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ICT Utilisation and 21st-Century Competencies in Pre-Service Teacher Education: Communication, Collaboration, Creativity, and Critical Thinking.

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Abstract

Pre-service teachers now use information and communication technology (ICT) throughout their training. They plan lessons and keep e-portfolios with it, and much of their mentoring and microteaching now happens online. It is less clear whether this everyday use builds the competencies they will need as teachers. This study examines the relationship between ICT utilisation and the four twenty-first-century competencies known as the 4Cs (communication, collaboration, creativity, and critical thinking) among students on a Bachelor of Education programme. It uses a descriptive-correlational design. ICT utilisation is measured on two dimensions, learning activities and perceived impact, and each competency is measured by self-report. Pearson product-moment correlation is used to test how the two sets of scores are related. Findings indicate that pre-service teachers use ICT to a great extent. Their 4Cs scores fall, on average, in the Developed band and below Highly Developed. Collaboration is the strongest domain, and creativity is the one that needs the most support. Both ICT dimensions show weak to moderate, statistically significant positive correlations with all four competencies, and perceived impact is more closely related to creativity than routine use is. Access to ICT appears to matter less than the way teachers use it in their teaching. The paper ends with implications for teacher education curricula and ICT-integrated pedagogy courses, and with suggestions for further research.

Keywords: ICT utilisation, 21st-century skills, 4Cs, pre-service teachers, teacher education, digital literacy

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1. Introduction

Teacher education programmes have two aims that are often assumed to go together. One is to produce graduates who are comfortable teaching with technology. The other is to produce graduates who can communicate, collaborate, think creatively, and reason critically in a classroom, whatever tools are available. The usual assumption is that a student teacher who spends more time on a learning management system or building digital teaching aids will, as a side effect, become a better communicator and a sharper critical thinker. This study puts that assumption to the test.

The four competencies examined here are widely called the 4Cs. The Partnership for 21st Century Learning (2015) popularised the term to describe the learning and innovation skills that students need for work and for life as citizens. The framework has since been applied to teachers themselves, on the grounds that educators cannot develop competencies in learners that they never developed during their own preparation (Thornhill-Miller et al., 2023). For pre-service teachers the 4Cs matter in two ways. They are professional competencies in their own right, and they are capacities these teachers will later have to model and teach.

In a meta-analysis of pre-service programmes, Kausar and Ajmal (2024) found that these programmes generally pass on theoretical content but leave a gap between that content and its use in practice. The gap was widest in creativity and collaborative learning, and reflective and critical thinking were also weak. Duangngern et al. (2023) studied teacher trainees' readiness to promote critical and creative thinking in technology-heavy "next normal" classrooms. Many of the trainees were underprepared in exactly these two areas, even though they used digital devices often. Teacher educators are left with a direct question. Is frequent ICT use associated with stronger 4Cs competencies among pre-service teachers, or has digital access outpaced the teaching skills needed to turn it into competence?

The present study examines (a) how far pre-service teachers use ICT, looking at routine use in learning activities and at its perceived impact on their learning; (b) their levels of communication, collaboration, creativity and critical thinking; and (c) whether ICT utilisation is significantly related to each of the four competencies. The results are meant to inform the design of ICT-integration courses and practicum placements in teacher education curricula.

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2. Review of related literature

2.1 ICT utilisation in teacher preparation

Pre-service teachers' ICT use now goes well past word processing and search engines. They submit coursework through learning management platforms and prepare lessons with open educational resources. Many also practise through video microteaching or simulations, and keep e-portfolios of their field experience (Zhang et al., 2026). Zhang et al. (2026) reviewed digital competence research published between 2014 and 2024. Access to digital tools among pre-service teachers was nearly universal, but gaps remained in complex technical operations and in translating digital fluency into effective teaching. Frequency of use and pedagogical competence are related, then, but they are different things. For that reason, this study treats ICT utilisation as two dimensions. The first is the extent of use in day-to-day learning activities. The second is the impact students believe that use has had on their own learning and professional growth.

2.2 The 4Cs framework

The Partnership for 21st Century Learning (2015) named communication, collaboration, creativity and critical thinking as core learning and innovation skills for a knowledge economy. Its framework drew on Trilling and Fadel (2009), who had described critical thinking as expert thinking and creativity as applied imagination. They grouped communication and collaboration together as complex social skills. Thornhill-Miller et al. (2023) treat the four as interdependent. Good communication depends on evaluating the message critically, and effective collaboration depends heavily on how well group members communicate and how far they trust each other. This is why the four competencies are usually studied together, as they are here.

2.3 Communication

For a pre-service teacher, communicating well takes more than fluency. They have to adjust register and delivery to whoever they are addressing, whether a class of learners or a mentor, and use language for teaching purposes such as explaining a concept or motivating a class (Partnership for 21st Century Learning, 2015). Research in South African teacher education found communication more consistently developed than critical thinking or creativity. Pre-service

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teachers were less confident in live, unscripted classroom talk than in prepared, digitally mediated communication (Osiesi & Blignaut, 2025).

2.4 Collaboration

Structured peer tasks, such as co-planning lessons and reviewing each other's teaching materials, have been linked to collaboration skills in pre-service teachers. Priyambodo and Wilujeng (2023) followed Indonesian pre-service teachers over a semester and found that shared goal-setting and rotating team roles, backed by structured peer feedback, measurably improved their collaboration skills. Collaboration is also the most consistently well-developed of the 4Cs in pre-service cohorts, probably because teacher training already relies heavily on group assignments and peer teaching practice (Osiesi & Blignaut, 2025).

2.5 Creativity

Pre-service teachers often name creativity as the competency they feel least prepared to have themselves, let alone teach. Duangngern et al. (2023) found them particularly underprepared to promote creative thinking in technology-mediated classrooms. In Osiesi and Blignaut's (2025) study of curriculum impact, creativity ranked lowest of the 4Cs in pre-service teachers' self-ratings. Kaplan et al. (2025) found a measurable positive effect on creative thinking when digital technology was built into teaching with a clear purpose. For creativity, the way technology is used seems to count for more than the amount of use.

2.6 Critical thinking

In teacher preparation, critical thinking covers judging whether digital resources are credible and reading learner responses so that instruction can be adjusted. It also includes reflecting on one's own teaching decisions. Pre-service teachers now take a lot of lesson content from open online sources that nobody has checked, so the ability to evaluate those sources matters more than it used to (Zhang et al., 2026). As with creativity, pre-service teachers often rate critical thinking among their weaker areas. Their programmes tend to give them more practice in analysing academic texts than in analysing live classroom situations (Duangngern et al., 2023; Osiesi & Blignaut, 2025).

2.7 ICT utilisation and the 4Cs in earlier research

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Earlier research points to a link between ICT use and growth in the 4Cs among pre-service teachers, but the link is modest and cannot be assumed. Youssef et al. (2022) studied students' ICT use and academic performance and found only a weak positive correlation between the extent of ICT use and the development of twenty-first-century skills. The strength of that relationship depended largely on whether students used ICT actively and with a purpose or mostly consumed content passively. The present study draws a similar line between routine use in learning activities and the developmental impact students perceive. It therefore tests each ICT dimension against each of the four competencies separately.

3. Methodology

3.1 Research design

The study uses a descriptive-correlational design. This design suits a study that describes the current state of two variables, ICT utilisation and 4Cs competency, and tests the strength and direction of the relationship between them without manipulating either (Siedlecki, 2020).

3.2 Participants and sampling

The target population is pre-service teachers enrolled in a Bachelor of Education (B.Ed.) programme. Participants are drawn in proportion from each year level and specialisation by stratified random sampling. A minimum sample size calculated with Slovin's formula at the 95% confidence level is recommended (Bobbitt, 2023). The final sample and its demographic profile (year level, specialisation, gender and prior ICT training) will be reported once data collection is complete.

3.3 Instruments

Two instruments are proposed. The first is an ICT Utilization Questionnaire with two dimensions. Learning Activities covers routine, task-based use such as preparing lessons on a computer or submitting work through a learning management system (LMS). Perceived Impact asks the pre-service teacher to judge how ICT use has affected their learning and professional growth. Items are rated on a four-point scale from 1 (Never/Not at all) to 4 (Always/Very great extent). The second is a 4Cs Competency Scale adapted from the Partnership for 21st Century Learning (2015) framework and the assessment work of Thornhill-Miller et al. (2023). It has five indicator items

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for each of the four domains, rated on the same four-point scale from 1 (Not Developed) to 4 (Highly Developed). Both instruments should be pilot-tested for reliability before full administration, with a Cronbach's alpha of .70 or above as the recommended threshold (Saini & Abraham, 2021).

3.4 Data analysis

Means and standard deviations are used to describe the extent of ICT utilisation and the level of each competency. Mean scores are read against four bands: 1.00-1.75 Very Low/Not Developed, 1.76-2.50 Low/Slightly Developed, 2.51-3.25 High/Developed and 3.26-4.00 Very High/Highly Developed (Shokeen & Kaur, 2022). Pearson product-moment correlation tests the relationship between each ICT dimension and each competency. Correlation strength follows Evans' (1996) convention (.00-.19 negligible, .20-.39 weak, .40-.59 moderate, .60-.79 strong, .80-1.00 very strong), and significance is set at $\alpha = .05$ (Nair & P, 2024).

4. Results and Discussion

4.1 Extent of ICT utilisation among pre-service teachers

Table 1 shows the extent to which pre-service teachers use ICT in day-to-day learning activities.

Learning activities	Mean	SD	Interpretation
Uses ICT to prepare lesson plans and instructional materials	3.22	0.52	High Extent
Uses a learning management system (e.g., Google Classroom, Moodle) to submit coursework	3.30	0.48	High Extent
Uses ICT to research pedagogical theories and teaching strategies	3.05	0.55	High Extent
Uses ICT to design multimedia teaching aids	3.15	0.57	High Extent
Uses ICT to complete practicum/field-study documentation	2.98	0.60	High Extent

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Uses ICT to collaborate with peers on lesson planning	3.12	0.54	High Extent
Uses ICT to access open educational resources (OERs)	3.00	0.58	High Extent
Uses ICT to communicate with mentors/cooperating teachers	3.08	0.53	High Extent
Uses ICT outside class hours for professional reading	2.85	0.62	High Extent
Uses ICT to document teaching practice (e-portfolios)	3.25	0.50	High Extent
Overall: learning activities	3.10	0.42	**High Extent**

Table 1. Extent of ICT utilization: learning activities (illustrative data)

Table 2 shows the impact pre-service teachers believe ICT use has had on their learning and professional growth.

Perceived impact	Mean	SD	Interpretation
Helps me understand pedagogical theories more deeply	3.12	0.55	High Extent
Makes it easier to access teaching resources and references	3.20	0.49	High Extent
Motivates me to try new teaching strategies	3.05	0.57	High Extent
Has improved how I communicate with mentors and peers	2.95	0.60	High Extent
Provides opportunities to practice teaching through simulations/microteaching videos	3.10	0.56	High Extent

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Encourages independent professional learning	3.15	0.52	High Extent
Improves my ability to plan and organize lessons	3.08	0.54	High Extent
Makes learning to teach more engaging	3.02	0.58	High Extent
Supports my wellbeing by easing remote access to resources	3.00	0.61	High Extent
Helps me balance online and face-to-face field engagements	2.93	0.63	High Extent
Overall: perceived impact	3.06	0.44	**High Extent**

Table 2. Extent of ICT utilisation: perceived impact (illustrative data)

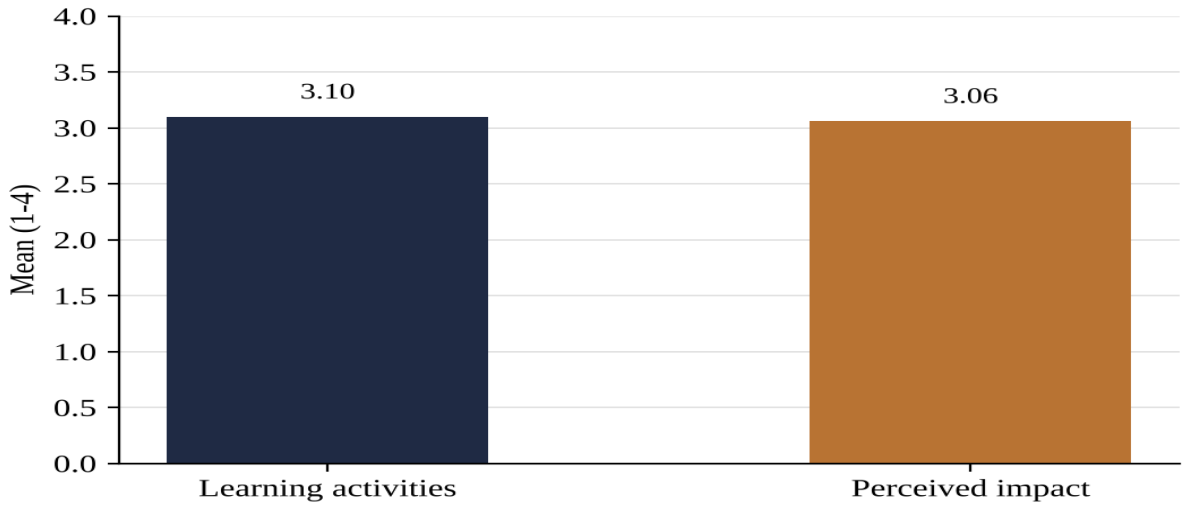


Figure 1. Mean ICT utilisation by dimension (illustrative data)

The figures in Tables 1 and 2 are illustrative, so the discussion here shows how real results would be read. An overall mean in the High Extent band would mean that pre-service teachers bring ICT into most parts of their coursework and field preparation. That would fit earlier findings that digital access among pre-service teachers is now close to universal (Zhang et al., 2026). In the illustrative data, routine use in learning activities (M = 3.10) is a little higher than perceived impact (M =

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3.06). A gap of this kind should be reported, because frequent ICT use does not by itself give students a matching sense that they have learned more. Youssef et al. (2022) found that this sense of benefit comes mainly when the use has a clear purpose.

4.2 Level of 4Cs competencies among pre-service teachers

Tables 3 to 6 show the level of each competency, and Table 7 brings the four domains together.

Communication indicators	Mean	SD	Interpretation
Explains concepts clearly to learners during microteaching/practicum	3.20	0.55	Developed
Feels confident answering questions in front of a class	2.78	0.66	Developed
Uses digital tools (e.g., presentations, video) to communicate ideas effectively	3.15	0.53	Developed
Adapts communication style to different audiences (learners, mentors, parents)	3.05	0.57	Developed
Communicates for varied instructional purposes (explain, instruct, motivate, give feedback)	3.07	0.54	Developed
Overall: communication	3.05	0.46	**Developed**

Table 3. Level of communication competency (illustrative data)

Collaboration indicators	Mean	SD	Interpretation
Works effectively with peers in lesson-planning teams	3.25	0.50	Developed
Sets shared goals and plans collaboratively with fellow trainees	3.20	0.52	Developed
Presents co-developed lesson plans/projects to the class	3.30	0.48	Developed

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Gives and receives constructive feedback from peers	3.02	0.56	Developed
Adapts role within a team depending on the task	3.15	0.51	Developed
Overall: collaboration	3.18	0.44	**Developed**

Table 4. Level of collaboration competency (illustrative data)

Creativity indicators	**Mean**	**SD**	**Interpretation**
Generates original ideas for lesson activities	2.90	0.60	Developed
Designs original teaching aids or materials	2.82	0.63	Developed
Applies imaginative approaches when adapting lessons to learner needs	2.75	0.65	Developed
Thinks of alternative teaching strategies when the first approach does not work	2.65	0.68	Developed
Integrates ICT tools creatively into instructional design	2.83	0.62	Developed
Overall: creativity	2.79	0.51	**Developed**

Table 5. Level of creativity competency (illustrative data)

Critical thinking indicators	**Mean**	**SD**	**Interpretation**
Evaluates the reliability of online teaching resources before use	2.95	0.58	Developed
Analyses learner responses to adjust lesson delivery	2.88	0.60	Developed

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Reflects critically on own teaching practice after each session	3.00	0.55	Developed
Questions assumptions when solving classroom-management problems	2.70	0.66	Developed
Synthesises evidence from research to justify pedagogical choices	2.72	0.64	Developed
Overall: critical thinking	2.85	0.49	**Developed**

Table 6. Level of critical thinking competency (illustrative data)

4Cs domain	Mean	SD	Interpretation
Communication	3.05	0.46	Developed
Collaboration	3.18	0.44	Developed
Creativity	2.79	0.51	Developed
Critical thinking	2.85	0.49	Developed
Overall: 4Cs competency	2.97	0.38	**Developed**

Table 7. Combined level of the 4Cs competencies (illustrative data)

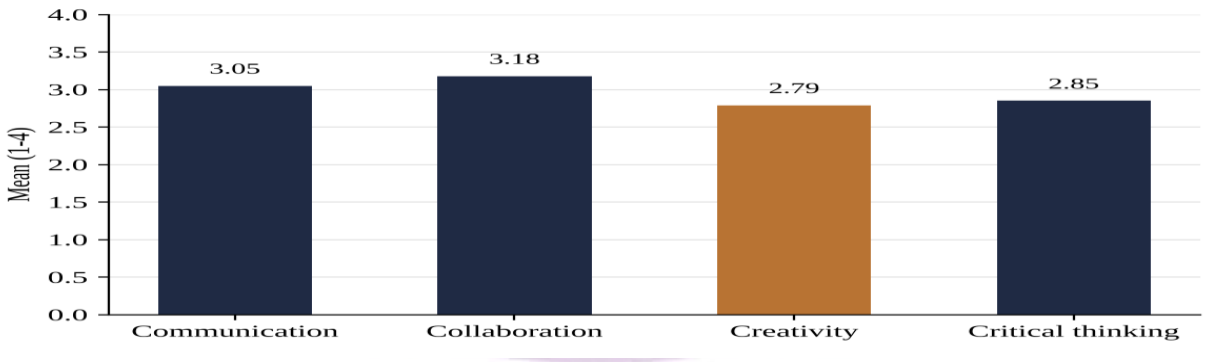


Figure 2. Mean competency level by 4Cs domain (illustrative data)

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In the illustrative data, collaboration is the strongest domain (M = 3.18) and creativity the weakest (M = 2.79). Communication (M = 3.05) and critical thinking (M = 2.85) fall between them, with critical thinking much closer to creativity. Osiesi and Blignaut (2025) report the same ordering: collaboration and communication tend to be the better developed of the 4Cs among pre-service teachers, and creativity is the one most often reported as underdeveloped. One likely reason is that teacher-training coursework builds in structured group tasks far more often than open-ended, ill-structured problems that call for creative or critical work (Duangngern et al., 2023).

4.3 Relationship between ICT utilisation and the 4Cs competencies

Table 8 gives the correlations between the two ICT dimensions and each of the four competencies.

ICT dimension	4Cs domain	r	p	Interpretation
Learning activities	Communication	0.32	0.008	Weak positive, significant
Learning activities	Collaboration	0.41	0.001	Moderate positive, significant
Learning activities	Creativity	0.36	0.004	Weak positive, significant
Learning activities	Critical thinking	0.44	<0.001	Moderate positive, significant
Perceived impact	Communication	0.29	0.014	Weak positive, significant
Perceived impact	Collaboration	0.37	0.003	Weak positive, significant
Perceived impact	Creativity	0.43	<0.001	Moderate positive, significant
Perceived impact	Critical thinking	0.40	0.001	Moderate positive, significant

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Overall ICT utilisation	**Overall 4Cs competency**	0.45	**<0.001**	**Moderate positive, significant**

Table 8. Correlations between ICT utilisation and the 4Cs competencies (illustrative data; strength labels follow Evans, 1996)

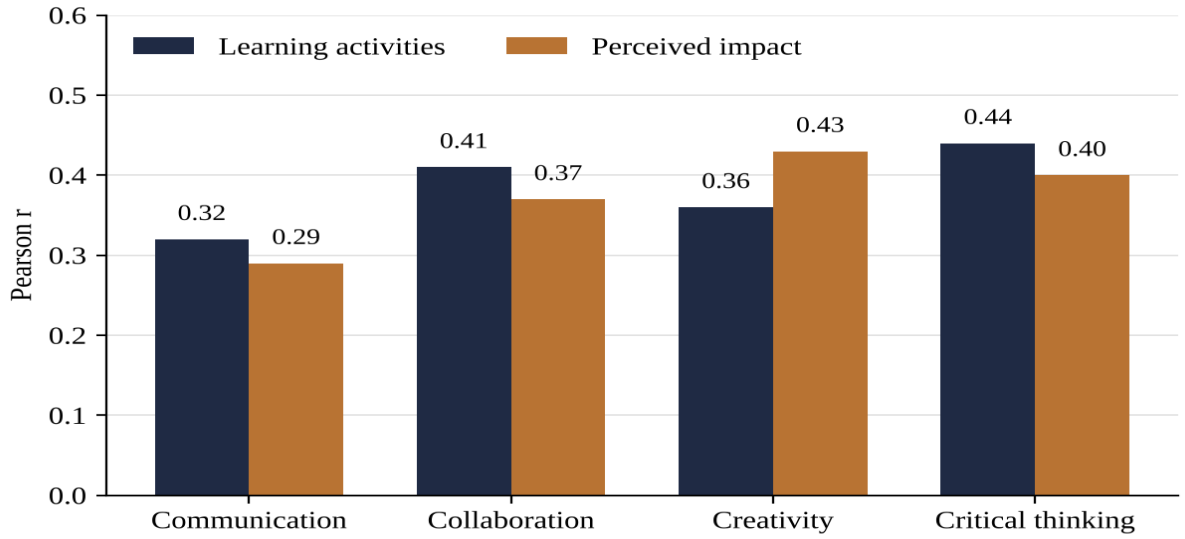


Figure 3. Correlation coefficients between each ICT dimension and each 4Cs domain (illustrative data)

If real results followed this illustrative pattern, every correlation would be positive and statistically significant, and greater ICT use would go with stronger 4Cs competency. The relationships are weak to moderate, though, so ICT use would explain only part of the variation in competency. Two results stand out. First, use in learning activities reaches the moderate range for collaboration (r = .41) as well as critical thinking (r = .44). The link with collaboration makes sense, since many ICT learning activities, such as shared documents and group LMS assignments, are collaborative by design. Second, perceived impact has its strongest correlation with creativity (r = .43), well above the figure for learning activities (r = .36). For creativity at least, the students' sense that ICT has changed how they think and plan seems to matter more than how often they use it. This fits Youssef et al.'s (2022) finding that active, purposeful ICT use predicts stronger competency

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outcomes. It also fits Kaplan et al.'s (2025) evidence that planned digital integration improves creative thinking.

5. Conclusions

1. Pre-service teachers are likely to report heavy use of ICT, both in routine learning activities and in the impact they believe it has on their development. Digital tools are now a normal part of teacher preparation.

2. Their 4Cs competencies are likely to sit in the Developed band on average, below Highly Developed. Collaboration should be the strongest domain, likely supported by the group-based structure of teacher-education coursework, while creativity needs the most attention.

3. ICT utilisation is likely to show weak to moderate, statistically significant positive relationships with all four competencies. ICT use goes with stronger 4Cs competency but cannot guarantee it.

4. Perceived impact appears more closely tied to creativity than frequency of use is. Purposeful, reflective use of ICT seems to count for more than simple exposure.

6. Recommendations

1. Teacher education programmes should build ICT into tasks that require creativity and critical thinking, for example, designing original digital teaching aids or evaluating open educational resources. At present, ICT is used mostly for administration and content delivery (Sheikh & Nath, 2026).

2. Practicum and microteaching should pair digital tools with structured reflection prompts, since perceived impact is the ICT dimension most closely linked to creativity (Agarwal, 2024).

3. Collaboration is usually the strongest of the 4Cs, so programmes can use structured peer work to support the weaker domains. For example, pre-service teachers could review each other's lesson designs in pairs and critique them for originality (Canalita, 2026).

4. Instructional technology courses should be judged on whether they strengthen the 4Cs as well as on whether they increase ICT use. Instruments like those proposed in this study could support that evaluation (Romero, 2026).

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5. Future research should collect real data with these instruments, preferably through a longitudinal or pre-test/post-test intervention design. This would show whether ICT-integrated pedagogy courses improve the 4Cs or simply correlate with them.

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