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MODEL FOR PEDAGOGICAL-DIGITAL COMPETENCE DEVELOPMENT IN E-LEARNING

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ABSTRACT

In this study requirements and preferences of educators regarding the implementation of technology-enhanced learning approaches were determined. Learning materials were developed, and instructional formats were selected based on the gathered insights. Participants then took part in an online course and were required to participate in synchronous meetings, engage in self-directed learning tailored to their individualized learning objectives and utilizing provided support materials, collaborate within learning support groups, and apply acquired knowledge and skills in practical contexts with their students or colleagues over a span of up to two consecutive years. The developed online course underwent evaluation with 1347 educators across four distinct cohorts, each consisting of 173–501 educators, with minor adjustments made for subsequent cohorts. Data on participant learning experiences was collected through evaluation forms, learning reflection exercises, and participant contributions within a customized virtual learning environment. The effectiveness of the e-learning components was assessed based on participant feedback and the extent to which acquired knowledge and skills were implemented in practice. Leveraging the accumulated data a model for organizing e-learning to enhance educator pedagogical-digital competence in an online setting is proposed.

Keywords: *pedagogical-digital competence, model for e-learning, professional development online, competence development online, practice-based learning online, collaborative learning online, experiential learning online.*

Introduction

E-learning has surged in popularity worldwide, offering learners advantages, such as flexibility, affordability, and a wide range of learning content options (Hurley, 2023; OECD, 2020; Panigrahi et al., 2018). The flexibility of e-learning enables learners to study at their own time, pace and place, making it particularly appealing for adult learners with busy schedules (Aragon, 2010; Chen et al., 2020; Diep et al., 2021; Okojie et al., 2017). Various formats, including synchronous, asynchronous, and blended learning, cater to different learning preferences and needs. Synchronous learning fosters real-time interaction and collaboration, while asynchronous learning offers flexibility and self-paced

study options (Anastasiades, 2005; Hrastinski, 2008; Nor & Karim, 2013; Varkey et al., 2022). The blended learning approach integrates asynchronous online content delivery with face-to-face or virtual synchronous sessions, fostering active engagement and potentially enhancing the practical application of learned content (Diep et al., 2021; Lou et al., 2012; Nouby & Alkhazali, 2017). Furthermore e-learning activities allow participants to experience technology-enhanced learning (TEL) firsthand during their own learning process. This has beneficial implications for educators, as it has the potential to enhance the implementation of TEL in their work. And is especially important because educators recognize the shortage of practical examples as one of the main challenges in qualitative TEL implementation in their lessons (Falloon, 2020; Instefjord & Munthe, 2017; Røkenes & Krumsvik, 2014; Štemberger & Konrad, 2021). Furthermore a practice-based learning approach, coupled with the opportunity to engage with a supportive learning community, offers even more opportunities for developing, sharing and improving TEL practices across various educator groups. This is critically important, considering the rapid development of digital technologies that are continuously opening up new avenues for organizing e-learning and TEL in innovative ways (Maddix, 2010; Rubene, Daniela, Sarva, et al., 2021, Secore, 2017; Swan, 2002).

Despite its benefits, e-learning poses challenges, such as the need for self-motivation, limited social interaction, and potential digital literacy barriers. Strategies to address these challenges such as fostering supportive online communities, providing personalized support, and enhancing digital literacy skills can help mitigate some of these risks (Bonde et al., 2014; Dhawan, 2020; Reimers & Schleicher, 2020). These approaches were also integrated and tested in the e-learning course during this research.

In today's digital era, the development of digital competence is paramount for adults, with a particular focus on educators who play a crucial role in shaping the next generation's learning experiences. As technology continues to advance, educators must possess the necessary skills to effectively integrate digital tools and resources into their teaching practices. Additionally, educators should also facilitate the development of these skills in their students (From, 2017; Ghomi & Redecker, 2019; Krumsvik, 2014; Mishra & Koehler, 2007). The e-learning format can therefore be advantageous due to its integration with technology for learning purposes. This research aims to bridge the gap between theory and practice by developing an online course tailored for educators to improve their pedagogical digital competence (PDC). Through a participatory action research design, e-learning approaches will be refined to meet the specific needs of participants. The overarching goal is to conceptualize the experience of educators during this online course by exploring different e-learning approaches while simultaneously developing educators' PDC and creating a functional model for organizing educator PDC development online.

Methodology

The research was part of a up to two year online professional development course by the National Centre for Education, Republic of Latvia, within the "School 2030" project.

Educators of various experience, all subject fields and student age groups, who were willing to become technology mentors for other educators, took part in the course. Over 60% of course participants had more than 10 years of work experience in the field, while educators with 2 years or less comprised approximately 5% of the group. The majority of participants, about 20%, were from the technology field, followed closely by those from languages, mathematics, and natural sciences, each representing around 15% of participants. Social and civic education, along with culture and self-expression educators accounted for approximately 10% of participants, while health and physical education educators comprised about 5% of the group. Most educators came from primary and secondary schools, each representing about 25% of participants, followed by preschool at 20%. High school educators made up 15%, with the remaining participants working in vocational, higher, further, or special education, or leading after-school programs. Overall 1347 participants who were divided into four learning cohorts and 57 learning groups took part in the course. The course consisted of 22 modules, of which five are analyzed in this research. Throughout the course, both quantitative and qualitative data was collected to assess the quality, utility, and effectiveness of the offered course content and format. Participants provided feedback through surveys after each module, as well as regular surveys on collaboration in learning support groups and their learning progress. Additionally, participants submitted individual tasks reflecting on the use of DSs (digital solutions) in their practice. Summarized data was shared with participants, instructors, and organizers. Participants' professional needs were reassessed at the course's end, along with reflections on the course and a proposed model for online professional development. Continuous literature analysis informed course improvement, content creation, and data interpretation (Figure 1).

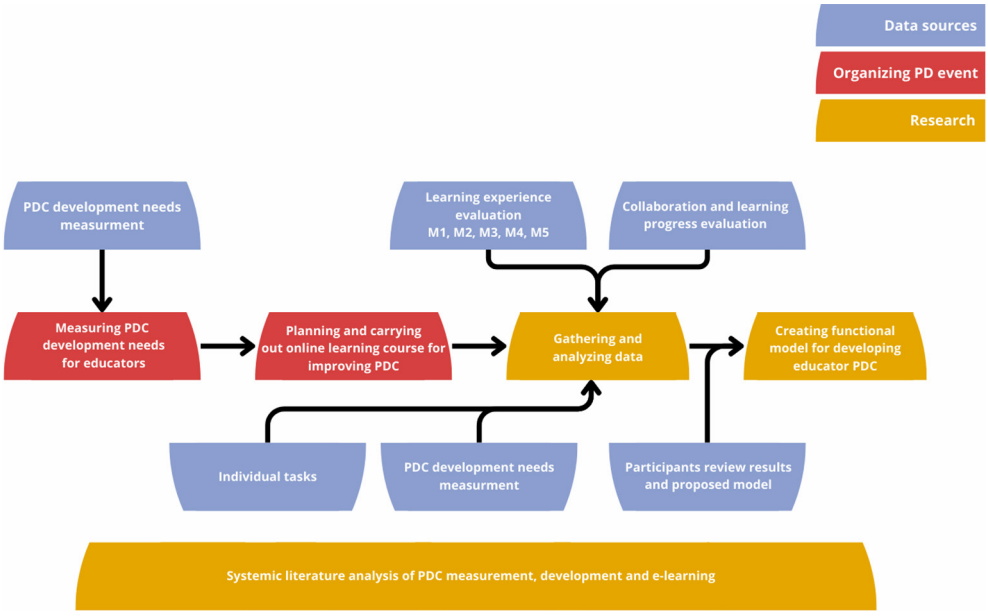

Figure 1 Research design

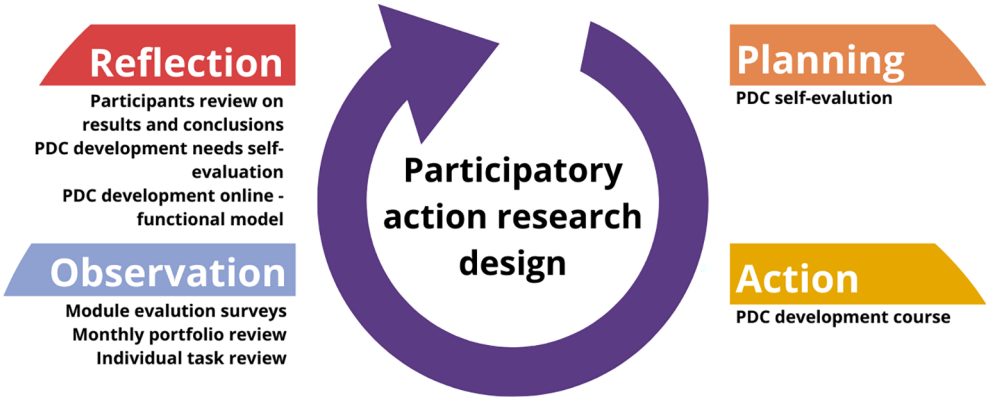

Figure 2 Elements of participatory action research design in this research

The research employed a Participatory Action Research (PAR) design, a flexible and adaptable approach suitable for various settings, including education, healthcare, community development, and organizational change (Arcaya et al., 2018; Berger & Peerson, 2009; Cahill et al., 2010; De Oliveira, 2023; McIntyre, 2007). This encompassed planning and executing an online course aligned with participant professional development priorities as well as evaluating participants' learning experiences, perceptions of course format, content, and organization during and after the course. This research incorporates all elements of the PAR cycle (Figure 2).

The same tool was used at the beginning and end of the course to measure PDC development needs (Sarva et al., 2022). Participants determined their Technology-Enhanced Learning (TEL) priorities at the start and selected learning goals accordingly. After each module, participants updated their portfolios, summarizing progress, adding practice examples, reflecting on collaboration in learning groups, tracking overall progress, and sharing their accomplishments and challenges. In the semi-structured survey, participants were required to disclose their name (used to track individual success), learning group, and evaluate the success of collaboration in their learning groups using a Likert scale from 1 to 5, where one represents "very bad" and five "very good". They also evaluated progress towards their learning goals on a Likert scale from 1 to 5, where one represents "very bad" and five "very good". Additionally, they shared their main successes and challenges during the learning period in an open-ended question. Another open-ended question was provided for any additional comments (Appendix A).

For the learning modules regular evaluations involved a semi-structured survey focusing on content, structure, and the quality of support during the learning experience. Participants were asked to express their opinions using a descriptive Likert scale with six levels ranging from "definitely no" to "definitely yes." Surveys also included optional open ended response fields to share any additional comments or explanations. This research analyzes five learning modules, referred to as M1, M2, M3, M4, and M5 in the sequence they occurred during the course. For M2 and M4 which were composed of

several submodules, surveys were branched to allow evaluation of the offered submodules separately (Appendix A).

The last module (M5) provided a summary of participants' reflections on their learning experiences, along with the proposed and explained functional model for online PDC development based on the course structure. It included a summary of participants' PDC development needs and a comparison of changes over time. The summary also detailed the course structure, including the number of participants in each cohort, topics of learning modules, number of learning content authors, group instructors, and the probable number of participants expected to successfully complete the course according to actual data. Additionally, the summary included participants' evaluations of collaboration in groups, self-assessment of reaching planned learning goals, main challenges, and successes. Summaries of four module evaluation surveys, the most popular DSs, and analysis for M2 submodule participants' reasoning for choosing DSs were provided, along with conclusions on each data set. Participants were asked to reflect on this information using a semi-structured survey, evaluating 13 statements about their experience during the online course using a Likert scale of seven levels (from "definitely yes" to "definitely no", including the option "can not evaluate"). They also compared learning formats – synchronous, asynchronous, and experience exchange events – ranking their preferences and noting their main challenges and successes during the course (Appendix A).

The course was created using principles and approaches drawn from scientific literature analysis, which have been shown to be effective for adult e-learning. These principles and approaches were applied and assessed through participant-shared experiences and work during the online course. To evaluate the e-learning course Kirkpatrick's Four-Level Model, developed by Donald Kirkpatrick, was used. This model is widely recognized for evaluating the effectiveness of learning programs (Kirkpatrick & Kirkpatrick, 2006; Rodriguez et al., 2009). Although originally designed for evaluating traditional face-to-face training, it can be applied to e-learning environments (Galloway, 2005; Hamtini, 2008; Kusumaningrum et al., 2018; Rodriguez et al., 2009). The four levels of Kirkpatrick's model are: (1) Reaction, (2) Learning, (3) Behavior, and (4) Results. To triangulate the results of the research each of these levels was evaluated through multiple data sets (Table 1).

Table 1 Data collection procedure relation to Kirkpatricks' model levels

Data collection procedure	**Level of Kirkpatricks' four stage model – (1) reaction, (2) learning, (3) behaviour, and (4) results**
PDC development needs self-assessment	2, 4
Module evaluation surveys (M1-M5)	1, 2, 3
Portfolio review, learning success and group collaboration evaluation	1, 2
Participant individual tasks for implementing DSs in their practice	2, 3, 4
Participant review on results and conclusions	1, 2, 4

Mainly quantitative methods were employed for data analysis. A self-assessment tool gathered participants' PDC development needs using closed questions and a Likert scale. Learning module evaluation surveys collected feedback through closed questions and a descriptive Likert scale. Surveys for participant portfolios included closed questions using a numeric Likert scale for collaboration and personal development goals. Qualitative data was collected through open-ended questions in surveys, portfolio evaluations, and analysis of practical work. A combination of qualitative and quantitative data was used to analyze 13 e-learning model components. Quantitative data was analyzed using Google Spreadsheets, SPSS, and R, while qualitative data was analyzed using NVivo and, in some cases, a double-blind approach with categorization.

The research adhered to GDPR regulations. Participants were informed that the data collected during the online course might be used for research purposes. Written permission was obtained from the e-learning course organizers. Additionally, the research methodology was approved by the Ethics Committee of the University of Latvia (Riga, 08.03.2023, No. 71-46/55).

Results

At the course's outset, PDC development priorities were set to tailor content to participant needs, and at its conclusion, to assess any shifts in these priorities. A total of 1202 participants completed a self-assessment before the course, with 610 doing so afterward. The PDC development priorities tool comprised 38 TEL statements, assessing their importance and implementation in participants' practice. The PDC Development Priority Index (PDCDPI) was calculated for each statement by subtracting the sum of high self-assessment instances (c = completely; e = enough) from the sum of high perceived importance instances (v = very important; i = important), using the formula: PDCDPI = $(v + i) - (c + e)$. Since sample sizes varied, all PDCDPI values were converted to percentages. To clarify, if all participants deemed a TEL statement important or very important but felt they didn't implement it in practice enough, the PDCDPI value would be 100%. Conversely, if all participants felt they implemented a TEL statement completely or enough, the value would be 0%. Negative values suggest no need for PDC development – participants' self-assessment of implementation exceeds perceived usefulness. The percentage calculation formula is: PDCDPI (%) = $(v + i) - (c + e)$ / respondent count × 100.

The results indicate a significant decrease in participant PDCDPI (%) for all TEL statements, confirmed by a Two-tailed T-test ($p < .01$). However, the perceived importance of TEL statements remained unchanged ($p > .05$), suggesting that the shifts are due to participants' increased self-assessment of TEL implementation in practice. Participants still recognize the importance of these TEL statements for organizing learning but have shown improved implementation. Consequently, the urgency for professional development in this area has diminished. Table 2 shows a notable decrease in the need for professional development in digital threat prevention systems, formative feedback

provision, and support for students with special needs by the course's end, indicating enhanced clarity among participants in these TEL elements. Additionally, participants have improved self-assessments regarding productivity enhancement, collaborative learning, digital reputation, and student-led learning. However, minimal changes were observed in areas such as peer-assessment facilitation, sharing student work, providing additional support for students who require it, getting to know students, and individual student communication. These TEL aspects align with the DIGCOMPEDU domain of empowering learners, highlighting the shift towards student-centered learning. Such changes necessitate adjustments not only in TEL implementation but also in teaching methodology and attitude, which were not the primary focus of this online course.

Table 2 PDCDPI (%) in the beginning of the course (n = 1202) and the end of the course (n = 610) in descending order according to PDCDPI (%) changes

	Beginning of the course	End of the course	PDCDPI (%) changes
System for digital threat prevention	51	30	–21
Digital solutions to provide feedback	36	16	–21
Students with special needs use digital technologies	45	25	–20
Digital solutions for formative assessment	36	16	–20
Digital solutions for increasing productivity	26	7	–19
Learning support pairs/groups	34	15	–19
A positive digital reputation	40	21	–19
Students plan, observe and evaluate their own learning	49	30	–19
Learning platform	30	11	–19
Data protection conditions	44	26	–18
Use online information resources and media for learning	36	18	–18
Receive support that helps using digital solutions	39	21	–18
Appropriate equipment	40	22	–17
Copyright	43	26	–17
Learning in groups using digital solutions	31	14	–17
Training to develop pedagogical-digital competence	25	7	–17
Creation of a variety of digital content	32	16	–17
Solve problem situations related to the use of technology	34	18	–16
Consider student technical abilities and resources	34	18	–16
Suitable environment	44	28	–16
Student interests	29	15	–15

Table 2 continued

	Beginning of the course	End of the course	PDCDPI (%) changes
Evaluation and improvement of the learning process	33	18	–14
Learning pace	31	17	–14
Healthy habits when working with digital solutions	30	15	–14
Experience exchange activities	30	16	–14
Digital solutions for summative assessment	30	16	–14
Virtual communication procedure	34	20	–14
Environmentally responsible use of digital technologies	32	19	–13
School management platform	16	4	–12
Independently master new digital solutions	27	15	–12
Communication platform	11	0	–12
Anticipate technological challenges and plan solutions	36	24	–12
In-depth learning for students who are ready for it	31	21	–11
Students conduct peer assessment	26	16	–10
Students share their work	25	15	–10
Additional support measures for students who require them	29	19	–10
Get to know students	26	17	–10
Individual communication	26	18	–8

To assess each of the selected 13 components (C1-C13) in the proposed model, various data sets collected through different methods during the online course were used. A threshold of 50% positive or very positive responses ("definitely yes" or "yes") was established to approve each of the 13 components (Table 3).

Data for implementing C1 was collected through PDC development needs self-assessment at the course's outset and utilized for course planning. A follow-up measurement at the course's end demonstrated statistically significant improvements in all tested statements. Module evaluation surveys (M1-M5) assessed the usefulness of the learning experience for professional development, with positive responses exceeding 50% for all modules and increasing over time (M2 > 75%, M3 > 85%, M4 > 70%, M5 > 70%). Participants' portfolios reflected on progress towards learning goals, with the top two positive responses exceeding 60%. Regular data collection throughout the course (n = 8636) ensured consistency. With over 50% positive responses and alignment with Kirkpatrick's model levels one to four, C1 is validated.

Similar to C1 in C2, portfolio reviews gauge participants' progress towards learning goals, with over 60% positive responses. Main successes include learning new DSs and organizing learning events, while challenges may arise in completing course tasks. Furthermore in the participants' review of course results and conclusions, over 75% expressed success in using DSs for learning and work. With over 60% positive portfolio review responses and alignment with Kirkpatrick's model levels one, two, and four, C2 is validated.

C3 involves determining participants' initial PDC development needs. The PDC Development Priorities Index (PDCDPI) was created to gauge the PDC development needs. Learning content and course structure were determined based on PDCDPI. Module evaluation surveys (M1-M5) assessed the adjustment of the learning experience to participant needs, with over 50% positive responses. Portfolio reviews reflected the course's capacity to meet individual needs, with over 60% positive responses. In the review of results and conclusions, over 60% positive responses signified the course's ability to address participant needs. With over 50% positive module survey responses, over 60% positive portfolio review responses, and alignment with Kirkpatrick's model levels one to four, C3 is validated.

Component four (C4) represents self-assessment, peer-evaluation and instructor feedback during learning. At this point participants have taken an active role in learning. And though analysis is still in process and the course design is adjusted, main components are already in place and functioning. For C4 portfolio reviews provide 60% or more positive responses for statements related to self-assessment and peer-evaluation and 95% or more positive responses for instructor feedback noting that it is especially highly valued. This is reinforced with 55% positive or very positive responses from participant review on results and conclusions. According to Kirkpatricks' model 1–4 level, C4 can be considered validated.

In C5 participants autonomously adjust their professional development goals throughout the course to meet their evolving needs, either setting new goals or modifying existing ones to maintain motivation and adaptability. Portfolio reviews indicate over 60% positive responses, reflecting participants' progress towards their chosen learning goals. Participant self-assessments demonstrate over 60% positive responses for statements related to goal-setting and progression. Additionally, participant reviews of results and conclusions show over 55% positive responses for statements concerning goal-setting and its impact on learning. C5 can be considered validated according to Kirkpatrick's model levels one, two, and four.

Components six through eight (C6, C7, C8) involve learning activities such as searching for and evaluating DSs, planning their use, and practising learned content. With support from instructors, learning groups, and course materials, participants explore, evaluate, and apply DSs in their educational settings, sharing experiences and seeking assistance as needed. Module surveys (M1-M5) evaluate these components, with statements like "I successfully used DSs for online collaboration" (M1) receiving over 60% positive responses. Similarly, statements like "Gained new ideas in the subject matter that

I want to apply in practice" (M2-M4) and "the course content was qualitative" and "the course format was appropriate" (M1-M5) garnered positive responses above 60% and 65–70% respectively. The usefulness of the learning experience for professional development, assessed through these components, received over 70% positive responses. Portfolio reviews and individual tasks provide additional insights into participant experiences and DSs usage. Participant responses on course review and conclusions further validate these components, with over 70% positive responses indicating practical application of DSs and future plans to implement similar approaches to those experienced during the online course in their practice. Overall, C6-C8 are validated according to Kirkpatrick's model levels one to four.

C9, C10 focus on compiling, evaluating, and sharing learning experiences. In M1, participants formed learning support groups, with over 70% reporting successful collaboration with chosen partners. Additionally, over 65% agreed on cooperation within the support groups. M2 included an evaluation survey item related to presenting good practice examples, receiving over 75% positive responses. Sharing experiences also occurs through individual tasks, with participants utilizing a variety of DSs in practice. Participant reflections in the review of results and conclusions revealed active involvement in support groups and collaborative learning, with over 55% noting the benefits of group collaboration. Furthermore over 70% participants reported using DSs with colleagues or students, and over 75% found practical DSs application beneficial for learning. Additionally, over 75% of participants shared their practice examples and more than 70% of them noted that colleague shared practice examples were beneficial for their professional development. According to Kirkpatrick's model levels one to four, C9 and C10 can be considered validated.

Components 11–13 delineate the course structure, encompassing multimedia tools (C11), the learning management system (C12), and learning analytics system (C13). Module surveys (M1-M5) included a statement on the appropriateness of the course format, with positive responses exceeding 70%, 75%, 85%, 75%, and 75%, respectively. In the review of results and conclusions, over 75% of participants credited practical DSs application for their learning. Moreover, over 75% appreciated the content and activity choices available, reflecting positively on C11. Additionally, over 65% expressed satisfaction with the course format, and 50% planned to employ a similar approach in their work, indicating validation of C11-C13 across Kirkpatrick's model levels one to four.

In the review of results and conclusions, participants provided feedback on their overall course experience. Over 75% expressed appreciation for the choice offered in both format and activities, while over 65% expressed overall satisfaction with this learning approach. Additionally, 50% indicated plans to adopt a similar approach for organizing learning with their students or colleagues. Based on the validation results of components C1-C13 and Kirkpatrick's models 1–4, the functional model (Figure 3) is deemed valid for online PDC development (Table 3).

Table 3 Information on the validation of the functional model during a participatory action research carried out in an online course, model component numbering is used in the table Figure 3

Model component	When it was approbated (B – before the course, D – during the course, A – after the course)	How it was approbated and the average proportion of very positive ("definitely yes") or positive ("yes") feedback in percent where applicable, not applicable (n/a) if not	Validated / Not validated
1	BDA	PDC development needs self evaluation (n/a) Module evaluation surveys (M1-M5) (50% or above) Portfolio review (60%)	Validated
2	BDA	PDC development needs self evaluation (n/a) Portfolio review (60%) Participant review on results and conclusions (70% or above)	Validated
3	BDA	PDC development needs self evaluation (n/a) Module evaluation surveys (M1-M5) (50% or above) Portfolio review (60%) Participant review on results and conclusions (60% or above)	Validated
4	BDA	Portfolio review (60% or above for self and peer-evaluation and 95% or above for instructor work) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (55% or above)	Validated
5	D	Portfolio review (60% or above) Module evaluation surveys (M1, M2, M4) (60% or above) Participant review on results and conclusions (55% or above)	Validated
6	D	Module evaluation surveys (M1-M5) (50% or above) Portfolio review (60%) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (50% or above)	Validated
7	D	Module evaluation surveys (M1-M5) (50% or above) Portfolio review (60%) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (50% or above)	Validated
8	D	Module evaluation surveys (M2-M5) (60% or above) Portfolio review (60%) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (50% or above)	Validated
9	D	Module evaluation surveys (M1, M3) (65% or above) Portfolio review (60%) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (55% or above)	Validated

Table 3 continued

Model component	When it was approbated (B – before the course, D – during the course, A – after the course)	How it was approbated and the average proportion of very positive ("definitely yes") or positive ("yes") feedback in percent where applicable, not applicable (n/a) if not	Validated / Not validated
10	D	Module evaluation surveys (M1, M3) (65% or above) Portfolio review (60%) Individual tasks for implementing DSs in practice (n/a) Participant review on results and conclusions (55% or above)	Validated
11	D	Module evaluation surveys (M1-M5) (65% or above) Participant review on results and conclusions (50% or above)	Validated
12	D	Module evaluation surveys (M1-M5) (65% or above) Participant review on results and conclusions (50% or above)	Validated
13	BDA	Module evaluation surveys (M1-M5) (65% or above) Participant review on results and conclusions (50% or above)	Validated
Whole model	A	Participant review on results and conclusions (50% or above)	Validated

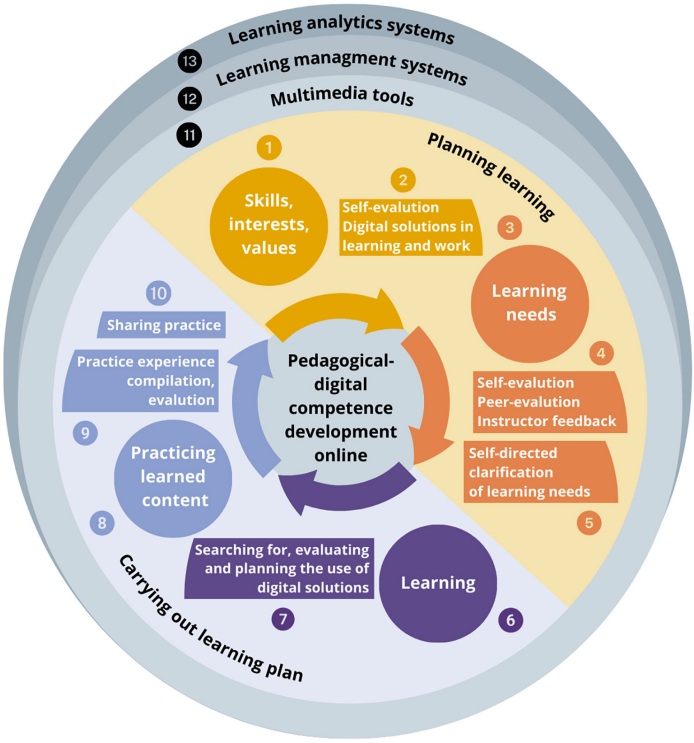

Figure 3 Functional model for organising PDC development online with 13 model elements referenced

Table 4 Course completion rate and average academical hours granted to participants compared between the four learning cohorts

Cohort	Participant count who took part in the course	Participant count who completed the course		Completion rate, %	Average academic hours granted, %
1.	501	431		86	50
2.	290	176		61	53
3.	383	206		54	51
4.	173	118		68	57
In total	**1347**	**931**	**Average**	**69**	**53**

The objective of this study was to translate the findings of the research into a practical model for structuring e-learning courses aimed at enhancing educator PDC. Over a two-year period, an e-learning course was conducted to achieve this objective. Elements of the proposed model were embedded into the course experience and continuously assessed to evaluate their effectiveness. Course activities were tailored and improved based on feedback from participants and group coordinators, as well as other gathered data. Any modifications or new elements introduced during the course were also incorporated into refining the functional model (Figure 3). In the final module of the course, the latest version of the model was presented to participants, and their feedback on its elements was collected to inform further enhancements.

Out of 1574 applicants for the course, 227 did not start or left it prematurely. Among those who left, 103 cited various reasons such as time constraints, job changes, or dissatisfaction with the course. This yields an overall retention rate of approximately 85%. Of the 1347 participants who completed the course, 931 received certificates, representing around 60% of the total applicants and 70% of the course participants. Completion rates varied across cohorts, with the highest (86%) in the first cohort and the second highest (68%) in the last cohort (Table 4). This discrepancy may be due to differing levels of motivation or support from instructors. Interestingly, while the completion rate was highest in the first cohort, participants from the last cohort contributed more hours on average to course assignments. This suggests a need for further investigation into the optimal course duration and intensity. However, qualitative research is necessary to fully understand the underlying factors behind these differences.

Conclusions

Educators' pedagogical-digital competence development needs were measured before and after taking part in an online course. Initial assessment highlighted pressing needs such as establishing digital threat prevention systems, fostering self-directed learning among students, and integrating digital technologies for students with special needs amongst others. This information was used to design an online professional development course that participants were enrolled in. Evaluation after taking the online course

demonstrated a notable decrease in professional development needs across all 38 measured aspects, indicating the course's positive impact on participants' competence. Particularly significant was the reduction in pedagogical-digital competence development requirements aligned with the participants' initial priorities, showcasing the course's targeted approach to addressing participant key needs.

Various data sets collected during the online course were used to evaluate each of the selected 13 components of the online course, with a threshold of 50% positive or very positive responses set for approval. Each of the 13 components were validated through two to four data sets collected through: (1) PDC development needs self evaluation; (2) Module evaluation surveys (M1-M5); (3) Portfolio review; (4) Individual tasks for implementing DSs in practice; (5) Participant review on results and conclusions. Taking in consideration the validation results a functional model was developed. Moreover, participants had the chance to provide feedback on the proposed model and its components during the course's conclusion. The high satisfaction levels reported by participants in all five data collection formats, coupled with evidence of applying learned content in practice, and high course retention and completion rate validate the effectiveness of the functional model employed. Given the broad scope of the research, which includes educators from diverse fields and with varying levels of experience as well as working with students of all age groups, it is reasonable to conclude that this learning model could be applied to the professional development needs of educators across all fields. However, further research focused on specific education fields, student age groups, and educator experiences could identify opportunities for customization, potentially enhancing participants' learning experiences and outcomes by tailoring the structure to their specific contexts.

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APPENDICES

Appendix A Digital tools used for evaluation during the course

Nr.	Name of the tool	Full version in PDF format (authors translation – English)	Full version in PDF format (original language – Latvian)	Interactive online version (original language – Latvian)
1.	PDC development needs self-assessment	https://drive.google.com/file/d/163C-8TYc44KubwP3R-2WZTP3sY7u6jB4XJ/view?usp=drive_link	https://drive.google.com/file/d/1YZZGHX-WOYLjmTKZ8ZSO-eV9KxuX5FOk4Z/view?usp=sharing	https://forms.gle/w3pukwzyFzhK6PMg9
2.	Module 1 evaluation survey	https://drive.google.com/file/d/1FJox-j5FAeb9GFC-qk86hz2qc4Hl3m5ZIu/view?usp=sharing	https://drive.google.com/file/d/1O_lFMT-dZZmZ8vrNRt-kTS_bqsQHP5EXXT/view?usp=sharing	https://forms.gle/oWEmgVAe7L36g5zJA
3.	Module 2 evaluation survey	https://drive.google.com/file/d/1FJox-j5FAeb9GFC-qk86hz2qc4Hl3m5ZIu/view?usp=drive_link	https://drive.google.com/file/d/1Bg-Ke3AZnt9ZMm8_TYWOPZTfvEV0Aavn9/view?usp=sharing	https://forms.gle/JAKeuk5CqChKp2ab8
4.	Module 3 evaluation survey	https://drive.google.com/file/d/1fB-8ju4R_Hyf-yIKdL-JDRnHxtWZVw5VOJ/view?usp=sharing	https://drive.google.com/file/d/1O_lFMT-dZZmZ8vrNRt-kTS_bqsQHP5EXXT/view?usp=drive_link	https://forms.gle/7fLYZkhEnEw6xesL9
5.	Module 4 evaluation survey	https://drive.google.com/file/d/1m-mUyLzIM_eks7i13M-WvdMQjpL_U2X4xX/view?usp=sharing	https://drive.google.com/file/d/12SrX-qaFPwoiWQgaR-8SUAXMTcY58rzNkh/view?usp=drive_link	https://forms.gle/xgAToT6Ns2fkX1ao7
6.	Module 5 evaluation survey	https://drive.google.com/file/d/161G2E-b0O4IScPT1aqyN-ZLYrT-VqFRn2X/view?usp=drive_link	https://drive.google.com/file/d/1wr1P-STzy1PxDTEB82W-bgIwDje1-pcxtr/view?usp=sharing	https://forms.gle/Z24wAxFBfTLDNBwP6
7.	Portfolio review, learning success and group collaboration evaluation survey	https://drive.google.com/file/d/1E0Hm-9kc3pKOGtwUkdYM-bQCDTBQMHTl_G/view?usp=sharing	https://drive.google.com/file/d/1Ld-30Fx21a9Tac90Wy-HIkZYhoM3ms-KI3/view?usp=sharing	https://forms.gle/UVaU6GvS11iGsDpn8
8.	Participant review on results and conclusions survey	https://drive.google.com/file/d/1hS-Myc271NeGjYfo-bYvUPnKJ70Ptm--O0/view?usp=sharing	https://drive.google.com/file/d/18x-Sw3M5YkCMsPMXwVw-cwQ7h4nkkvmu6b/view?usp=sharing	https://forms.gle/Xi3NKyMVtfr3viy1A