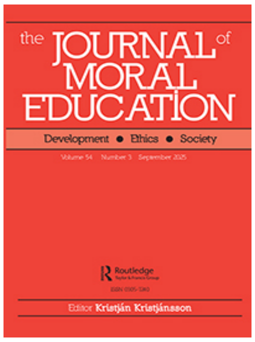

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Exploring teacher perspectives on integrating character education into K-3 computer science curriculum

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ABSTRACT

The rapid expansion of computer science (CS) education in early childhood education requires robust professional development (PD) to adequately train educators to teach CS. Traditional pedagogies often prioritize technical proficiency without respect to human values and character development. The present work employed a mixed methods design to examine whether a self-paced online PD course improved teachers' coding skills and expanded their beliefs on virtues in CS education. Findings showed teachers significantly improved in their coding proficiency and expanded their understanding of virtues and character strengths in the teaching of coding. Implications for further research are presented.

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coding; professional development; virtues; values; character education

Introduction

Over the past decade, there has been growing recognition of the unique challenges and demands posed by rapid technological developments. In response, K-12 schools have oriented their efforts toward equipping students with the foundational skills and competencies essential for flourishing in an increasingly digitally mediated world, primarily through the promotion of computational thinking (CT) (Bers et al., 2022; Lodi and Martini 2021; Wing, 2006) and the integration of computer science (CS) into K-12 curriculum frameworks (Manches & Plowman, 2017).

While early CS learning frameworks have largely concentrated on developing technical competencies (i.e., learning to code) and enhancing cognitive abilities related to CT, including algorithmic thinking, abstraction, and pattern recognition (Bers et al., 2022; Grover & Pea, 2013; Lodi & Martini, 2021; Wing, 2011), emerging initiatives are increasingly considering the integration of character education (Bers, 2001, 2021). These efforts aim to support the holistic development of learners by enriching their technical skills with the development of virtues and character strengths necessary not only to navigate the complexities of an ever-evolving digital landscape, but also to flourish as human beings (M. U. Bers 2022; Kropfreiter et al., 2024; McGrath, 2018; Pasricha, 2023; Stavrakakis et al., 2022).

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This initiative emerges within a push to make computer science education a humanistic endeavor (Bers, 2025) and within existing movements that recognize the importance and presence of values in the domain of engineering. Traditionally, engineers act in accordance with rules, but there are situations that require their personal discretion, which may be motivated by their personal beliefs and virtues (Harris, 2008). As such, some have proposed frameworks to standardize the implementation of virtue ethics paradigms into engineering education (Schmidt, 2014). For example, methods on the part of educators can include moral modeling (emulating good morals and ethics for students to imitate) and activity-based ethics education (explicitly enabling students to be involved in ethics-related decision-making activities) (Han, 2015).

While some formal approaches to character education have employed memetic models of teaching that prioritize the transmission of knowledge from educator to student as a means to inculcate virtue, this approach has shown to be inadequate for cultivating genuine character development in students (Fallona & Richardson, 2006; Solomon et al., 2001; Willems et al., 2012). Thus, a robust body of literature has emerged on the role of educators as moral exemplars, emphasizing teacher modeling and embodiment of virtue within the classroom as a cardinal practice for carrying out meaningful character education (Engelen et al., 2018; Henderson, 2022; Kristjánsson, 2015, 2020; Sanderse, 2013; Sanderse et al., 2015; Vaccarezza & Niccoli, 2019).

Given the pivotal role teachers play in implementing virtues and character education initiatives, it is crucial to examine their underlying beliefs about character education and how these beliefs guide their instructional approach. Specifically, exploring how teachers ascribe meaning to different character strengths, and whether certain virtues are emphasized in their teaching, offers a window into how these beliefs shape not only their pedagogical decisions but also the behaviors and choices students demonstrate in the classroom.

This work investigates the impact of an online professional development (PD) course on K-3 teachers' beliefs regarding the integration of virtues in early CS education. The PD focuses on the 'Coding as Another Language' (CAL) curriculum developed by Bers (2019), which employs a character-driven and virtue-ethics pedagogical framework for teaching CS in early childhood, emphasizing playful and holistic learning experiences (Bers et al., 2023). The present study explores the perceptions of 73 early childhood teachers regarding embedding virtues into CS education, following their participation in the asynchronous PD course. This paper uses three frameworks relevant for grounding the current study: the CAL pedagogy developed by Bers (2019, 2022), the Values-in-Action (VIA) Classification of Strengths proposed by Peterson and Seligman (2004), and a conceptual framework for PD developed by Sancar et al. (2021).

In the work presented in this paper, the words virtues and character strengths will be used interchangeably. Although these are closely related concepts, they represent distinct levels of psychological and moral functioning. Virtues are broad, foundational qualities—such as wisdom, courage, humanity, justice, temperance, and transcendence—that reflect universal moral standards valued across cultures and historical periods. They serve as overarching categories that guide ethical behavior and personal development. In contrast, character strengths are the specific, measurable traits or capacities that exemplify and operationalize these virtues in daily life. For example, the virtue of courage may be expressed through character strengths such as bravery, perseverance, and honesty. Thus, while virtues represent abstract ideals, character strengths are the tangible expressions through which individuals enact those ideals in their thoughts, emotions, and behaviors. In the study described in this paper, teachers were interviewed about their beliefs about virtues and were also asked to reflect on character strengths that develop through the activity of learning how to code. For example, open-mindedness and curiosity to consider different approaches for problem solving or debugging a not-working project, generosity and gratefulness in sharing time and resources to help each other find solutions and develop new strategies for fixing errors, and forgiveness when things do not work as expected and more effort is needed. All of these can be grouped under the virtue of courage. At the same time, purposefully thinking about fairness in how materials are distributed in a classroom and how time for working in projects is allocated, plays a big role when embarking in teaching computer science.

To date, the CAL pedagogy is the only framework that provides a pedagogical roadmap for teaching CS in early childhood while explicitly and intentionally incorporating a virtues-driven informed approach (Bers, 2019, 2022) using the *Coding as a Palette of Virtues* (PoV) metaphor, which places equal emphasis on fostering character strengths and building technical skills in early childhood. This dual focus aims to equip young children with the competencies necessary to solve problems in creative and innovative ways while also providing them with a strong foundation for applying these skills responsibly and becoming aware of the consequences of their actions. The PoV metaphor highlights ten virtues that are found to be most salient in the context of teaching CS in creative ways in the context of playful project-based learning environments: *curiosity*, *open-mindedness*, *perseverance*, *patience*, *optimism*, *honesty*, *fairness*, *generosity*, *gratitude*, *forgiveness* (M. U. Bers, 2022). However, new virtues can emerge from diverse experiences and specific learning contexts. While the PoV offers a pedagogical tool for cultivating character strengths alongside technical knowledge, its significance relies on the intentional promotion and modeling of these virtues by educators. Therefore, this approach encourages teachers to reflect on the types of virtues and character they already embody in their own practice and to consider how they might extend to their instruction of coding.

Coding or computer programming is the process of putting together a sequence of instructions that a computer can understand and execute. These instructions can be given using text-based programming languages, such as Python, Java, C++, or JavaScript, or block-based languages such as the free introductory programming language, ScratchJr, that was used in the study described in this paper. The goal of coding is to tell a computer or a smart device, such as a robot, what to do by giving it a set of precise instructions to perform.

Values-in-action classification of strengths

The present work uses the VIA Classification of Strengths as the theoretical framework for establishing the virtues described by the PoV metaphor. The VIA Classification of Strengths proposed by Peterson and Seligman (2004) focuses on 24 character strengths representing attributes that carry moral value and contribute to human flourishing. Character strengths are defined as the mechanisms or techniques that evoke the manifestation of a specific virtue in practice (Peterson & Seligman, 2004).

Table 1. Definitions of six morally valued virtues by Peterson and Seligman (2004).

Virtue	Definition
Wisdom	The cognitive strengths that entail the acquisition and use of knowledge.
Courage	The emotional strengths that involve the exercise of will to accomplish goals in the face of opposition —whether they are external or internal obstacles.
Humanity	The interpersonal strengths that involve tending to and befriending others.
Justice	The civic strengths that underlie healthy communal life.
Temperance	The strengths that protect against excess or overindulgence.
Transcendence	The strengths that forge connections to the larger universe and create meaning.

Each strength is categorized into one of the six core virtues identified by Dahlsgaard et al. (2005) as universal across the major moral traditions according to historical text, including Confucianism, Buddhism and early Greek philosophy. These six virtues include: *wisdom, courage, humanity, justice, temperance, transcendence*. Table 1 presents Peterson and Seligman's (2004) definitions of the six morally valued virtues.

The VIA Inventory of Strengths (VIA-IS; Peterson & Seligman, 2004) was developed as an instrument for measuring the 24 character strengths in adults ages 18 and up. The inventory includes 240 items, or 10 items per strength subscale. The VIA-IS has been widely used across a large number of studies and found to be psychometrically sound (Arbenz et al., 2023; Dubord et al., 2022; Peterson & Seligman, 2004; Ruch et al., 2010). Arbenz et al. (2023) examined the basic properties of the character strengths outlined by Peterson and Seligman (2004) and assessed how comprehensively these properties were represented in the VIA-IS. The study found that while some strengths, such as forgiveness and perseverance, were narrower and thus more precisely defined, others, such as love and bravery, were broader and consequently represented less comprehensively. Importantly, the VIA framework is imperfect, with critiques outlining that the list of character strengths may be incomplete, that it lacks character weaknesses, and that some character strengths overlap with or conflict with each other (C. B. Miller, 2019). Additionally, self-reporting using the VIA-IS may be inaccurate, and the VIA-IS also fails to measure a person's motivation behind their actions (C. B. Miller, 2019). Furthermore, some critique the measurement of virtues in general, arguing that it is not the place of empirical scientists to make moral or ethical judgements (Kristjánsson, 2015). While these critiques are important and relevant, the VIA framework still stands as prominent. Additionally, Kristjánsson's (2015) call to use the objective term 'virtue' and not the subjective term 'value' would argue for the use of the VIA framework. Thus, this paper utilizes it to frame the study presented here, which expands on this work by utilizing the PoV metaphor.

Although the VIA Classification distinguishes between virtues and character strengths, M. U. Bers (2022) uses both terms interchangeably, also sometimes referring to them with the term values. However, while the term values is normative, the term virtues is skill-oriented, and therefore better captures the essence of the work presented here. Moreover, the present work aims to provide a detailed contextualization of how these character strengths may manifest within a specific population. That is, early childhood educators who seek to integrate character education into their coding instruction. Table 2 classifies each virtue from the PoV under its respective core VIA virtue.

Table 2. VIA and PoV virtues classification.

VIA Virtue	PoV Virtue
Transcendence	Optimism
	Gratitude
Wisdom	Curiosity
	Open-mindedness
Courage	Perseverance
	Honesty
Humanity	Generosity
Justice	Fairness
Temperance	Patience
	Forgiveness

Teacher professional development

While teachers have generally advocated for the integration of character education into existing curricula rather than its teaching in isolation from other subjects (Arthur et al., 2018), many have raised concerns about their ability to successfully implement these initiatives. This includes challenges such as time constraints and lack of adequate PD opportunities, which circumscribe their preparedness for teaching character education (Mathison, 1999; Sanderse et al., 2015; Kropfreiter et al., 2024). Given the increased demand of teaching CS, and the growth of PD opportunities in this field, this paper explores how CS PDs can also focus on character education. This includes exploring how the language of virtue can be infused into and made relevant for existing subjects.

Moreover, although traditional methods of PD delivery typically afford for in-person collaboration and real-time feedback (Patterson et al., 2020; Rodgers et al., 2019), conventional models often pose significant challenges for educators, including scheduling conflicts, limited accessibility, and scalability issues (Barrett & Pas, 2020; Hill, 2015; Mihaly et al., 2022; Patterson et al., 2020; Rodgers et al., 2019,). Therefore, to address these issues, it is essential to design PD delivery methods that are both accessible and flexible for a diverse range of educators, while ensuring that the content effectively prepares teachers to implement these initiatives in their classrooms (K. Miller et al., 2019). Among the most flexible and accessible PD options is fully online, asynchronous training (Dahri et al., 2022; Traxler & Vosloo, 2014). This method enables learners to participate at their own pace, eliminating the need for logistical coordination with facilitators, particularly when offered at no cost.

Building on this foundation, Sancar et al. (2021) developed a conceptual framework for effective PD that synthesizes existing literature on the key features of high-quality PD. This holistic framework explores how individual teacher characteristics, such as beliefs, self-efficacy, identity, and experiences, shape in-class teaching behaviors and practices, thereby influencing both the PD process and teachers' engagement with it (Desimone, 2009; Korthagen, 2016, Sancar et al., 2021). Moreover, the framework considers how aligning PD content with teachers' unique attributes can enhance its impact and relevance, particularly in terms of improving teachers' confidence and their ability to apply the training to classroom practices (Sancar et al., 2021).

Taken together, these insights suggest that PD is most effective when it incorporates built-in opportunities for reflection, observation, and discussions of personal experiences directly relevant to the content (Antoniou & Kyriakides, 2013; Girvan et al., 2016; Sancar et al., 2021). Designing PD in this manner encourages teachers to examine how their individual attributes and experiences inform their teaching, while ensuring that their beliefs and perspectives are both reflected in and supported by the PD content, ultimately enhancing the relevance and applicability of the PD experience for educators across diverse contexts.

Building on these principles, the present work integrates these elements into an asynchronous PD course designed to train educators in implementing a strengths-based, character-driven early coding curriculum, while also helping them identify contextually relevant virtues to incorporate into their practices for teaching coding using the CAL pedagogy.

Research questions

This paper focuses on the impact of an asynchronous virtual PD on a group of 73 early childhood educators. Specifically, we sought to investigate the following research questions:

RQ1: To what extent did the professional development opportunity increase teachers' coding skills?

RQ2: To what extent did the course change teachers' beliefs about the place of human virtues in computer science education?

RQ3: What specific human virtues do teachers aim to incorporate into their teaching practices post-training, assuming the training was successful?

Method

We employed a sequential explanatory mixed-methods approach to evaluate the effects of the PD training on teachers' knowledge and their beliefs and self-efficacy towards incorporating human virtues in CS education. The qualitative phase served to explain and elaborate on the quantitative findings, providing context and depth to understand why certain values are considered important in CS education (Creswell & Creswell, 2017).

Quantitative data were collected using the Automated Coding Stages Assessment (CSA-A), which assesses coding skills through a task-based assessment, and an 8-item Likert survey assessing beliefs and self-efficacy regarding human virtues in CS education. Qualitative data were gathered via open-ended survey responses and discussions during training. Analysis included ANCOVA and MANCOVA to assess change over time, controlling for demographic covariates, followed by deductive thematic coding using the VIA framework (Fereday & Muir-Cochrane, 2006/2006; Peterson & Seligman, 2004). Our mixed-methods approach was informed by the principles outlined in the Mixed Methods Appraisal Reporting Standards (MMARS; Hong et al., 2018), particularly regarding the integration and complementarity of quantitative and qualitative components.

Sample

Seventy-three pre- and in-service elementary teachers participated in an asynchronous PD training course offered from January through May 2024. The average years of teaching experience among participants was 12.5 ($SD = 11.1$). Participants predominantly identified as female (87.7%) and 72.6% resided in North America. With regard to race, 54.8% of participants identified as White, 13.7% were Asian, 11% were Hispanic or Latin, 8.2% were Black or African American, 5.9% were of mixed race, and 6.9% opted not to respond. Regarding participants' primary language, 92% primarily spoke English and 8% spoke Spanish. Table 3 summarizes the demographic characteristics of the study participants. This study was approved by the Boston College Institutional Review Board [Protocol #24.157.01], and all participants provided consent prior to partaking in the PD course. Participants were recruited using an internal mailing list sent to a network of teachers from around the world. Additionally, some participants were recruited through

Table 3. Demographic breakdown of participants in the professional development training course.

Variable	*n*	%
Language		
English	67	91.78
Spanish	6	8.22
Gender		
Female	64	87.67
Male	9	12.33
Race		
White	40	54.79
Other	33	45.21
Educational Level		
Postgrad	31	42.47
Undergrad	25	34.25
Other	17	23.29
Location		
North America	53	72.60
South America	5	6.85
Other	6	8.22
Africa	6	8.22
Europe	3	4.11
Prior Programming Experience		
No	49	67.12
Yes	24	32.88
Prior Teaching Programming Experience		
No	41	56.16
Yes	32	43.84
Grades Taught		
Multiple Grades	39	53.42
Secondary	13	17.81
Elementary	10	13.70
Unknown	4	5.48
Pre-kindergarten	2	2.74
K to elementary	2	2.74
PreK to elementary	1	1.37
Pre-kindergarten and Kindergarten	2	2.74
Post Secondary Background		
No	28	38.36
Yes	45	61.64

Note. Mean years of teaching experience was $M = 12.5$ ($SD = 11.1$). Percentages may not total 100 due to rounding.

the Boston College community. All interested teachers, administrators, and students who completed all parts of the research components were included in the analysis.

Study design

Course structure

An asynchronous PD training course was created using the EasyGenerator toolkit and designed in alignment with the CAL approach to provide educators with the essential skills and knowledge for teaching CS in early childhood classrooms (Kapoor et al., 2022). The course was administered online and free of charge. It took an average of four to six hours to complete, however it was self-paced. Progress was saved automatically, such that participants may divide the work time into many shorter sessions. There were no synchronous sessions as part of the course.

Course content

The PD course focused on the ScratchJr programming language block-based introductory programming language for children ages 5–8 and its corresponding curricula 'Coding as Another Language' curricula. All of these (PD, ScratchJr and CAL curricula) are free and can be accessed on-line. It consisted of 5 modules and maintained a cohesive progression of materials and concepts throughout. It started with a course overview, then it introduced ScratchJr, followed by the CAL pedagogy and curriculum, a *Show What You Know* assessment (a questionnaire measuring students' understanding and mastery of specific CS skills) and concluded with an overview of a curriculum that participants had access to so they could implement ScratchJr and the corresponding pedagogy in the classroom. Each section had embedded videos and text followed by activities for participants to practice the content and checkpoints for them to reflect on their learning (see Table 4). In addition, the course utilized interactive methods to keep participants actively engaged, including opportunities for discussion and collaboration via the Slack messaging app. The inclusion of a community chat feature allowed participants to connect before, during, and after the course, enabling them to share insights, resources, and offer support to one another throughout the PD process. Figure 1 displays the study design of the intervention.

The course introduced the PoV metaphor by defining each of its 10 virtues. For each one, participants were prompted to reflect on their own perception of the virtue, and to

Table 4. An overview of the content provided by the on-line PD.

Course Overview	ScratchJr	The Pedagogy	Show What You Know	CAL-ScratchJr Curriculum
Overview	Overview	Overview	Overview	Overview
Navigating the Course	Introduction to ScratchJr	Introduction	Making a ScratchJr Program	Curriculum by Grade
Pause & Reflect	The ScratchJr Interface	Idea 1: Coding as Another Language	Debugging a ScratchJr Program	Lesson Deep Dive
	Pause & Reflect	Quiz	Quiz 1	Examples of Creative Coding
		Idea 2: Coding As a Palette of Virtues	Advance ScratchJr Features	Resources
		Pause & Reflect	Pause & Reflect	Pause & Reflect

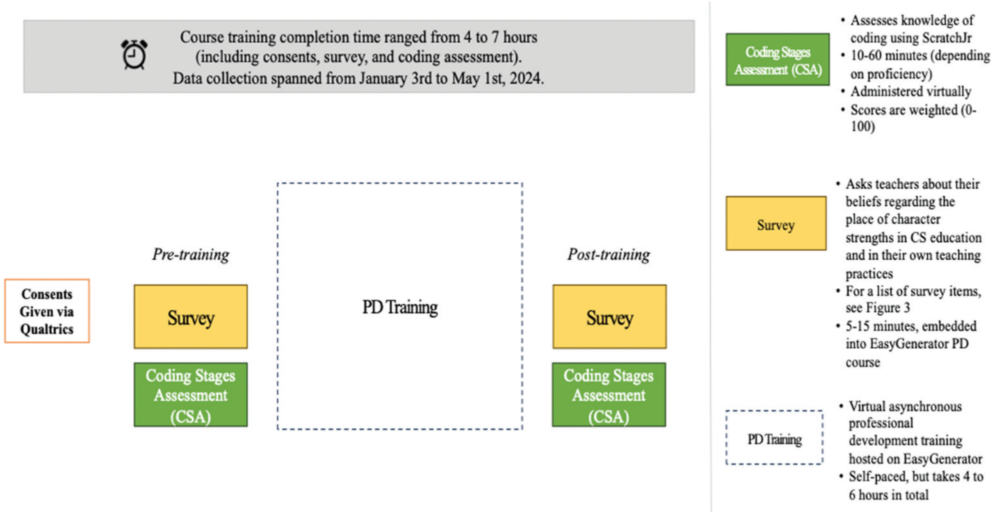

Figure 1. Course table of contents study design, timeline and instruments.

imagine what it might look like for a student to show this virtue in the coding classroom. Then, participants were shown video footage from teachers who were prompted to reflect on their experiences with certain virtues. Participants were then asked to reflect on other virtues they noticed as teachers spoke, and to consider how these virtues might show up in their own learning settings (see Figure 2).

Data collection

Coding stages assessment - automated (CSA-A)

The CSA-A is an adaptive online task-based assessment designed to assess respondents' coding proficiency with the ScratchJr programming language. Upon completing the assessment, respondents are classified into one of five Coding Stages based on their skills performance: Emergent, Coding and Decoding, Fluency, New Knowledge, Purposefulness (De Ruiter & Bers, 2022). Additionally, a weighted overall score is computed as a composite indicator of CSA performance, with scores ranging from 0 to 30. This instrument provides a window into the coding process and skill level of the participant.

Survey

In addition to the CSA assessment, participants completed a survey before and after the training, which was a combination of 8 Likert-scale items (ranging from 5 - strongly agree to 1 - strongly disagree) and 3 open-ended questions. These survey items, created specifically for this study, assessed teachers' perceptions of character strengths relevant to CS education and their plans for integrating these strengths into their teaching practices. We specifically aimed to understand their beliefs about the role of human virtues in CS education, their self-efficacy in teaching these values, and their overall perception of the POV as a metaphor through which

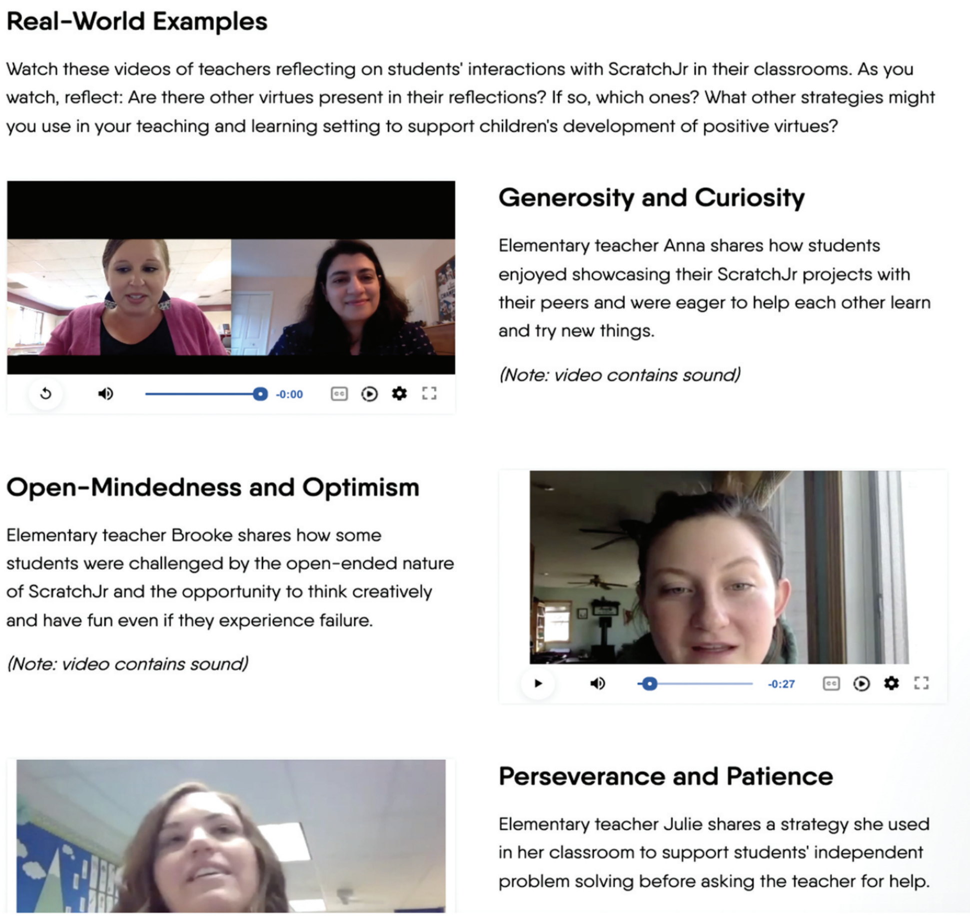

Figure 2. Activity on Palette of virtues in the course.

coding can be taught. As such, the survey questions were split into these 3 categories. Midway through the training, teachers were also asked to identify which virtues they considered most important to foster in early childhood and to explain their reasoning.

Survey items were developed based on existing studies that examined teacher self-efficacy and beliefs in early CS education and were adapted to evaluate these constructs within the context of virtues education in CS (Bers et al., 2013; Kapoor et al., 2022; Kaya et al., 2019). To ensure content relevance and validity, the full item set was reviewed by a panel of three experts: two researchers specializing in CS education and early childhood development, and one scholar with a specific focus on the integration of human values in computing education. While the instrument was not piloted formally, cognitive walk-throughs were conducted with three early childhood educators to assess clarity, item interpretation, and response flow. This process informed minor revisions prior to deployment. Table 5 displays the analysis for each of the three research questions. Screening analyses were performed to investigate normality, linearity, outliers, and presence of missing data.

Table 5. Research questions and data analysis plan.

Research Question	Data Source	Analysis Method
RQ1: To what extent did the professional development (PD) course increase teachers' coding skills?	Coding Stages Assessment – Automated (CSA-A) (Pre-PD, Post-PD)	Analysis of covariance (ANCOVA)
RQ2: To what extent did the PD course change teachers' beliefs about the place of human values in early computer science education?	Teacher Survey (Pre-PD, Mid-PD, Post-PD)	Multivariate analysis of covariance (MANCOVA)
RQ3: What specific human values do teachers aim to incorporate into their teaching practices post-training, assuming the PD was successful?	Responses to open-ended questions from Teacher Survey (Pre-PD, Mid-PD, Post-PD)	Directed content analysis

Data analysis

Initially, we examined the impact of the PD training on teachers' coding knowledge. We then assessed their beliefs and self-efficacy through a combination of survey responses and qualitative analysis. Additionally, we used a qualitative approach to understand which specific values they considered important to incorporate, using the VIA framework to analyze participants' responses to two questions.

A repeated measures multivariate analysis of covariance (MANCOVA) was conducted to assess whether there were significant differences in beliefs and self-efficacy across different time points, while controlling for demographic variables such as race, gender, location, educational level, teaching experience, and prior experience in programming and STEM. This allowed us to analyze the combined effects of time and multiple dependent variables (Beliefs and Self-efficacy) while simultaneously controlling for demographic covariates, thus reducing Type I error associated with multiple comparisons (Tabachnick & Fidell, 2019).

Additionally, we used a repeated measures analysis of covariance (ANCOVA) to examine significant differences in coding scores before and after training (normalized to a 0–100 scale), again controlling for the same demographic variables. This approach allowed us to isolate the effect of the training intervention while statistically adjusting for potential confounding factors (Field, 2018). Effect sizes were calculated to estimate the magnitude of observed changes. Partial eta squared (ηp^2) was used for MANCOVA and ANCOVA (Field, 2018), while Cohen's d was used for pairwise t-test comparisons using the formula $d = \frac{2t}{\sqrt{df}}$, suitable for repeated measures comparisons (Lakens, 2013). The results were examined based on an alpha level of .05.

For qualitative analysis, we used a deductive coding approach based on the VIA framework to classify our codes. This involved predefined categories derived from the framework, ensuring that our analysis was grounded in an established theoretical basis. In the initial phase, two authors jointly coded 10 responses to calibrate their understanding and application of the framework. They then independently coded the remaining responses. Initial inter-coder agreement was 63%; however, through regular discussions, all discrepancies were resolved, resulting in 100% agreement. To address potential biases and support analytical rigor, we implemented several strategies: joint coding sessions to standardize procedures, independent coding to ensure consistency, and collaborative resolution of disagreements. We also engaged in ongoing reflexive discussions about how our positionalities might shape interpretation. We report these procedures in alignment with the COREQ guidelines (Tong et al., 2007), including coder training, discrepancy resolution, and reflexivity considerations.

Results

RQ1

The results of the ANCOVA analysis are presented in Table 6. The covariate, gender (Male as a reference group), was significantly related to coding scores, $F(1, 42) = 6.43$, $p = .015$, indicating that there is a significant difference in coding growth between male and female participants, with a moderate effect size. No other significant effects for the covariates were found. Following recent reporting recommendations, we refrained from interpreting p-values between .05 and .10 as marginally significant (Amrhein et al., 2019; Benjamin et al., 2018).

The main effect for the within-subjects factor (i.e., time effect from pre- to post-training) was significant, $F(1, 42) = 8.10$, $p = .007$, indicating a significant change over time in coding growth after controlling for the covariates. This suggests that the training had a significant positive effect. The interaction effect between time and location was significant, suggesting that there are significant differences in coding growth over time across different geographical locations.

Tukey comparisons were used to test the differences in the estimated marginal means for each combination of within-subject (Time) effects. Coding baseline scores was significantly less than endline scores, $t(42) = -3.70$, $p < .001$, Cohen's $d = 1.14$. This indicates a significant improvement in coding skills as a result of the training. Table 7 presents the marginal means contrasts for the Repeated Measures ANCOVA.

Tukey comparisons were also used to test the differences in the estimated marginal means for the geographical location across the time points. The significant increase in coding scores in Europe and North America regions suggests that the PD training

Table 6. Repeated measures ANCOVA results ($n = 53$).

Source	*df*	*SS*	*MS*	*F*	*p*	$\eta_p 2$
Between-Subjects						
Gender (Male)	1	2,789.17	2,789.17	6.43	.015	0.13
Race (White)	1	1,338.22	1,338.22	3.09	.086	0.07
Location	4	2,039.51	509.88	1.18	.335	0.10
Years of Teaching	1	208.16	208.16	0.48	.492	0.01
Programming Experience	1	1,772.38	1,772.38	4.09	.050	0.09
STEM Background	1	152.96	152.96	0.35	.556	0.008
Residuals	42	18,214.70	433.68			
Within-Subjects						
Within Factor (Time)	1	1,946.04	1,946.04	8.10	.007	0.16
Gender (Male):Within.Factor	1	69.87	69.87	0.29	.593	0.007
Race (White):Within.Factor	1	85.76	85.76	0.36	.553	0.008
Location:Within.Factor	4	2,800.87	700.22	2.91	.032	0.22
Years of Teaching:Within.Factor	1	20.98	20.98	0.09	.769	0.002
Programming Experience:Within.Factor	1	504.62	504.62	2.10	.155	0.05
STEM Background:Within.Factor	1	2.75	2.75	0.01	.915	0.0003
Residuals	42	10,092.01	240.29			

Table 7. The marginal means contrasts for each combination of within-subject variables for the repeated measures ANCOVA.

Contrast	Difference	*SE*	*df*	*t*	*p*
Baseline - Endline Coding Scores	−25.35	6.84	42	−3.70	<.001

Note. Tukey Comparisons were used to test the differences in estimated marginal means. Cohen's $d = 1.14$.

Table 8. The marginal means contrasts for baseline - Endline coding scores for each geographical location.

Contrast	Difference	*SE*	*df*	*t*	*p*	Cohen's *d*
Africa						
Baseline - Endline	−8.06	8.78	47	−0.92	.364	0.27
Europe						
Baseline - Endline	−29.48	12.42	47	−2.37	.022	0.69
Other						
Baseline - Endline	−49.71	12.42	47	−4.00	<.001	1.17
South America						
Baseline - Endline	−0.80	10.76	47	−0.07	.941	0.02
US						
Baseline - Endline	−10.99	3.59	47	−3.07	.004	0.89

Note. Tukey Comparisons were used to test the differences in estimated marginal means.

successfully addressed the needs of teachers in these regions, leading to substantial improvement in their knowledge (see Table 8). Conversely, the non-significant changes in Africa and South America regions suggest that the PD training did not lead to a statistically measurable improvement in coding skills. This might indicate the need for region-specific modifications to the training program to better support teachers in these areas, beyond mere translation.

RQ2

Table 9 presents the MANCOVA results. For between subject effects, only the covariate gender (with Female as the reference group) was significantly related to Beliefs and Self-efficacy, $F(1, 61) = 7.09$, $p = .010$, indicating that there is a significant difference in the measured outcomes between male and female participants. Race (with White as the reference group), geographical location (with North America as the reference group), years of teaching experience, educational level and programming experience and STEM background were all found not significantly related to Beliefs and Self-efficacy regarding human values.

As for within-subjects effects, the main effect for Time (pre- to post-training) was significant $F(1, 61) = 5.05$, $p = .028$, indicating there were significant differences in Beliefs and Self-efficacy, controlling for demographic factors. This suggests that the training had a significant effect on both their beliefs regarding human values in CS and their self-efficacy beliefs towards their ability to incorporate these values into their teaching practices. The main effect for human values scale (HV; Beliefs and Self-efficacy together) was also significant $F(1, 61) = 305.60$, $p < .001$. However, the main effect for Time and HV was not significant $F(1, 61) = 0.15$, $p = .703$, indicating that the relationships between the levels of HV (Beliefs and Self-efficacy) were similar across the time points after controlling for demographic variables. As for within-covariate interactions, the interaction effect between overall human values and gender was significant, $F(1, 61) = 4.47$, $p = .038$, indicating that the relationships between Beliefs and Self-efficacy differed significantly between male and female participants. All other interactions were not significant.

Table 9. Repeated measures MANCOVA results (n = 73).

Source	*df*	*SS*	*MS*	*F*	*p*	$\eta_p 2$
Between-Subjects						
Gender (Male)	1	77.81	77.81	7.09	.010	0.10
Race (White)	1	17.52	17.52	1.60	.211	0.03
Location	4	67.80	16.95	1.54	.201	0.09
Years of Teaching	1	3.72	3.72	0.34	.563	0.006
Educational Experience	2	3.13	1.56	0.14	.868	0.005
Programming Experience	1	1.18	1.18	0.11	.745	0.002
STEM Background	1	6.83	6.83	0.62	.433	0.01
Residuals	61	669.88	10.98			
Within-Subjects						
Time	1	16.75	16.75	5.05	.028	0.08
Gender (Male):Time	1	8.01	8.01	2.42	.125	0.04
Race (White):Time	1	0.29	0.29	0.09	.767	0.001
Location:Time	4	32.44	8.11	2.45	.056	0.14
Years of Teaching:Time	1	1.53	1.53	0.46	.500	0.007
Educational Experience:Time	2	0.76	0.38	0.11	.892	0.004
Programming Experience:Time	1	0.28	0.28	0.08	.773	0.001
STEM Background:Time	1	1.03	1.03	0.31	.579	0.005
Time Residuals	61	202.28	3.32			
Human Values (HV)	1	958.48	958.48	305.60	<.001	0.83
Gender (Male):HV	1	14.03	14.03	4.47	.038	0.07
Race (White):HV	1	0.08	0.08	0.03	.872	0.0004
Location:HV	4	24.34	6.08	1.94	.115	0.11
Years of Teaching:HV	1	0.55	0.55	0.18	.676	0.003
Educational Experience:HV	2	14.03	7.02	2.24	.115	0.07
Programming Experience:HV	1	0.03	0.03	0.01	.925	0.0001
STEM Background:HV	1	0.24	0.24	0.08	.783	0.001
HV Residuals	61	191.32	3.14			
Time:HV	1	0.34	0.34	0.15	.703	0.002
Gender (Male):Time Factor:HV	1	1.09	1.09	0.47	.494	0.008
Race (White):Time:HV	1	0.10	0.10	0.05	.832	0.0007
Location:Time:HV	4	9.31	2.33	1.02	.405	0.06
Years of Teaching:Time:HV	1	0.06	0.06	0.03	.870	0.0004
Educational Experience:Time:HV	2	3.79	1.89	0.83	.442	0.03
Programming Experience:Time:HV	1	0.19	0.19	0.08	.776	0.001
STEM Background:Time:HV	1	0.007	0.007	0.00	.957	0.00005
Time:HV Residuals	61	139.51	2.29			

RQ3

We employed a deductive coding approach to analyze the 3 open-ended survey questions and discussions during the training. We used the six core virtues from the VIA framework to ground our analysis in an established theoretical basis. In order to create codes to categorize the responses into subthemes, a directed content analysis was employed. Three researchers initially coded 10 responses together to align their understanding and application of the framework. They then independently coded the remaining responses, reaching a 100% agreement on *all* codes after discussing the discrepancies.

Prior to the PD training, Wisdom accounted for 25% of participants' responses, with 54% coded as Curiosity and 46% as Open-mindedness. Similarly, 25% of responses were under Courage, with 52% reflecting Perseverance, 47% Honesty, and 1% Confidence. Transcendence comprised 18% of responses, split between Optimism (53%) and

Gratitude (47%). Temperance made up 17% of responses, with Patience (64%) being more frequent than Forgiveness (36%). Justice, representing 11% of responses, was predominantly associated with Fairness (72%), followed by Responsibility (14%), Respect (12%), and Equity and Inclusion (2%). Table 10 displays the results of participants' responses at pre-training.

During the training, teachers emphasized specific virtues as being particularly important in early childhood education. Thirty percent of responses were categorized under the VIA Virtue of Wisdom, with 59% of these focused on Curiosity and 41% on Open-mindedness. Similarly, 30% of responses were within the VIA Virtue of Courage, where 70% reflected Perseverance and 30% Honesty. Nineteen percent of responses fell under Temperance, with a predominant focus on Gratitude (70%) and the remaining 30% on Optimism. Humanity accounted for 7% of responses, all of which were classified as Generosity, while 5% of responses were attributed to Justice, entirely represented by Fairness. Figure 3 displays the results of participants' responses during the training.

Participants' responses shifted slightly across the virtues following the PD training. Wisdom decreased to 22%, with Curiosity (51%) and Open-mindedness (47%) still dominant, while a new subcategory, Growth, emerged at 2%. Courage accounted for 20% of responses, with Perseverance (53%) and Honesty (46%) remaining stable, and Confidence unchanged at 1%. Temperance rose to 19%, with Patience (60%) and Forgiveness (40%) maintaining similar proportions. Transcendence remained at 18%, now equally split between Gratitude (50%) and Optimism (49%), with Pride emerging as a new category at 1%. Justice stayed consistent at 11%, with a notable increase in Fairness (84%) and smaller shares for Respect (11%), Responsibility (3%), and Equity and

Table 10. Character strengths at pre- and post-training using directed content analysis.

	Timepoint	
Virtue	Pre	Post
Transcendence	18%	18%
Optimism	53%	49%
Gratitude	47%	50%
Pride	N/A	1%
Wisdom	25%	22%
Curiosity	54%	51%
Open-mindedness	46%	47%
Growth	N/A	2%
Courage	20%	20%
Perseverance	52%	53%
Honesty	47%	46%
Confidence	1%	1%
Humanity	9%	10%
Generosity	72%	85%
Empathy	23%	13%
Awareness	5%	2%
Justice	11%	11%
Fairness	72%	84%
Respect	12%	11%
Responsibility	14%	3%
Equity & Inclusion	2%	2%
Temperance	17%	19%
Patience	64%	60%
Forgiveness	36%	40%

Figure 3. Character strengths at Mid-training using directed content analysis.

Inclusion (2%). Additionally, a new category, Humanity, accounted for 10% of responses, primarily focused on Generosity (85%), with Empathy (13%) and Awareness (2%) also represented. Overall, the proportion of responses categorized under Wisdom slightly decreased, whereas Temperance and Humanity showed a slight increase in their share of the total responses. Table 10 shows the results of participants' responses after the training.

Discussion

This section discussed the findings in relation to the three research questions presented earlier and explores the implications of the results within the context of early childhood computer science (CS) education, moral education and character development.

RQ1: To what extent did the professional development course increase teachers' coding skills?

The results of the ANCOVA analysis revealed a significant improvement in participants' coding skills following the training. This suggests that the program effectively enhanced their technical proficiency in CS, despite the fact that their training wasn't solely focused on teaching technical skills and incorporated pedagogical materials and approaches to support students' character development. However, the variation in growth across gender and geographical locations emphasizes the importance of tailoring future training programs to these contextual factors. The persistent gender gap in STEM, particularly in fields like CS (Encinas-Martín & Cherian, 2023), further underscores the need to design interventions that are sensitive to gender disparities and regional differences. These findings highlight the importance of equitable access to training and the potential for customized support to ensure all teachers can benefit equally, which may, in turn, help address broader gender gaps in STEM education.

RQ2: To what extent did the course change teachers' beliefs about the place of human virtues in computer science education?

The MANCOVA results indicate that the training had a significant positive effect on teachers' beliefs regarding the integration of human virtues into CS education and their self-efficacy in teaching these values. Although all teachers felt confident in incorporating elements of character development into their teaching practices, there were significant gender differences in beliefs and self-efficacy, further highlighting the role gender plays in PD outcomes. These findings suggest that while the training successfully reinforced the importance of virtues in CS education, future programs should address gender-related disparities in confidence and perception. This could involve creating more inclusive training environments or offering additional support tailored to underrepresented groups.

RQ3: What specific human virtues do teachers aim to incorporate into their teaching practices post-training, assuming the training was successful?

Teachers' reflections revealed a deep awareness of the role they play in the classroom in nurturing virtues such as perseverance, honesty, open-mindedness, and generosity in their students. As noted by one participant, school offers an opportunity to cultivate these virtues, especially for students who may not receive this guidance at home:

> For those whose parents solve everything for them, or for those whose parents give them a tablet to prevent them from acting up, they might not develop virtues like perseverance, honesty, open-mindedness and generosity. Therefore, school can be a place that can support these virtues. It's a way to complement what students get at home. –Participant 6 (Hispanic, Female, 13 years of teaching in the U.S.)

The interconnectedness of these virtues became apparent during the training, with teachers recognizing that fostering one value can often lead to the development of others. For example, honesty and generosity were seen as foundational virtues that could naturally promote fairness and optimism, while perseverance, combined with curiosity, was thought to encourage students to explore and persist in their learning. One teacher explained,

> It is tough to only pick [specific virtues to incorporate in their teaching practices] because so many are important. I believe that with honesty and generosity, many of these other virtues will naturally follow. Once students can be honest and generous with each other, they will learn to be fair and optimistic. I believe fostering perseverance with a sense of curiosity allows children the opportunity to explore and not give up when things get challenging.

Prior to taking the course, teachers integrated perspective-taking into the broader concept of open-mindedness. Teachers explained that, while open-mindedness is awareness of the existence of multiple ways of thinking, perspective-taking is the embodiment of another point of view. When working with problem-solving type of situations (such as those that come up when learning CS), understanding the problem from multiple points of views is of crucial importance to come up with a good solution. Teachers also emphasized how encouraging curiosity among students fosters open-mindedness, as curiosity naturally prompts children to explore new ideas and approaches, particularly in fields like CS. This aligns with Dweck's notion of the growth mindset (Dweck, 2014), where the willingness to learn and adapt is essential for intellectual and personal growth. One teacher explained,

> They are at a stage where new things about the environment are [being] introduced, and the earlier their desire to learn something, especially like coding, they are more open-minded to it and all other life endeavors. Curiosity connects to the value of Open-mindedness, once they are curious, they are open-minded to new ideas. -Participant 15, (Black/African American, Female, 6 years of teaching in the U.S.)

Other participants noted that fostering curiosity encourages children to ask questions, seek knowledge, and engage actively in learning. Participant 2 (Hispanic Female from Argentina with 6 years of teaching experience) expressed, 'Curiosity is the little engine that makes us ask ourselves questions to understand how everything works (us, the world, [and] societies).' This engagement not only promotes a love for learning but also, as some teachers noted, enhances critical thinking, creativity, and innovation, which are essential skills in today's rapidly evolving technological landscape.

Integrating wisdom, including perspective-taking, open-mindedness, and curiosity, into educational practices not only enriches students' learning experiences but also prepares them to navigate complexities and challenges with resilience and creativity to adapt to 21st century needs, as noted by participants. By promoting these qualities, teachers empower students to develop a lifelong love for learning and a proactive approach to understanding and shaping their world. Participant 1 (White Female from the U.S. with 11 years of teaching experience) remarked, 'I think it's vital to fuel kids' natural curiosity and encourage them to continue to be curious about the world around them and how they can have agency over creating that world.'

Teachers participating in the course identified the character strength *Courage*, emphasizing its connections with honesty, perseverance, and confidence.

> I want students to understand that if they are going to write code, there's no cutting corners. You need to make sure it works. You need to make sure it maintains a standard of safety. -Participant 49 (White, Female, 17 years of teaching in the U.S.)

Honesty was a focal point during discussions, with teachers linking it closely with integrity. They defined honesty as crucial for establishing a foundation of truth on which others can rely, promoting trust and 'healthy relationships.' Participants also stressed the importance of thoroughness in coding, cautioning against 'cutting corners,' and emphasizing the need to meet safety standards. The combination of these two character strengths were viewed as 'integrity,' since dishonesty and carelessness together can result in the spread of misinformation. Participant 16 (White Female with 12 years of teaching experience in the U.S.) cautioned that 'society does not work well when others' actions and responses are built on false information.' In the realm of CS, with technological developments such as generative AI, this issue is particularly prevalent. While in the early childhood CS classroom, students may not be working with AI directly, they must still grasp the implications of being dishonest. A diligent and truthful young student will have original ideas and regularly test out their code. By promoting these character strengths at a young age, they will develop the foundation necessary to safely and effectively interface with any advanced technologies.

Furthermore, teachers recognized that diligence and honesty cannot exist without perseverance, particularly in the context of debugging and overcoming coding challenges. They also linked perseverance to confidence, since each time a student overcomes challenges in their work, their confidence grows. Teachers found that the process of persisting in the face of challenge was instilling a sense of accomplishment and confidence in students that empowered them in future tasks. They noted that the more that this process occurred, the more self-assured students were. This realization aligns with Dweck's theory on growth mindset, where perseverance in debugging and 'altering code' fosters a mindset of continuous improvement and ethical responsibility in their digital interactions.

Teachers participating in the course emphasized the significance of *Humanity*, focusing notably on empathy and awareness of others, as well as self-awareness. These qualities were seen as important for creating a positive and supportive classroom environment conducive to learning and social growth.

> I believe that all that is designed, taught, shared, done out of a heart of love and for the benefit of others will help solve most of human related problems through technology. –Participant 13 (Black/African-American, Female, 9 years of teaching in Kenya)

During our discussions with teachers, empathy and love emerged as central themes. Additionally, compassion emerged as a sub-theme, defined by Participant 32 (Female from Maryland) as, 'a child's compassion is their love and care for other people. A child's ability to feel this way will help them build good relationships with other people.' This sentiment underscores compassion as the presence of both empathy and the desire to take action in order to foster supportive interactions among peers. While some teachers used empathy and compassion interchangeably, we acknowledge the commonly accepted distinction between empathy (feeling *with* others) and compassion (feeling *for* others; Singer & Klimecki, 2014). By instilling in students both empathy and compassion as foundational character strengths, teachers have the opportunity to 'address bullying and harassment' before issues can arise, as one teacher noted.

Throughout the course, teachers also expanded on the importance of generosity (85%). Participant 13 created a link between generosity and teamwork, noting that 'it takes a generous heart to be able to ask with hope of receiving an answer.' This teacher expanded on this by creating another connection between generosity and patience, saying that students 'will need to be patient with self and others . . . [and be] grateful for every step [of the process].' Furthermore, teachers extended the definition of patience beyond simply persevering through challenges. In order to be patient, one must also be open-minded and 'flexible in taking different perspectives.' Such a mindset will enable students to value diverse ways of thinking while collaborating in order to achieve common goals.

Teachers also viewed generosity, much like compassion, as empathy in action, emphasizing its importance in promoting collaboration and knowledge-sharing among students. Participant 27 (White Female with 15 years of teaching experience in Greece) remarked that 'sharing what we know will push us to learn more,' noting that the generosity of knowledge often leads to reciprocal learning, where students benefit from one another's insights. For example, in a CS classroom, a student named Scarlet generously shares her coding tips with Violet and Scott, helping them troubleshoot. Later, when Violet encounters a bug in her code, Scott (having learned from Scarlet) steps in to assist. This cycle of generosity cultivated an environment where collaborative learning flourished, demonstrating the profound impact of sharing knowledge in the classroom.

Throughout the course, discussions centered on both awareness of others and self-awareness. Initially, teachers emphasized empathy, encouraging students to adopt different perspectives and 'put themselves in someone else's shoes.' As the course progressed, they also highlighted the importance of self-awareness, recognizing how their own actions influence both others and the broader learning environment. By integrating character strengths such as empathy, compassion, and generosity into early childhood CS education, teachers noted that they could foster a supportive learning environment while also 'equipping students with essential life skills.' These strengths not only encourage empathy-driven actions but also promote collaborative learning, promoting a culture of mutual respect and shared knowledge.

> I always tell [students] that 'fair' and 'equal' are different - not everyone needs or gets the SAME medicine from the doctor (equal) but they do get the medicine that they need (fair). I think this is one of the hardest lessons for some children and adults to learn and understand. –Participant 11 (White, Female, 31 years of teaching in the U.S.)

Teachers underscored the significance of *justice*, connecting it with key virtues like fairness (84%), respect (11%), responsibility and leadership (3%), as well as equity and inclusion (2%). Fairness emerged as a recurring concern in early childhood CS classrooms, especially regarding disparities in students' prior experience with coding. Some students, having had more exposure to coding, picked up concepts more easily, while others needed additional time and support, which some classmates viewed as 'unfair.' One teacher explained, 'some students have had more time or practice with coding, while for others it is the first time they have attempted [it]'.

To address these disparities, teachers made a point to explain how unequal access to resources early on shaped skill differences. They also highlighted the importance of fostering 'empathy and understanding,' encouraging students to view coding as an opportunity to understand different perspectives and 'step into someone else's shoes.' Another participant emphasized that fairness means equitably 'sharing knowledge,' given that not all students have had the same opportunities to explore coding from a young age. A U.S. teacher added that treating everyone 'with dignity and respect,' regardless of background, is crucial, particularly in relation to differences in religion, socio-economic status, or ethnicity. After the training, teachers reflected on the importance of instilling these virtues early, not only through direct teaching but also by modeling these behaviors themselves, acknowledging that children often learn valuable lessons through 'watching adults behave.'

Participants also connected justice with responsibility, emphasizing the importance of students fulfilling their commitments and 'keeping their end of the bargain,' especially in collaborative settings. This sense of responsibility extends to taking initiative, showing leadership, and demonstrating respect for peers in order to 'create a positive learning environment.' Patience and respect, even in small actions like sharing and caring for shared devices, were seen as key to fostering this environment. Participants underscored that respect should also be present in digital interactions, as seen on platforms like ScratchJr, where children collaborate on storytelling projects. For example, if a teacher assigns a creative coding project in ScratchJr where students share their favorite holiday traditions with a partner, they might find themselves sharing practices unfamiliar to their partner. In these moments, it is vital for teachers to emphasize the importance of respecting one another's diverse backgrounds, beliefs, and unique experiences, fostering a classroom where differences are valued.

Participants emphasized that instilling these virtues early on is essential. By modeling these behaviors and encouraging students to embody them, educators create a shared commitment: ensuring that 'all students have [equitable] access to computer science education.' This foundation not only prepares students for academic success but also nurtures their growth into responsible citizens capable of contributing to societal progress.

> [A los niños] en este camino [tendrán] obstáculos, que al mismo tiempo deberán superarse siendo persistentes y perseverantes, no darse por vencidos y continuar el camino con paciencia . . . Con [la responsabilidad], los niños aprenden a cuidar su entorno y cumplir con las actividades encomendadas.
>
> English: [children] will encounter obstacles, which they overcome by being persistent and perseverant, not giving up, and continuing with patience . . . with [responsibility], children learn to take care of their environment and fulfill the tasks assigned to them. –Participant 3 (Mixed-race, Female, 2 years of teaching in Ecuador)

Participants emphasized the character strength of *Temperance*, with a particular focus on students' patience (60%) and their capacity for forgiveness (40%)—both toward themselves and others. One participant remarked, 'patience and forgiveness are important because the kids might feel demotivated after making mistakes so they either end up blaming themselves or lose interest due to lack of patience.' The process of grasping CS concepts, especially for young learners, demands time and persistence. Another participant stressed that 'patience is essential in coding, as it involves trial and error, debugging, and refining code until the desired outcomes are achieved.' This process requires, as noted by some participants, perseverance, curiosity, self-control, emotional regulation, and the ability to tolerate frustration.

During the training sessions, participants shared classroom experiences that highlighted the importance of these virtues. One participant noted how patience allows students to wait their turn, listen attentively, and persevere through [coding] challenges.

It creates a positive learning environment where children feel supported and respected.' By embodying these traits, students not only excel in coding but also develop essential life skills that prepare them to adapt, innovate, and succeed in an ever-evolving technological landscape.

Participants also observed that not all children develop these character strengths at home. As one participant explained, virtues like perseverance, honesty, open-mindedness, and generosity can be difficult for children to cultivate when parents either solve problems for them or rely on technology like tablets as a preventative measure against misbehavior. Schools play a key role in nurturing these virtues, complementing the virtues children may (or may not) learn at home. Another participant highlighted the importance of teaching delayed gratification, stating, 'Teachers can help children develop the mindset and skills they need to grow academically, socially, and emotionally.' By embedding these virtues into the curriculum, educators felt that they had a chance at supplementing what students may be lacking at home, fostering resilience and character that will enable them to positively impact the world around them.

> I chose gratitude as kids need to be grateful for everything that they have. It is also a positive emotion that arises when you know that you see the goodness in everything around you. I chose optimism as optimism builds resilience. It also keeps us motivated towards achieving our goals. –Participant 19 (Asian, Female, 20 years of teaching in the South Africa)

Transcendence emerged as a significant character strength, accounting for 18% of the responses, predominantly associated with optimism (49%) and gratitude (50%). Interestingly, pride (1%) emerged as a noteworthy aspect following the training sessions, indicating its growing recognition in the context of fostering positive attitudes and emotional resilience among students. Participants emphasized that optimism plays a key role for both students and educators in overcoming challenges, particularly in CS education. They emphasized that optimism builds resilience and maintains motivation toward achieving goals. One participant stated, 'students and teachers need to have a positive outlook when it comes to coding. Feeling like they can't do it or it may be too much work will serve as a hindrance to everyone's performance.' Classroom discussions, according to participants, should be structured to encourage optimistic perspectives by incorporating phrases like 'yes and. . .,' which validate student contributions and foster a collective belief in overcoming challenges together. This optimism, combined with curiosity and perseverance, was viewed as essential for nurturing a can-do attitude, critical for students' growth in coding proficiency and problem-solving, aligning with growth mindset principles.

Gratitude was also highlighted as a key factor in nurturing positive attitudes and relationships within the classroom. Participants stressed the importance of helping children appreciate their surroundings and acknowledge the support they receive, fostering humility and a sense of interconnectedness. Participant 16 (White Female with 12 years of teaching experience in Minnesota) explained, 'gratitude is a necessary reciprocation to foster collaboration in a society where humans work in close quarters and contact with others. I focus on these in my classroom in everything we do.' Beyond simply saying thank you, gratitude was seen as enriching children's 'overall life experiences' and 'laying the foundation for empathy.' By promoting a culture of gratitude, educators aim to create a supportive learning environment where students feel valued and encouraged to collaborate.

Although initially less emphasized, pride gained recognition post-training as a character strength for its role in fostering students' self-esteem and a sense of accomplishment. Participants observed that cultivating pride in students' work can significantly boost confidence and motivation, helping them persist through challenges. This emerging focus on pride highlights its growing importance as teachers refine their approaches to nurturing students' holistic development in coding education.

Although most character strengths remained stable or increased post-training, we observed decreases in specific subthemes, such as empathy (23% to 13%) and responsibility (14% to 3%). These patterns may reflect a shift in participants' focus from interpersonal and communal virtues (e.g., empathy) to more individual, cognitive, or temperance-based strengths (e.g., curiosity, perseverance). It's possible that the emphasis in training activities, centered on problem-solving and exploratory learning, made cognitive and self-regulatory strengths more salient to participants. Rather than suggesting a devaluation of moral virtues, these results may indicate a recalibration of perceived instructional relevance in early CS education. Future training iterations could consider making virtues more explicit in content delivery and reflection exercises.

Also, while there were observable shifts in the prioritization of character strengths (e.g., a rise in Temperance and Humanity) the overall distribution remained relatively stable. This may reflect the training's emphasis on reinforcing existing virtues rather than radically reshaping them. It's also possible that the brief intervention timeframe limited large-scale conceptual change. Future research might explore whether prolonged engagement produces more pronounced changes in moral-virtue prioritization.

The insights provided by participants underscore the role of character strengths such as optimism, gratitude, and emerging pride in shaping a positive and supportive learning environment for early childhood coding education. These strengths not only enhance students' technical skills but also cultivate essential life skills such as resilience, empathy, and collaboration. Moving forward, integrating these character strengths into educational practices can further empower students to thrive academically and personally, preparing them for future success in an increasingly digital and interconnected world.

Conclusion

The goal of this work was to explore how computer science education initiatives, which are growing in popularity in K-12, can integrate character education. These efforts aim to support the holistic development of learners by enriching their technical skills with the development of virtues. Given the pivotal role teachers play in implementing character education initiatives, the present study reports on how 73 early childhood teachers embedded virtues into their teaching of coding, following their participation in an asynchronous PD course.

Results underscore the effectiveness of the training program in enhancing educators' coding skills and fostering positive changes in their beliefs and self-efficacy regarding the importance of character strengths in CS education. By embedding virtues like optimism and gratitude into the curriculum, we were able to cultivate a supportive and growth-oriented learning environment that prepares students not only for academic success but also for personal development in an increasingly digital landscape. Future directions could explore how cultivating human virtues within CS education can promote young children's ethical development and civic participation, supporting their journey toward becoming morally-informed individuals capable of applying both technical and sociomoral skills as they navigate the complexities of an ever-evolving technologically-rich world.

Furthermore, as Artificial Intelligence and the use of smart devices is growing all over the world, it is of crucial importance to implement CS educational interventions that do not just focus on teaching technical skills, but that also incorporate an ethical and moral perspective. The virtue ethics paradigm, and its emphasis not only on doing good, but on being good by promoting virtues or character strengths, which informs the work presented in this paper and the POV metaphor, provides an opportunity for conceptualizing virtues within a specific discipline. In this case, CS. However, it can apply to other related endeavors that require problem-solving strategies.

This study is not without its limitations. First, the sample size of 73 participants, while insightful, is relatively small and may not fully capture the broader diversity of educators' perspectives. Participation was also self-elected, which may introduce bias. As a result, the findings may not be representative of the entire population of early childhood educators, nor do they account for geographical and cultural differences that may influence how character strengths are perceived and implemented in various educational contexts. Additionally, the qualitative data in this study were based on self-reported measures. Self-reported data may not always reflect actual practices or outcomes observed in the classroom. Future research should aim for a more representative sample, and explore the impact of integrating human values teaching on students' cognitive and affective states.

Despite these limitations, the study, which investigates the impact of an online professional development (PD) focused on the 'Coding as Another Language' (CAL) curriculum on K-3 teachers' beliefs regarding the integration of virtues in early CS education, provides valuable insights into how a character-driven and virtue-ethics pedagogy can be integrated into the teaching of technical subjects. It serves as a foundation for future research and pedagogical innovation. The present study explores the perceptions of 73 early childhood teachers regarding embedding virtues into CS education, following their participation in the CAL asynchronous PD course. Open-ended questions and structured surveys, before, during and after the intervention were completed by teachers, as well as the Coding Stages Assessment (CSA) to evaluate their learning of coding skills.

By continuing to explore and refine these approaches, educators can better equip students with the tools they need to thrive academically, emotionally, and socially, preparing them for success in an interconnected, technologically advanced world.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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