY OF SOCIAL AND BEHAVIOURAL SCIENCES

General guidelines for the use of this form

1. This form can be used for a single research project or a series of related studies (hereinafter referred to as: "research programme"). Researchers are encouraged to apply for the assessment of a research programme if their proposal covers multiple studies with related content, identical procedures (methods and instruments) and contains informed consent forms and participant information, with a similar population. For studies by students, the FERB recommends submitting, in advance, a research programme under which protocol multiple student projects can be conducted so that their execution will not be delayed by the review procedure. The application of such a research programme must include a proper description by the researcher(s) of the programme as a whole in terms of the maximum burden on the participants (e.g. maximum duration, strain/efforts, types of stimuli, strength and frequency, etc.). If it is impossible to describe all the studies within the research programme, it should, in any case, include a description of the most invasive study known so far.
2. Solely the first responsible senior researcher(s) (from post-doctoral level onwards) may submit a protocol.
3. Any approval by the FERB is valid for 5 years or until the information to be provided in the application form below is modified to such an extent that the study becomes

more invasive. For a research programme, the term of validity is 2 years and any extension is subject to approval. The researcher(s) and staff below commit themselves to treating the participants in accordance with the principles of the Declaration of Helsinki and the Dutch Code of Conduct for Scientific Practices as determined by the VSNU Association of Universities in the Netherlands (which can both be downloaded from the FERB site on the Intranet[1]) and guarantee that the participants (whether decisionally competent or incompetent and/or in a dependent relationship vis-a-vis the researcher or not) may at all times terminate their participation without any further consequences.

4. The researcher(s) commit themselves to maximising the quality of the study, the statistical analysis and the reports, and to respect the specific regulations and legislation pertaining to the specific methods.
5. The procedure will run more smoothly if the FERB receives all the relevant documents, such as questionnaires and other measurement instruments as well as literature and other sources on studies using similar methods which were found to be ethically acceptable and that testify to the fact that this procedure has no harmful consequences. Examples of studies where the latter will always be an issue are studies into bullying behaviour, sexuality, and parent-child relationships. The FERB asks the researcher(s) to be as specific as possible when they answer the relevant questions while limiting their answers to 500 words maximum per question. It is helpful to the FERB if the answers are brief and to the point.
6. **Our FAQ document that can be accessed through the Intranet provides background information with regards to any questions.**

[1] See: https://intranet.uu.nl/facultaire-ethische-toetsingscommissie-fetc

7. The researcher(s) declare to have described the study truthfully and with a particular focus on its ethical aspects.

Signed for approval[2]:

Date:

A. **GENERAL INFORMATION/PERSONAL DETAILS**

1a. Name(s), position(s) and department(s) of the responsible researcher(s):

Bas Bruggink, Master student educational sciences, social sciences

Under supervision of: Dr. Pieter Wouters, Lecturer, educational sciences

1b. Name(s), position(s) and department(s) of the executive researcher(s):

Bas Bruggink, Master student educational sciences, social sciences

2. Title of the study or research programme - Does it concern a single study or a research programme? Does it concern a study for the final thesis in a bachelor's or master's degree course?:

Single study - Master Thesis: Behavioural Intentions for Teaching Computational Thinking

3. Type of study (with a brief rationale):

A quantitative testing study, using a questionnaire. The effect of four independent variables on the dependent variable “intention to use computational thinking” will be measured. Beside this, the relationships between the four independent variables will be measured.

[2] The senior researcher (holding at least a doctoral degree) should sign here.

4. Grant provider:

-

5. Intended start and end date for the study:

04/02/2019 – 31/08/2019

6. Research area/discipline:

Educational Sciences

7. For some (larger) projects it is advisable to appoint an independent contact or expert whom participants can contact in case of questions and/or complaints. Has an independent expert been appointed for this study?[3]

No, only the help of the Method and Statistics department will be consulted, in order to check my analyses.

8. Does the study concern a multi-centre project, e.g. in collaboration with other universities, a GGZ mental health care institution, a university medical centre? Where exactly will the study be conducted? By which institute(s) are the executive researcher(s) employed?:

No.

[3] This contact may, in principle, also be a researcher (within the same department, or not) who is able to respond to the question or complaint in detail. Independent is to say: not involved in the study themselves. The FERB upholds that an independent contact is not obligatory, but will be necessary when the study is more invasive.

9. Is the study related to a prior research project that has been assessed by a recognised Medical Ethics Review Board (MERB) or FERB?

No.

B. SUMMARY OF THE BACKGROUND AND METHODS

1. What is the study's theoretical and practical relevance? (500 words max.):

In this study the focus will be on computational thinking because the importance of computational thinking as a skill and universal competence which every person should possess has established over the past years. In practice, teachers are expected to be competent in Computational Thinking (CT). It is important that we understand what factors influence the teaching of CT, so we can adapt practice. Current scientific research focusses on the implementation of 21st century skills and Computational thinking, lacking the focus on factors that influence the use and implementation of them.

2. What is the study's objective/central question?:

This study seeks to answer the following questions

"What factors influence teachers' intention to use CT in teaching programs and how do these factors relate to each other?"

3. What are the hypothesis/hypotheses and expectation(s)?:

Hypothesis 1: There is a positive relation between attitude and intention to teach CT.

Hypothesis 2: There is a positive relation between subjective norm and intention to teach CT.

Hypothesis 3: There is a positive relation between perceived control and intention to teach CT.

Hypothesis 4: The awareness of shared policy & vision relates to increased intention to teach CT.

Hypothesis 5: Subjective norm correlates positively with a person's attitude.

Hypothesis 6: Perceived control correlates positively with a person's attitude.

Hypothesis 7: policy & vision of a school correlates positively with subjective norm.

Hypothesis 8: policy & vision of a school correlates positively with a person's attitude.

Hypothesis 9: policy & vision of a school correlates positively with perceived control.

Hypothesis 10: Subjective norm and perceived control correlate with each other.

4. What is the study's design and procedure? (500 words max.):

This study has a quantitative design, as it examines the relationship between different factors. Due to this design choice, only one moment of measurement will be needed, as it measures among factors, not over time or the influence of an intervention.

The participants for this study will be teachers in primary education who are working on the development of computational thinking in their education. As not every school in the Netherlands is working on computational thinking, schools will be found through the 'academic workplace computational thinking' of Iselinge Hogeschool. In this academic workplace, a few schools with interest in Computational Thinking have assigned one or more teachers to transfer the knowledge towards the school. At this moment it is unknown what the exact number of available teachers is.

A questionnaire will be made that allows the measurement of the independent variables: (1) attitude; (2) subjective norm; (3) perceived control; (4) policy & vision. Beside the factors, the questionnaire will also contain questions measuring demographic questions

concerning the dependent variable “perceived competence in CT”. The questionnaire will be validated in a pilot.

The questionnaire will be validated using a pilot study. After the pilot study, teachers from different schools who are working on computational thinking will be asked to participate by filling in the questionnaire. The aim of the study will be made clear to the schools who are considering to participate. Before they participate, teachers will sign an informed consent form. The validation of the questionnaire will be done with factor analysis and reliability analysis and by letting an expert check the questionnaire.

For the data-analysis correlation analysis and *Structural Equation Modelling* will be used. By using this method, significant correlations will be shown among factors, indicating which factors are related to each other, also showing path coefficients

5a. Which measurement instruments, stimuli and/or manipulations will be used?[4]:

A questionnaire.

5b. What does the study’s burden on the participants comprise in terms of time, frequency and strain/efforts?:

The participants will have to fill in a questionnaire, which takes a maximum of 15 minutes to complete. This will be asked of them once.

[4] Examples: invasive questionnaires; interviews; physical/psychological examination, inducing stress, pressure to overstep important standards and values; inducing false memories; exposure to aversive materials like a unpleasant film, video clip, photos or electrical stimulus; long-term of very frequent questioning; ambulatory measurements, participation in an intervention, evoking unpleasant psychological or physical symptoms in an experiment, denial, diet, blood sampling, fMRI, TMS, ECG, administering stimuli, showing pictures, etc. In case of the use of a device (apparatus) or administration of a substance, please enclose the CE marking brochure for the relevant apparatus or substance, if possible.

5c. Will the participants be subjected to interventions or a certain manner of conduct that cannot be considered as part of a normal lifestyle?:

No.

5d. Will unobtrusive methods be used (e.g. data collection of uninformed subjects by means of observations or video recordings)?:

No.

5e. Will the study involve any deception? If so, will there be an adequate debriefing and will the deception hold any potential risks?:

No.

6. Will the participants be tested beforehand as to their health condition or according to certain disorders? Are there any inclusion and/or exclusion criteria or specific conditions to be met in order for a participant to take part in this study?:

A participant has to be a teacher in primary education of which the school they work at is currently working on computational thinking.

7a. Which risks does the study hold for its participants?

Participants offer information on their teaching, the data has to be handled with care, so their information remain anonymous.

7b. To what extent are the risks and objections limited? Are the risks run by the participants similar to those in daily life?

Offering information on their teaching is something that has to be handled with care. Participants do provide information they might not share with others.

8. How does the burden on the participants compare to the study's potential scientific contribution (theory formation, practical usability)?:

Answering the questionnaire does not seem to be a big burden asked from the participants. With their participation they contribute to the understanding of behaviour linked to the implication of Computational thinking, which is also practically usable.

9. Will a method be used that may, by coincidence, lead to a finding of which the participant should be informed?[5] If so, what actions will be taken in the case of a coincidental finding?:

The questions asked will not lead to any shocking information concerning critical facts.

10. How will the researchers analyse the data? Which statistical analyses will be used?:

Correlation analysis and Structural Equation Modeling.

11. What is the number of participants? Provide a power analysis and/or motivation for the number of participants. The current convention is a power of 0.80. If the study deviates from this power, the FERB would like you to justify why this is necessary:

[5] For instance: dementia, dyslexia, giftedness, depression, extremely low heartbeat in an ECG, etc. If coincidental findings may be found, this should be included in the informed consent, including a description of the actions that will be taken in such an event.

Current attempt of calculating power showed between 40 and 85 persons. However, Methods and Statistics will be consulted in order to determine the right amount of people suited for the chosen analysis.

C. PARTICIPANTS, RECRUITMENT AND INFORMED CONSENT PROCEDURE

1. The nature of the research population (please tick):

General population without complaints/symptoms

2. Age category of the participants (please tick):

18 years or older

3. Does the study require a specific target group? If so, justify why the study cannot be conducted without the participation of this group (e.g. minors):

Yes, it is specified to teachers who are currently working or work in a school that is working on Computational Thinking in their education. This study can not be conducted with other teachers, as they might not even know what Computational Thinking is.

Recruitment of participants

4a. How will the participants be recruited?

Directors of Schools will be asked via an academic network if data may be collected at their school. The consent note will be given to the directors, so teachers are aware I am going to visit their school and ask them to participate. Participation of teachers is not made mandatory by the school, teachers get to choose if they want to participate or not. After the teachers have been informed by the directors, I will plan a moment in which I can visit the

school and ask the teachers in person to fill in the questionnaire. By doing so, I can collect the data immediately after teachers have finished filling in the questionnaire.

4b. How much time will the prospective participants have to decide as to whether they will indeed participate in the study?:

It is intended to make the teachers aware two weeks in advance of the data gathering.

5. Does the study involve informed consent or mutual consent? Clarify the design of the consent procedure (who gives permission, when and how). Does the study involve active consent or passive consent? If no informed consent will be sought, please clarify the reason:

Informed consents are used. Teachers are made aware two weeks before the data collection, but will sign the informed consent just before they start the questionnaire. This is a form of active consent. This will be done on paper. Teachers give consent by checking a box (stating that they do want to participate), and by writing down their name, the date and their autograph on the form.

6. Are the participants fully free to participate and terminate their participation whenever they want and without stating their grounds for doing so?:

Yes.

7. Will the participants be in a dependent relationship with the researcher?:

No.

8. Compensation

Will the participants be compensated for their efforts? If so, what is included in this recompense (financial reimbursement, travelling expenses, otherwise). What is the amount?

No.

D. PRIVACY AND INFORMATION

1a. Will the study adhere to the requirements for anonymity and privacy, as referred to in the Faculty Protocol for Data Storage[6]?:

- anonymous processing and confidential storage of data (i.e. storage of raw data separate from identifiable data): yes
- the participants' rights to inspect their own data: yes
- access to the data for all the researchers involved in the project: yes

1b. Has a Data Management Plan been designed?

Data will be handled with care and saved on Yoda (fsw server). Data will be digitalised by scanning the filled in paper questionnaires. Data which could lead to identification of persons will be saved separate from the anonymised data.

2a. Will the participant be offered the opportunity to receive the results (whether or not at the group level)?:

[6] This can be found on the Intranet: https://intranet.uu.nl/wetenschappelijke-integriteit-facultair-protocol-dataopslag

Results of the research will be shared, no results will be delivered on personal level.

2b. Will the results of the study be fed back to persons other than the participants (e.g. teachers, parents)?:

The results of the study will also be shared with the management of the schools that participate in the research. The results are not on individual level, they are based on the entire data base.

3a. Will the data be stored on the faculty's data server?

yes

3b. Will the data that can be traced back to the individual be stored separately on the other faculty server available for this specific purpose?

yes, separated maps will be used on Yoda so the filled in forms of consent and the filled in questionnaires cannot be linked to the dataset.

F. FORMS TO BE ENCLOSED (CHECKLIST)

- Text (advert) for the recruitment of participants
- Information letter for participant
- Informed consent form for participants
- Written or oral feedback information (debriefing text)
- (Descriptions of) questionnaires
- (Descriptions of) measurement instruments/stimuli/manipulations
- Literature/references

Signature(s):[7] Date and place:

Name, position:

[7] The senior researcher (holding at least a doctoral degree) should sign here.