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INVITE

Social Innovation Incubators for Inclusive Digital Healthcare

INVITE

Assessment of the INVITE Open Educational Resources

Developed by the *Project partner MEDITERRANEAN ECONOMIC FORESIGHT INSTITUTE (IPEMED)*



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1. Introduction

The Erasmus+ INVITE project – *Social Innovation Incubators for Inclusive Digital Healthcare* addresses the growing need to prepare future healthcare professionals for the opportunities and challenges created by digital transformation in healthcare. Digital technologies can improve access to healthcare, communication, continuity of care and patient autonomy, but their benefits are not equally accessible to everyone. Older adults and other vulnerable groups may face barriers related to digital skills, accessibility, confidence, socioeconomic circumstances, communication needs or trust in technology. For future healthcare professionals, digital competence therefore needs to include not only the ability to use technology, but also the capacity to recognise these barriers and support patients in an inclusive, empathetic and responsible way.

To contribute to this goal, INVITE developed a set of Open Educational Resources (OERs) for vocational healthcare education. The four modules were designed as complementary parts of a broader learning pathway rather than as isolated topics.

Module 1 introduces the foundations of inclusive digital health: what digital health is, how it can benefit patients, and what barriers older adults and vulnerable groups may face when using digital technologies.

Module 2 moves from understanding the barriers to understanding the person behind them, focusing on communication, empathy, patience and the ability to support older and vulnerable people in using digital-health tools.

Module 3 builds on this user-centred perspective and introduces students to digital health entrepreneurship, Design Thinking and social innovation. Students learn how real healthcare needs can be translated into ideas, tested with users and developed into potential solutions.

Module 4 adds the ethical and professional dimension, focusing on privacy, informed consent, trustworthy information, data protection, accountability and responsible use of digital technologies in healthcare.

Together, the four OER modules form a coherent learning progression:

Module 1: understanding digital health, inclusion and barriers

Module 2: communicating with and supporting people using digital health

Module 3: developing user-centred digital-health solutions

Module 4: using and developing digital health ethically and responsibly

This progression provides the educational logic for the evaluation: each module is assessed individually, while the cross-module analysis examines how the different types of learning build on one another and what this suggests for future OER and curriculum design.

The evaluation presented in this report examines how useful the INVITE OERs were in supporting the intended student learning outcomes. The main focus is on **perceived development in knowledge, understanding, skills, attitudes and confidence** before and after completion of the individual modules. The evaluation therefore goes beyond general satisfaction with the learning materials and asks whether students felt better prepared to understand, apply and reflect on the competences addressed by the OERs.

Where available, quantitative self-assessments are complemented by students' written reflections on what they learned, how their perspectives changed, which activities they found useful and what could be improved. These reflections are particularly important for competences such as empathy, communication, ethical responsibility and confidence, where the value of learning cannot be fully captured through factual knowledge questions alone.

The evaluation addresses three main questions:

1. **To what extent did students report development in the competences addressed by each OER module?**
2. **Which learning areas showed the strongest development, and which areas may benefit from further strengthening?**
3. **What can the pattern of results across the four modules tell us about how similar OERs and learning pathways should be designed in future projects?**

The OERs were tested with students from three vocational and educational (VET) medical schools in Croatia, Türkiye and Slovakia. The participating schools provided three implementation settings for the resources; the purpose of the evaluation is not to compare schools or national contexts, but to assess the usefulness of the OERs and identify learning patterns that may inform their further use and development.

The report therefore first examines each module separately, focusing on changes in the learning outcomes directly assessed by the questionnaires. It then considers the four modules together in a **cross-module analysis**. This second level of analysis is particularly useful because it allows us to distinguish between areas in which students began with relatively little prior familiarity and areas in which they already perceived themselves as competent.



This distinction has practical implications for future educational design. Some concepts, such as digital health entrepreneurship, social innovation incubators, Design Thinking or digital-health ethics, may require explicit conceptual introduction because they are relatively unfamiliar to students. Other competences, particularly empathy and communication, may begin with high self-assessed confidence and therefore show smaller perceived gains, even though they remain fundamental to professional healthcare practice. In such cases, the educational need may be less about explaining why a competence matters and more about creating opportunities to practise, receive feedback and apply it in realistic situations.

The findings are therefore intended to serve two purposes. First, they provide evidence of the extent to which the INVITE OERs supported their intended learning outcomes during project implementation. Second, they provide practical lessons for the **refinement, reuse and future design of educational resources**, including decisions about where theoretical input is necessary, where practical application should be strengthened, and how student learning can be assessed more meaningfully.

In this way, the evaluation considers the INVITE OERs not only as four completed project outputs, but also as a source of evidence for designing future learning experiences that are **more focused, more applied and more closely aligned with what students actually need to learn and practise**.

2. Evaluation methodology

2.1 Purpose of the evaluation

The evaluation examined the usefulness of the INVITE OERs in supporting the learning outcomes targeted by the four modules.

The main evaluation question was:

Do students report greater knowledge, understanding, skills and confidence after completing the INVITE OER modules?

Where additional student feedback was collected, the evaluation also considered what students identified as particularly useful and what they suggested could be improved.

The evaluation was therefore focused on **learning outcomes and perceived learning**, rather than on a comprehensive assessment of all aspects of OER quality. Technical characteristics such as platform usability, navigation or visual design were not systematically assessed and are therefore not part of the main analysis.

The questionnaires primarily used self-assessment statements such as “*I can...*”, “*I understand...*” and “*I feel confident...*”. Results are consequently interpreted as **self-reported or perceived competence development**, rather than as objective knowledge-test results. This is consistent with the original questionnaire design, which focuses on students' perceived knowledge, understanding, skills, attitudes and confidence.

2.2 Participants and data

The OERs were tested with students from three VET medical schools participating in the INVITE project:

- Medical School Split, Croatia;
- Lokman Hekim Medical School Bursa, Türkiye;
- Medical School Trnava, Slovakia.

The participating schools served as **testing settings for the OERs**. The purpose of the evaluation was not to compare the schools or assess differences between national contexts.

The available questionnaire responses were:

Table 1 Number of responses on questionnaires

Module / evaluation point	Number of responses
Module 1 – BEFORE	69
Module 1 – AFTER	57
Module 2	59
Module 3	43
Module 4	23

The number of responses differs between modules. These numbers refer to completed questionnaires and should not automatically be interpreted as the number of students completing the full INVITE learning pathway. The existing datasets do not allow individual students to be followed across all four modules.

Information about the three schools can be retained in the descriptive presentation of the sample. School-specific results may be mentioned only where they help confirm that a general pattern was not restricted to one testing setting, but **school comparison is not a separate evaluation objective**.

2.3 Evaluation design

Two forms of BEFORE–AFTER self-assessment were used.

Module 1

Module 1 used separate questionnaires before and after the module. The same eight learning outcomes were assessed at both points.

These eight learning outcomes covered students' ability to: (1) explain digital health and virtual care and their benefits; (2) identify challenges in digital-health adoption and understand benefits for patient outcomes; (3) use basic digital-health tools; (4) develop innovative and empathetic healthcare solutions; (5) apply informatics and communication tools in healthcare practice; (6) recognise the needs and barriers of older and vulnerable groups; (7) identify social, cultural, economic and psychological barriers to digital-health use; and (8) apply inclusive-design principles and support digital literacy.

There were **69 BEFORE responses** and **57 AFTER responses**. Because responses were not linked by an anonymous participant identifier, individual students cannot be matched between the two questionnaires.

Module 1 is therefore analysed as a **group-level BEFORE–AFTER comparison**.

The main indicators are:

- average BEFORE score;
- average AFTER score;
- difference between the two group means.

An increase in the group mean indicates that students completing the AFTER questionnaire rated their competence more highly than students responding before the module. It should not be interpreted as the measured individual gain of the same students.

Modules 2–4

Modules 2, 3 and 4 used a retrospective BEFORE–AFTER format. Students completed one questionnaire after the module and rated how they perceived their competence:

- **BEFORE** completing the module; and
- **AFTER** completing the module.

Because both ratings were provided by the same respondent, BEFORE and AFTER scores can be compared at individual level.

These differences are interpreted as **perceived learning gains**.

The retrospective format has the practical advantage that students assess their earlier and current competence from the same post-learning perspective. However, the BEFORE rating is retrospective and depends on students' recollection and judgement. Results therefore indicate perceived competence development rather than objectively tested learning.

2.4 Areas assessed

The questionnaires were directly related to the intended learning outcomes of the four modules.

Table 2 Main areas of modules assessed

Module	Main areas assessed	Learning outcomes assessed
Module 1 – Foundations of Inclusive Digital Health	Digital health and virtual care; digital-health tools; barriers experienced by older and vulnerable groups; inclusive digital-health practice	Explain digital health and virtual care; use basic digital-health tools; understand their benefits and challenges; recognise the needs and barriers of older and vulnerable groups; apply inclusive-design principles and support digital literacy.
Module 2 – Communication, Empathy and Supporting Digital-Health Use	Communication and empathy; supporting digital-health use; understanding barriers and individual needs; inclusivity; reflection	Communicate respectfully and empathetically with older adults; listen to their experiences and needs; adapt communication and provide clear explanations; understand barriers, stress and individual support needs related to digital technologies; support older adults in using digital-health tools; reflect on communication and trust.
Module 3 – Digital Health Entrepreneurship, Design Thinking and Innovation	Digital health entrepreneurship; digital needs of older adults; design thinking and project development; pitching and innovation support	Understand digital-health entrepreneurship, healthcare innovation and social innovation incubators; identify unmet healthcare needs and opportunities for digital-health solutions; understand older adults' digital needs and barriers; apply Design Thinking and user-centred approaches; understand user testing, project planning, pitching, storytelling and innovation communication; consider inclusion, ethics and sustainability.

Module	Main areas assessed	Learning outcomes assessed
Module 4 – Ethics and Responsible Digital Healthcare	Ethics in digital health; privacy and data protection; trustworthy information; informed consent; ethical reasoning; professional responsibility	Recognise ethical challenges in digital health; understand privacy, data protection and relevant regulations; identify trustworthy health information; understand informed consent and challenges associated with digital consent; apply ethical reasoning; consider patient and professional perspectives; demonstrate professional responsibility and accountability when using digital technologies in healthcare.

Detailed results will be presented primarily according to these learning areas, while individual questionnaire items will be used where they provide additional useful information.

For Module 3, two duplicated pairs of questionnaire statements were identified. The original responses will remain unchanged, but duplicated statements will not be given double weight when broader competence scores are calculated.

2.5 Quantitative analysis

The analysis is descriptive and designed to answer a straightforward question: **were students' ratings higher after completing the OERs?**

The analysis compares students' self-assessment scores before and after completing each module, using average scores on a five-point scale. For Module 1, the BEFORE and AFTER questionnaires were completed separately and the responses could not be matched to individual students; therefore, the analysis compares the average scores of the two groups. For Modules 2–4, students rated their competence before and after the module in the same questionnaire, allowing changes to be calculated for individual respondents. In all cases, the results indicate students' perceived learning and competence development rather than objectively tested knowledge or skills.

For each learning outcome, the following will be reported:

- **BEFORE mean score**
- **AFTER mean score**

- **Difference between BEFORE and AFTER**

For Modules 2–4, this difference represents the mean **perceived learning gain** because BEFORE and AFTER ratings come from the same students.

Where useful, results may also include the percentage of students giving a high AFTER rating, particularly **4 or 5 on the five-point scale**.

For Modules 2–4, the paired responses also allow calculation of the proportion of students whose AFTER rating was:

- higher than BEFORE;
- unchanged;
- lower than BEFORE.

This provides a simple indication of whether improvement was widespread across students rather than visible only in the group average.

Where several questionnaire items clearly assess the same competence area, they may be combined into a domain-level score. This is especially useful for Modules 2–4, where questionnaires contain multiple related items.

The main results will therefore focus on:

starting level → final level → difference.

No overall numerical grade or score will be assigned to an OER module.

2.6 Interpretation of results

The size of the BEFORE–AFTER difference will be interpreted together with the starting and final scores.

For example, a small numerical increase may still represent a strong result when students already reported high competence before completing the module. In such cases, there is less room for further improvement on a five-point scale.

Likewise, a large increase from a relatively low starting score may indicate that the module addressed an area that was initially unfamiliar to students.

Interpretation will therefore consider:

BEFORE score + AFTER score + difference

rather than using the magnitude of change alone as an indicator of usefulness.

For Module 1, findings will be described as **differences between the BEFORE and AFTER groups**.

For Modules 2–4, findings may be described as **perceived learning gains**, because the ratings are paired within individual respondents.

2.7 Student feedback

Modules 2 and 4 also contained open-ended questions.

These responses will be used to complement the quantitative findings and to identify:

- what students considered the most important learning;
- whether they felt more confident or prepared after completing the module;
- learning activities they found particularly useful;
- suggestions for improvement.

The analysis will remain simple. Responses will be reviewed and recurring ideas grouped into a small number of themes. Where appropriate, the number of students mentioning a recurring theme may be reported.

A small number of anonymised student comments may also be used to illustrate the findings.

The qualitative responses will **not be used to construct additional measures that were not included in the questionnaires**. Broader observations about implementation, teaching approaches or the development process can instead be discussed later in the reflection section of the report.

2.8 Cross-module assessment

In addition to the module-specific analyses, results from all four modules were reviewed together to identify **recurring patterns in students' starting levels, final self-assessments and perceived learning gains**. The purpose of this cross-module assessment was not to rank the modules or directly compare their effectiveness, particularly because Module 1 used an unmatched group-level pre/post design while Modules 2–4 used paired retrospective BEFORE–AFTER ratings. Instead, the cross-module analysis was used to explore which types of competences students appeared to be less familiar with at baseline, which areas showed the largest perceived development, and where high initial self-ratings may have limited the size of observed change. These patterns were then used to inform practical recommendations for future OER and curriculum design, while keeping the interpretation limited to outcomes directly measured by the questionnaires.

2.9 Limitations

The evaluation has several limitations that should be considered when interpreting the findings.

First, the questionnaires measure **self-reported learning and competence**, not performance assessed through an independent knowledge or skills test.

Second, Module 1 uses separate and unmatched BEFORE and AFTER groups, so individual learning gains cannot be calculated.

Third, the BEFORE ratings in Modules 2–4 were provided retrospectively after students had completed the module.

Fourth, response numbers differ between modules, and the available data do not allow individual students to be followed through the complete four-module learning pathway.

Finally, the evaluation focuses predominantly on **whether the OERs supported the intended student learning outcomes**. It does not provide a systematic evaluation of every possible dimension of OER quality, such as technical functionality, design, navigation or accessibility.

These limitations define the scope of the conclusions but do not prevent the questionnaires from providing direct evidence about the principal question addressed in this report: **whether students perceived the INVITE OERs as supporting their learning and competence development**.

3. Module-specific results

3.1 Module 1 – Foundations of Inclusive Digital Health

Evaluation sample

Module 1 was evaluated using separate questionnaires completed before and after the module. The BEFORE questionnaire included **69 responses**, while the AFTER questionnaire included **57 responses**. All eight quantitative learning-outcome questions were completed by all respondents.

As described in the methodology, individual BEFORE and AFTER responses could not be matched. The results therefore represent a **group-level comparison of students' self-assessed competence before and after completion of the OER**, rather than individually measured learning gains.

Overall result

Across all eight assessed learning outcomes, the average self-assessment increased from **3.24 before the module to 3.98 after the module**, corresponding to a difference of **+0.75 points on a five-point scale**.

Importantly, the AFTER mean was higher than the BEFORE mean for **all eight learning outcomes**.

Results by learning outcome

Table 3 Results by learning outcome

Learning outcome	BEFORE mean	AFTER mean	Difference	AFTER rating 4–5
1. Explain digital health, virtual care and their benefits	3.29	4.04	+0.75	78.9%
2. Identify challenges in digital-health adoption and understand benefits for patient outcomes	3.09	4.09	+1.00	78.9%
3. Use basic digital-health tools	3.19	3.86	+0.67	64.9%
4. Develop innovative and empathetic healthcare solutions	3.36	4.04	+0.67	73.7%
5. Apply informatics and communication tools in healthcare practice	3.45	3.91	+0.46	70.2%
6. Recognise the needs and barriers of older and vulnerable groups	3.30	4.05	+0.75	71.9%
7. Identify social, cultural, economic and psychological barriers to digital-health use	3.26	4.02	+0.76	73.7%
8. Apply inclusive-design principles and support digital literacy	2.97	3.88	+0.91	70.2%
Overall	3.24	3.98	+0.75	—

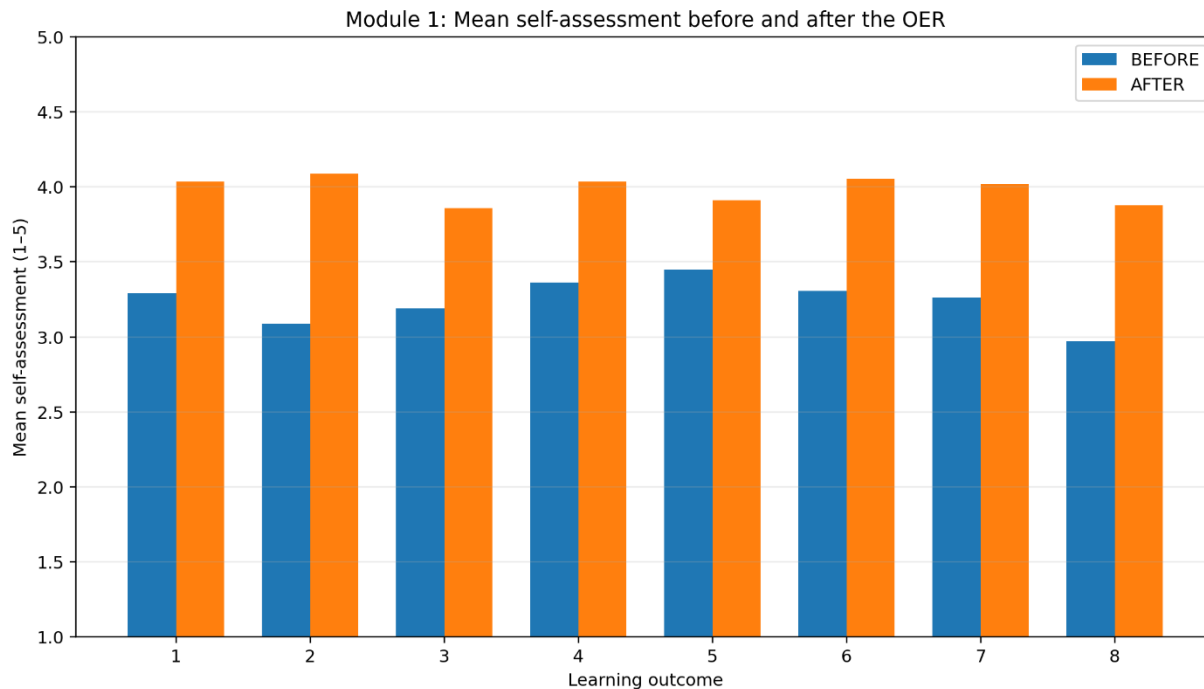


Figure 1. Module 1: Mean self-assessment before and after the OER

Group-level comparison of BEFORE and AFTER mean scores across the eight learning outcomes (1–5 scale).

Main findings

The **largest difference** was observed for students' ability to identify challenges in adopting digital health for vulnerable populations and understand how healthcare technologies can improve patient outcomes. The mean increased from **3.09 to 4.09 (+1.00)**.

A particularly relevant result for the aims of INVITE was found for **inclusive design and digital literacy**. This learning outcome had the lowest initial mean score (**2.97**) but showed the second-largest increase, reaching **3.88 after the module (+0.91)**. The proportion of students giving themselves a rating of 4 or 5 increased from **31.9% before the module to 70.2% afterwards**.

Students also reported considerable improvement in recognising the needs and barriers faced by older and vulnerable groups and in understanding the wider social, cultural, economic and psychological barriers affecting digital-health use. These two items increased by **+0.75 and +0.76**, respectively.

Together, these findings suggest that the value of Module 1 was not limited to introducing digital technologies. The results point particularly towards increased student awareness of **who may experience difficulties using digital health, why these difficulties arise, and how healthcare professionals can respond more inclusively**.

Competence-area results

For a clearer overview, the eight learning outcomes were grouped into four competence areas.

Table 4 Learning outcomes grouped into four competence areas

Competence area	BEFORE	AFTER	Difference
Understanding digital health and virtual care	3.19	4.06	+0.87
Use of digital-health tools	3.32	3.89	+0.57
Understanding needs and barriers	3.28	4.04	+0.75
Inclusive and empathetic digital-health practice	3.17	3.96	+0.79

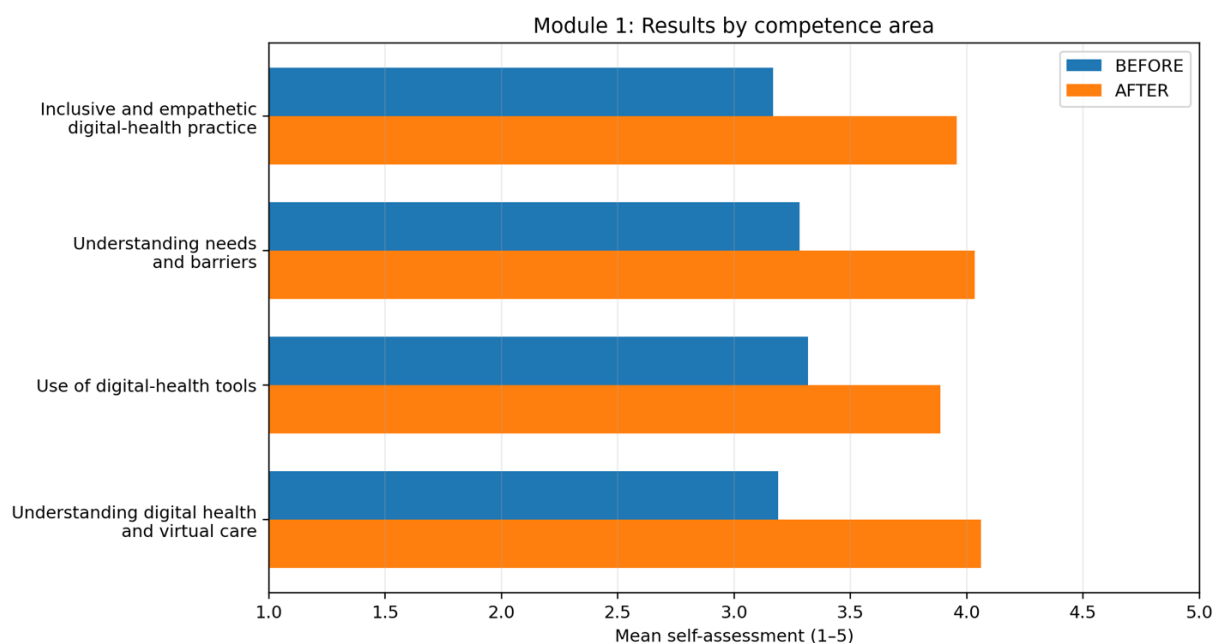


Figure 2. Module 1: Results by competence area

Group-level comparison of BEFORE and AFTER mean scores across four competence areas.

The strongest difference was found in **understanding digital health and virtual care (+0.87)**, followed closely by **inclusive and empathetic digital-health practice (+0.79)** and **understanding needs and barriers (+0.75)**.

The smallest increase was found in **use of digital-health tools (+0.57)**. This area also had a somewhat higher starting score than several other domains, so there was less scope for numerical improvement. Nevertheless, it may be useful to look more closely at practical digital-tool learning when considering future refinement of the OER.

In particular, the item concerning the use of basic digital-health tools such as telehealth platforms, mHealth applications, electronic health records and wearable devices had an AFTER mean of **3.86** and **64.9%** of respondents rated themselves 4 or 5. This was the lowest proportion of high AFTER ratings among the eight outcomes. The result is positive, but compared with the other outcomes it indicates that **additional hands-on practice with digital-health tools could potentially strengthen the module further**.

Overall assessment of Module 1

Module 1 showed a consistent positive pattern: AFTER scores were higher across all eight learning outcomes and all four competence areas. The strongest changes concerned challenges in digital-health adoption, inclusive design and digital literacy, and recognition of barriers experienced by older and vulnerable people. Practical experience with digital-health tools remained the clearest area for further strengthening.

Because Module 1 used unmatched BEFORE and AFTER groups, these findings are interpreted as group-level differences in self-assessment rather than individual learning gains.

Recommendation for future use

Strengthen hands-on practice with digital-health tools, particularly telehealth platforms, mHealth applications, electronic health records and wearable devices.

3.2 Module 2 – Communication, Empathy and Supporting Digital-Health Use

Evaluation sample

Module 2 was evaluated using a retrospective BEFORE–AFTER questionnaire completed by **59 students**. Students assessed their competence before and after the module using the same 15 statements on a five-point scale.

All 59 respondents provided complete BEFORE and AFTER ratings for the quantitative learning-outcome items. As both assessments were provided by the same respondents, the results can be interpreted as **paired perceived learning gains**.

In addition, the questionnaire contained an overall question on improvement in communication and empathy skills and five open-ended reflection questions.

Overall result

Across all 15 assessed learning outcomes, the overall mean increased from 3.82 BEFORE to 4.39 AFTER, an average perceived gain of +0.57 points. The AFTER mean was higher for all 15 outcomes.

At individual level, 86.4% of students had a higher overall AFTER score than BEFORE; 5.1% were unchanged and 8.5% had a slightly lower overall mean, indicating a broad positive pattern.

Results by learning outcome

Table 5 Results by learning outcome

Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
1. Communicate respectfully with older adults	3.68	4.49	+0.81	96.6%
2. Listen carefully to older people's experiences and needs	3.86	4.49	+0.63	93.2%
3. Understand how older adults may feel when using new technologies	3.66	4.41	+0.75	93.2%
4. Show patience when someone needs more time to learn	3.85	4.42	+0.58	93.2%
5. Feel confident helping older people use digital-health tools	3.68	4.31	+0.63	81.4%
6. Explain digital tools simply and clearly	3.46	4.05	+0.59	74.6%
7. Understand that digital technologies can cause stress or insecurity	3.83	4.39	+0.56	91.5%
8. Understand barriers older adults may face with digital technologies	3.81	4.47	+0.66	93.2%



Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
9. Understand that people may need different types of support	3.86	4.44	+0.58	91.5%
10. Adapt communication to the individual	3.68	4.24	+0.56	79.7%
11. Treat people with respect and understanding	4.27	4.53	+0.25	91.5%
12. Understand differences in health habits and lifestyle choices	4.19	4.49	+0.31	94.9%
13. Recognise when people need extra support within healthcare	3.88	4.42	+0.54	93.2%
14. Reflect on whether one's communication was effective	3.53	4.10	+0.58	86.4%
15. Understand that empathy improves communication and trust	4.14	4.64	+0.51	96.6%
Overall	3.82	4.39	+0.57	—

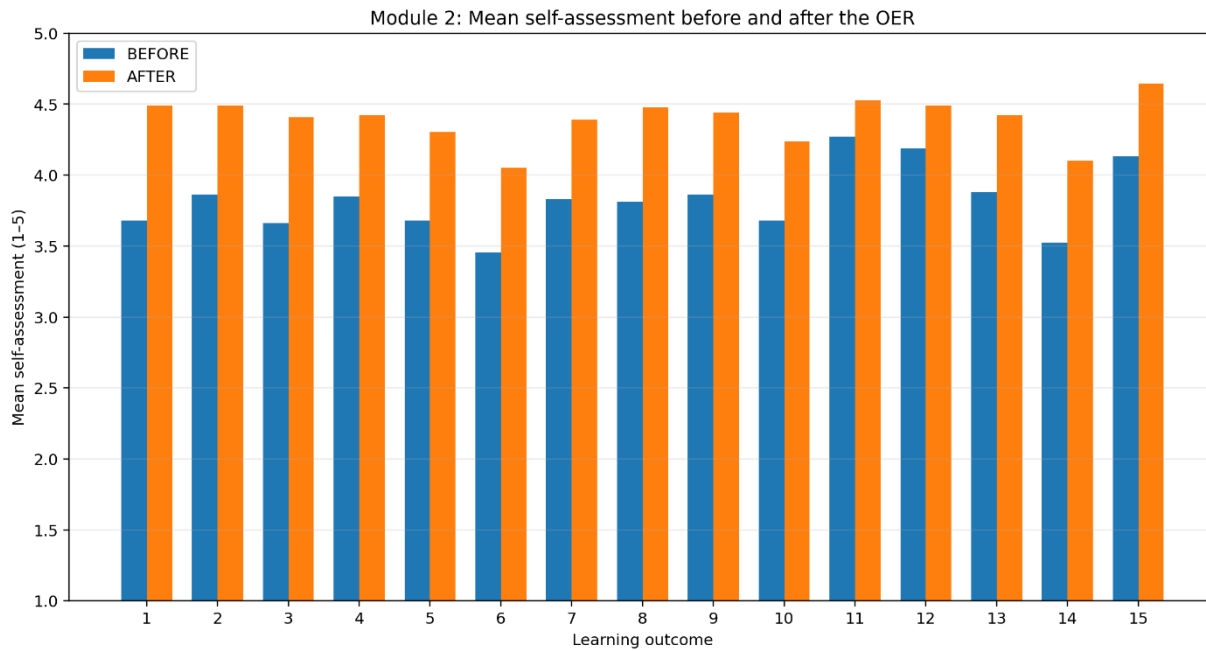


Figure 3. Module 2: Mean self-assessment before and after the OER

Paired retrospective BEFORE–AFTER mean scores across 15 learning outcomes (1–5 scale).

Main findings

The largest perceived gain was found in students' confidence in **communicating respectfully with older adults**, increasing from **3.68 to 4.49 (+0.81)**. After the module, 96.6% of students agreed or strongly agreed that they felt confident doing this.

A similarly strong change was observed in students' ability to **understand how older adults may feel when using new technologies**, which increased from **3.66 to 4.41 (+0.75)**.

Students also reported considerable development in recognising **barriers experienced by older adults when using digital technologies**. This increased from **3.81 to 4.47 (+0.66)**, with 93.2% of students selecting Agree or Strongly agree after the module.

These findings fit closely with the purpose of Module 2. The strongest changes were not simply in general attitudes towards older people, but in students' perceived ability to **communicate with them, understand their experience of technology and recognise the support they may need**.

Competence-area results

The 15 questions were organised in the questionnaire into five competence areas.

Table 6 Five competence areas questions

Competence area	BEFORE	AFTER	Perceived gain
Communication and empathy	3.76	4.45	+0.69
Supporting digital-health use	3.66	4.25	+0.59
Understanding barriers and needs	3.79	4.38	+0.60
Inclusivity and healthcare awareness	4.11	4.48	+0.37
Reflection and communication skills	3.83	4.37	+0.54

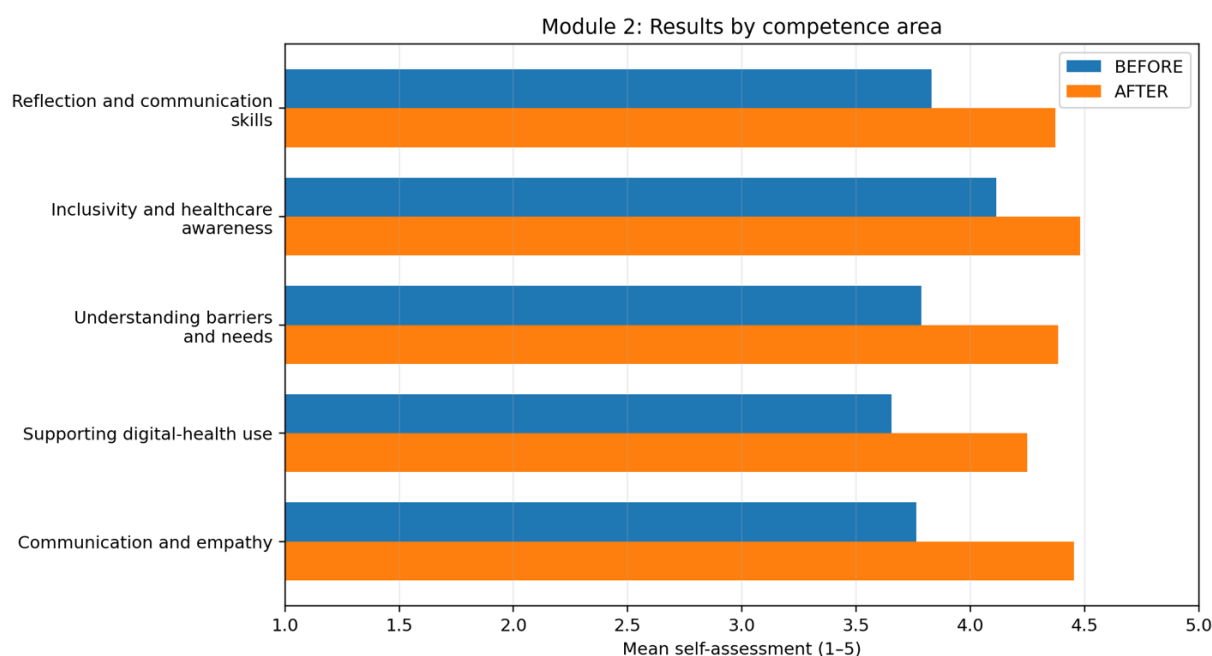


Figure 4. Module 2: Results by competence area

Paired retrospective BEFORE–AFTER mean scores across five competence areas.

The strongest development was found in **communication and empathy (+0.69)**. Importantly, improvement in this area was not based on one isolated question: students reported higher ratings for respectful communication, listening, understanding older adults' feelings and demonstrating patience.



A similarly clear development was observed in **understanding barriers and needs (+0.60)** and **supporting digital-health use (+0.59)**.

The smallest numerical increase occurred in **inclusivity and healthcare awareness (+0.37)**. However, this was also the domain with by far the **highest starting level (4.11)**. Students already strongly endorsed respect, understanding of individual differences and the need for additional healthcare support before completing the module. The relatively smaller change is therefore consistent with a ceiling effect rather than indicating limited usefulness of the module. The final mean of **4.48** was actually the highest of all five competence areas.

Students' overall perception of learning

The questionnaire also asked:

“Overall, how much did this module improve your communication and empathy skills?”

This question was answered by **57 students**.

The mean response was **4.28 out of 5**.

Of the 57 respondents, 86.0% rated the module's contribution to their communication and empathy skills as 4 or 5 out of 5 (43.9% selected 5 and 42.1% selected 4).

Student reflections

Key learning and perspective changes

The dominant themes were empathy, patience, respectful communication and a better understanding of barriers faced by older adults. Students repeatedly mentioned the value of simple language, step-by-step explanations and recognising that difficulty with technology should not be interpreted as inability. Most respondents who commented on perspective change described greater understanding and patience; some reported no change because they already held similar views, consistent with the relatively high baseline ratings.

Confidence in supporting digital-health use

Of the 50 students who answered the question about helping older adults use digital-health tools, the large majority reported feeling more confident. They linked this to greater knowledge of the tools, clearer explanation, step-by-step guidance, patience and empathy; only one respondent explicitly reported not yet feeling confident. This is consistent with the quantitative increase from 3.68 to 4.31 for this outcome.



Learning activities and suggestions for improvement

Students particularly valued practical tasks, real-life cases, discussion with classmates and step-by-step activities that required them to think from the older user's perspective. Suggestions for improvement centred on more simulations, videos and practical examples, while a smaller group suggested reducing repetition or the number of tasks. Overall, the feedback supports strengthening applied learning while keeping workload manageable.

Overall assessment of Module 2

Module 2 provides clear positive evidence of usefulness: students reported higher competence across all 15 outcomes and all five competence areas, and 86% rated its overall contribution to communication and empathy as 4 or 5 out of 5. Written reflections reinforced the quantitative pattern, particularly around empathy, patience, understanding barriers and confidence in supporting older adults.

The main area for further strengthening is explaining and demonstrating digital tools simply and clearly, which had the lowest AFTER mean (4.05) and lowest proportion of high ratings (74.6%). Additional hands-on practice with older or vulnerable users would directly address this gap.

Recommendation for future use

Add more hands-on practice in explaining and demonstrating digital-health tools simply and clearly to older or vulnerable users, while keeping the overall workload manageable.

3.3 Module 3 – Digital Health Entrepreneurship, Design Thinking and Innovation

Evaluation sample

Module 3 was evaluated using a retrospective BEFORE–AFTER questionnaire completed by **43 students**. Students assessed their competence before and after the module using 28 statements on a five-point scale.

Two pairs of statements in the questionnaire were duplicated: items 5 and 6, and items 13 and 14. These responses are retained in the item-level presentation because they formed part of the original questionnaire. However, in accordance with the methodology, the duplicated constructs were counted only once when calculating broader competence-area and overall scores.

Because BEFORE and AFTER ratings were provided by the same students, the differences can be interpreted as **paired perceived learning gains**.

Overall result

Across the unique learning outcomes assessed in Module 3, the overall mean increased from 3.18 BEFORE to 4.27 AFTER, representing an average perceived learning gain of +1.10 points. AFTER scores were higher for all 28 questionnaire items.

At individual level, 95.3% of students had a higher overall AFTER score. Across non-duplicated outcomes, the proportion of ratings at 4 or 5 increased from 37.1% BEFORE to 89.4% AFTER.

Results by learning outcome

Table 7 Results by learning outcome

Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
1. Understand what digital health entrepreneurship means	2.53	4.16	+1.63	88.4%
2. Recognise healthcare problems that could become digital-health ideas	2.93	4.26	+1.33	93.0%
3. Understand unmet healthcare needs	3.14	4.28	+1.14	95.3%
4. Understand why innovation is important in healthcare	3.28	4.37	+1.09	90.7%
5. Give examples of digital-health solutions for older adults	3.05	4.23	+1.19	88.4%
6. Give examples of digital-health solutions for older adults*	3.07	4.30	+1.23	93.0%
7. Understand the role of empathy in creating healthcare solutions	3.58	4.53	+0.95	95.3%
8. Understand that healthcare innovation should focus on real human needs	3.47	4.40	+0.93	93.0%
9. Understand why ethics are important in digital-health projects	3.33	4.35	+1.02	93.0%

Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
10. Understand the basic digital needs of older adults	3.42	4.42	+1.00	95.3%
11. Recognise common barriers older adults face when using technology	3.26	4.40	+1.14	95.3%
12. Understand why digital inclusion is important for health and quality of life	3.05	4.28	+1.23	93.0%
13. Understand the importance of confidence and motivation in digital learning	3.28	4.28	+1.00	88.4%
14. Understand the importance of confidence and motivation in digital learning*	3.44	4.35	+0.91	93.0%
15. Understand how healthcare students can support older adults using digital technologies	3.26	4.30	+1.05	93.0%
16. Understand accessibility and age-friendly digital design	3.26	4.28	+1.02	93.0%
17. Understand the basic stages of Design Thinking	2.77	4.12	+1.35	83.7%
18. Understand why empathy is the first step in solving healthcare problems	3.44	4.40	+0.95	90.7%
19. Understand why testing solutions with real users is important	3.05	4.40	+1.35	93.0%
20. Understand that even good ideas can fail if users are not involved	3.42	4.30	+0.88	90.7%



Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
21. Understand the importance of planning in turning an idea into a real project	3.23	4.30	+1.07	90.7%
22. Understand the importance of balancing innovation, ethics and sustainability	3.19	4.12	+0.93	83.7%
23. Understand what a social incubator is and how it supports innovation	2.70	4.00	+1.30	72.1%
24. Understand the purpose of a pitch presentation	3.02	4.07	+1.05	83.7%
25. Understand the importance of clear and simple communication in presentations	3.23	4.37	+1.14	93.0%
26. Recognise common mistakes in presentations and pitching	3.09	3.84	+0.74	67.4%
27. Understand how storytelling can make presentations more engaging	3.26	4.33	+1.07	88.4%
28. Understand that communication skills are important in healthcare innovation	3.42	4.37	+0.95	93.0%

*Duplicated statement in the original questionnaire.

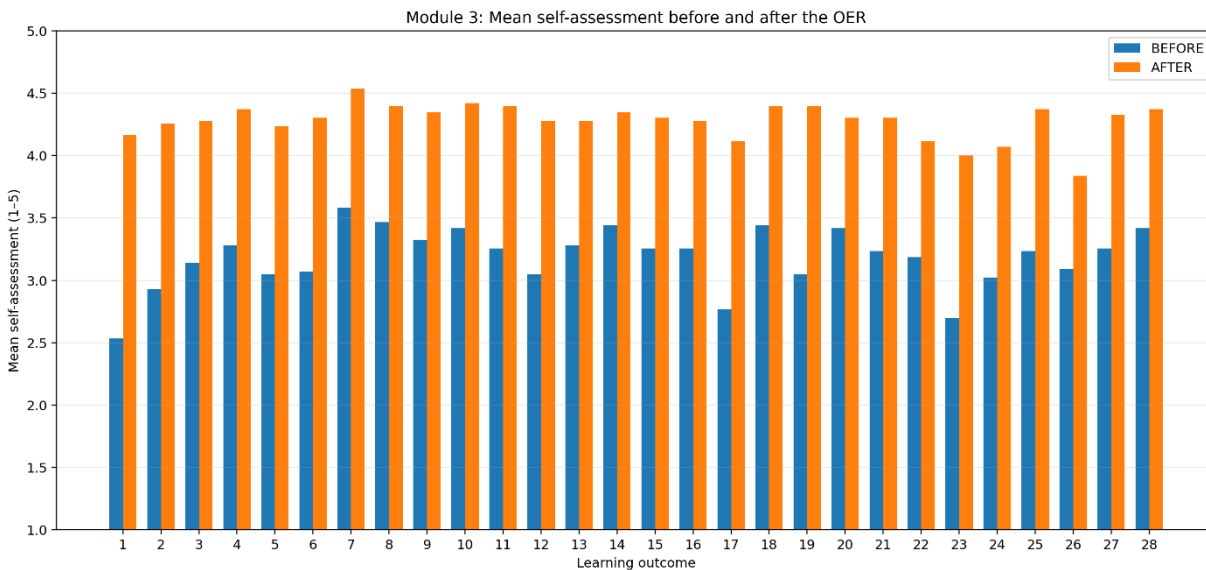


Figure 5. Module 3: Mean self-assessment before and after the OER

Paired retrospective BEFORE–AFTER mean scores across 28 questionnaire items (1–5 scale).

Main findings

The largest perceived learning gain was found in students' understanding of **digital health entrepreneurship**, which increased from **2.53 to 4.16 (+1.63)**. This was also the lowest baseline score in the entire questionnaire, indicating that the concept was relatively unfamiliar to students before the module.

Strong development was also observed in several highly practical innovation competences:

- understanding the **basic stages of Design Thinking**: **+1.35**;
- understanding why **testing solutions with real users** is important: **+1.35**;
- recognising healthcare problems that could become **digital-health ideas**: **+1.33**;
- understanding what a **social incubator** is and how it supports innovation: **+1.30**;
- understanding why **digital inclusion** matters for health and quality of life: **+1.23**.

This pattern is especially relevant to the purpose of Module 3. Students did not report improvement only in general awareness of innovation. The largest changes were seen in understanding **how an unmet need can become an innovation idea, how users should be involved in developing solutions, and how an idea can move towards implementation**.

Competence-area results

The 28 questionnaire items were organised into four broader competence areas. The duplicated items were excluded from the domain calculations so that the same construct was not given additional weight.

Table 8 Competence-area results

Competence area	BEFORE	AFTER	Perceived gain
Understanding Digital Health Entrepreneurship	3.16	4.32	+1.16
Digital Needs of Older Adults	3.25	4.33	+1.07
Design Thinking and Project Development	3.18	4.27	+1.09
Pitching and Innovation Support	3.12	4.16	+1.04

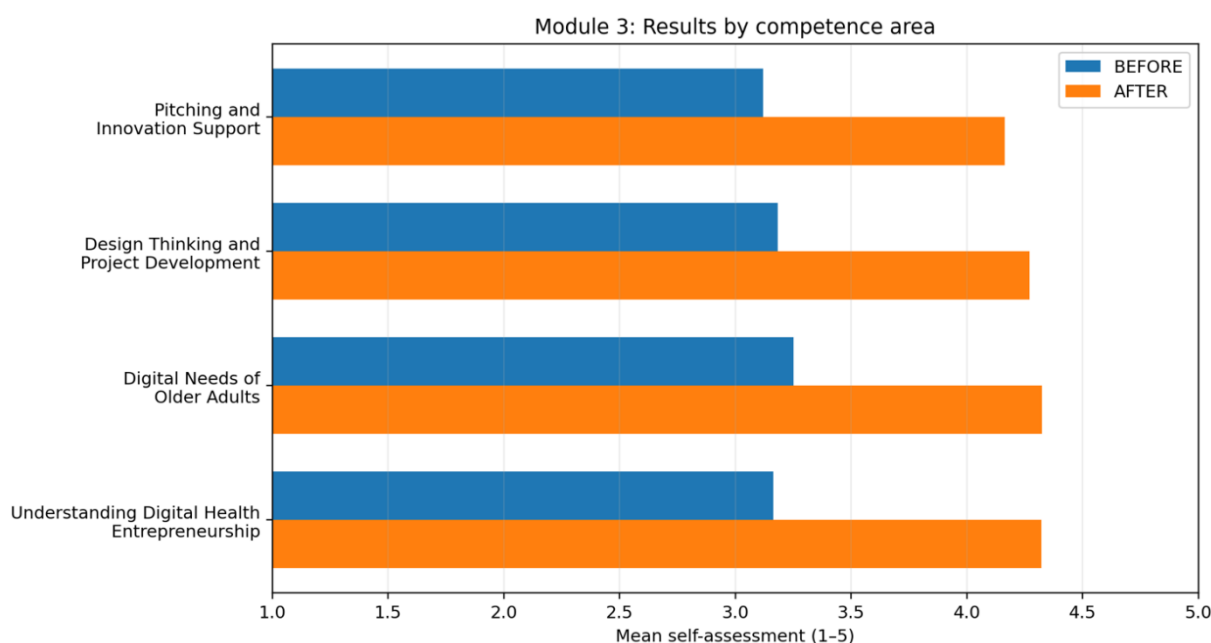


Figure 6. Module 3: Results by competence area

Paired retrospective BEFORE–AFTER mean scores across four competence areas; duplicated questionnaire items were excluded from the domain calculations.

All four competence areas showed substantial positive perceived learning gains of approximately **one point or more** on the five-point scale.

All four competence areas showed gains of approximately one point or more: Digital Health Entrepreneurship (+1.16), Design Thinking and Project Development (+1.09), Digital Needs of Older Adults (+1.07), and Pitching and Innovation Support (+1.04).

Areas particularly strengthened by the OER

Three learning areas stand out.

1. Understanding innovation as a process

Large increases in digital health entrepreneurship, social incubators and Design Thinking indicate that Module 3 successfully introduced students to innovation as a process that starts from a healthcare need and develops towards a solution.

2. User involvement in healthcare innovation

Students also strengthened their understanding of user involvement: the importance of testing solutions with real users rose from 3.05 to 4.40 (+1.35), and 90.7% agreed or strongly agreed after the module that even good ideas can fail when users are not involved. This reinforces the user-centred rather than technology-centred orientation of the OER.

3. Connecting innovation with inclusion

Innovation remained closely connected with inclusion. Students reported higher understanding of barriers faced by older adults, digital inclusion, accessibility and age-friendly design, and the role healthcare students can play in supporting older users.

Area for further strengthening

The lowest post-module result concerned recognising common mistakes in presentations and pitching (3.84; 67.4% rating 4 or 5). A concrete refinement would be more practical pitch analysis and rehearsal using examples of stronger and weaker pitches.

The concept of a social incubator also remained less firmly established than most other outcomes. Although it showed a large gain from 2.70 to 4.00 (+1.30), concrete examples of how an incubator supports a healthcare idea could reinforce understanding.

Overall assessment of Module 3

Module 3 provides strong positive evidence of usefulness: the overall mean increased from 3.18 to 4.27, 95.3% of students showed a higher overall AFTER score, and all four competence areas improved substantially. The strongest gains were in relatively unfamiliar concepts, particularly digital health entrepreneurship, Design Thinking, social incubators and user testing.

The module also preserved the inclusive focus of the preceding OERs by connecting innovation with real user needs, accessibility, digital inclusion and support for older adults.

Recommendation for future use

Strengthen practical pitch analysis and rehearsal, and use concrete examples to show how a social innovation incubator can support a healthcare idea.

3.4 Module 4 – Ethics and Responsible Digital Healthcare

Evaluation sample

Module 4 was evaluated using a retrospective BEFORE–AFTER questionnaire completed by **23 students**. Students assessed their competence before and after the module using 18 statements on a five-point scale.

Because BEFORE-AFTER ratings were provided by the same students, the differences can be interpreted as **paired perceived learning gains**.

The questionnaire also contained two optional reflection questions. Both were answered by **18 students**.

Overall result

Across all 18 learning outcomes, the overall mean increased from 3.18 BEFORE to 4.24 AFTER, representing an average perceived learning gain of +1.06 points. The AFTER mean was higher for all 18 outcomes.

At individual level, 91.3% of students had a higher overall AFTER score. Across all outcomes, the proportion of ratings at 4 or 5 increased from 40.3% BEFORE to 90.6% AFTER.

Results by learning outcome

Table 9 Results by learning outcome

Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
1. Recognise common ethical challenges in digital health	3.04	4.17	+1.13	91.3%
2. Understand the importance of privacy and data protection	3.17	4.22	+1.04	82.6%
3. Explain basic ethical principles related to digital health	2.87	4.00	+1.13	82.6%
4. Understand that healthcare data is protected by laws and regulations	3.22	4.26	+1.04	91.3%
5. Recognise when digital-health information may not be reliable	3.22	4.22	+1.00	95.7%
6. Identify trustworthy sources of health information online	3.35	4.17	+0.83	95.7%
7. Understand the importance of informed consent	3.22	4.30	+1.09	87.0%
8. Explain challenges patients may face when giving consent digitally	3.17	4.43	+1.26	91.3%
9. Understand different professional and patient perspectives on ethical issues	3.30	4.22	+0.91	91.3%
10. Think critically about ethical dilemmas related to digital technologies	3.09	4.22	+1.13	87.0%
11. Understand professional responsibility when handling sensitive health data	3.17	4.26	+1.09	95.7%



Learning outcome	BEFORE	AFTER	Gain	AFTER rating 4–5
12. Recognise risks of sharing personal health information digitally	3.26	4.30	+1.04	95.7%
13. Understand the need to balance innovation with ethical responsibility	2.96	4.17	+1.22	91.3%
14. Recognise where empathy is important in solving ethical issues	3.17	4.30	+1.13	87.0%
15. Feel confident discussing ethical concerns related to digital health	3.39	4.30	+0.91	91.3%
16. Understand accountability and professional integrity in digital healthcare	3.17	4.22	+1.04	91.3%
17. Apply basic ethical and regulatory principles to healthcare data protection	3.30	4.22	+0.91	91.3%
18. Feel responsible when managing sensitive patient information	3.22	4.30	+1.09	91.3%
Overall	3.18	4.24	+1.06	—

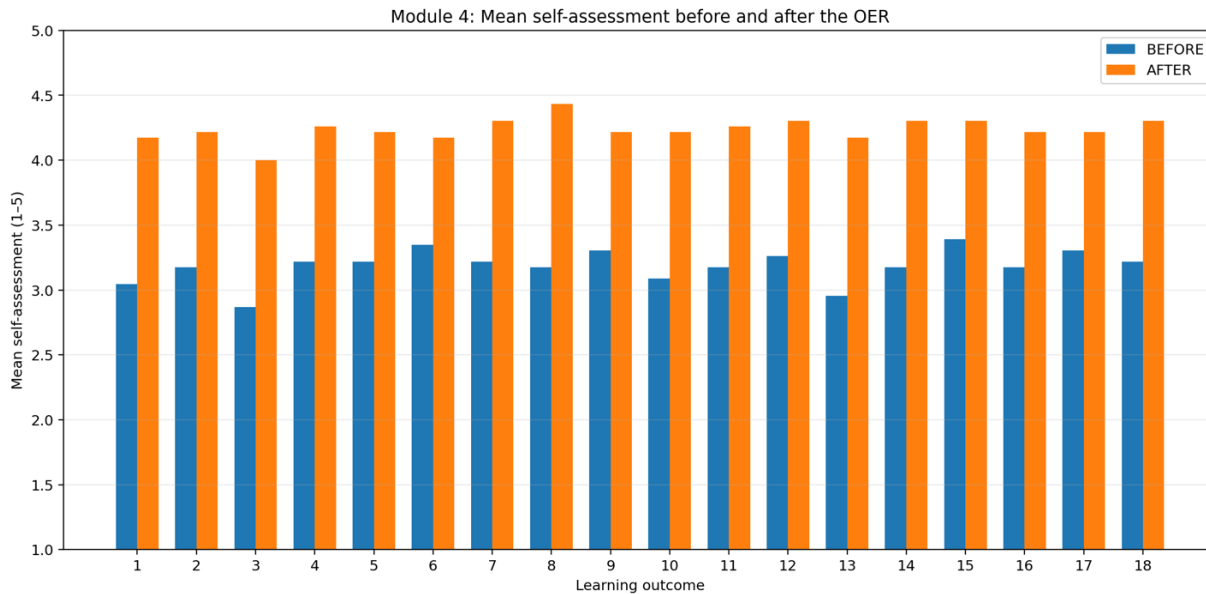


Figure 7. Module 4: Mean self-assessment before and after the OER

Paired retrospective BEFORE–AFTER mean scores across 18 learning outcomes (1–5 scale).

Main findings

The largest perceived learning gain concerned students' understanding of **challenges patients may face when giving informed consent in digital environments**, increasing from **3.17 to 4.43 (+1.26)**. This was also the highest AFTER mean among all 18 learning outcomes.

A similarly strong increase was found in students' understanding of the need to **balance healthcare innovation with ethical responsibility**, which increased from **2.96 to 4.17 (+1.22)**.

Other gains of more than one point included recognising ethical challenges, explaining basic ethical principles, critically considering ethical dilemmas, professional responsibility for sensitive data, risks of digital sharing, empathy in ethical decisions and accountability. Together, these results indicate development in ethical reasoning as well as awareness of rules and data protection.

Competence-area results

For interpretation, the 18 items were grouped into six competence areas reflecting the main themes of the questionnaire.

Table 10 Competence area results

Competence area	BEFORE	AFTER	Perceived gain
Ethical awareness	2.96	4.12	+1.16
Privacy and data protection	3.23	4.23	+1.00
Trustworthy health information	3.28	4.20	+0.91
Informed consent	3.20	4.37	+1.17
Ethical reasoning and perspectives	3.24	4.26	+1.02
Professional responsibility and accountability	3.21	4.27	+1.07

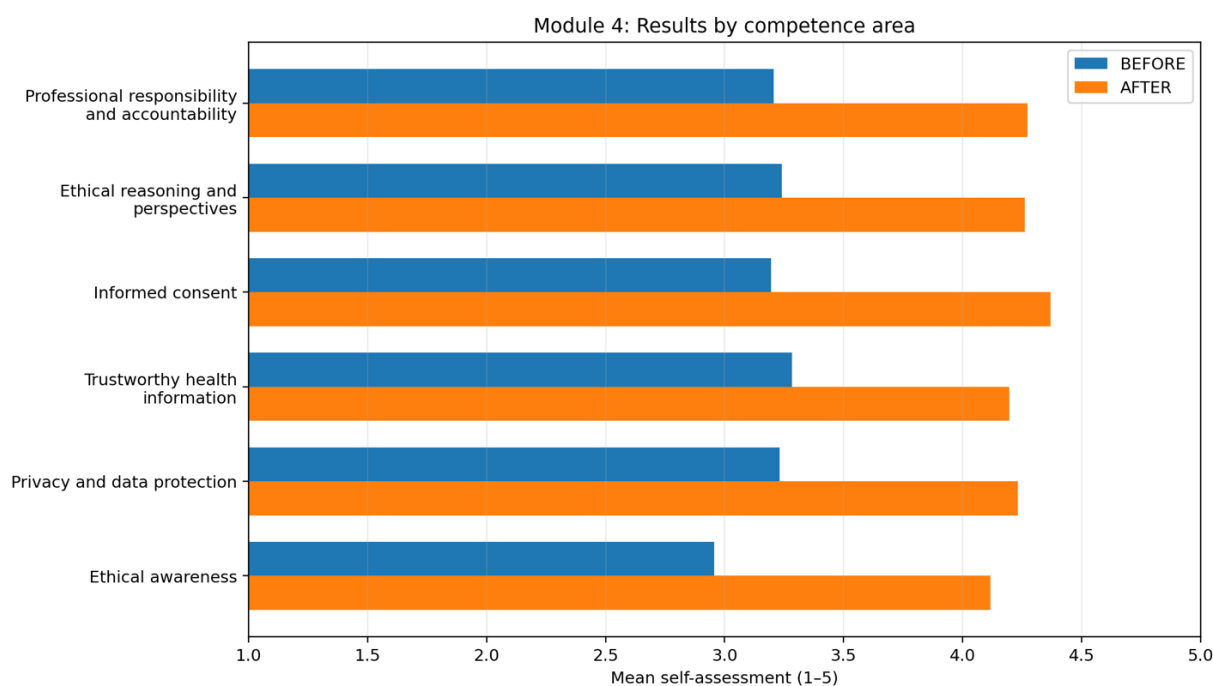


Figure 8. Module 4: Results by competence area

Paired retrospective BEFORE–AFTER mean scores across six competence areas.

All six competence areas showed substantial positive perceived learning gains.



The strongest domain-level gains were in informed consent (+1.17) and ethical awareness (+1.16), followed by professional responsibility and accountability (+1.07), ethical reasoning and perspectives (+1.02), privacy and data protection (+1.00), and trustworthy health information (+0.91).

Understanding ethics beyond rules and regulations

Improvement was not limited to knowing that healthcare data must be protected. Students also reported stronger competence in considering patient and professional perspectives, analysing ethical dilemmas, understanding informed consent, recognising the role of empathy and balancing innovation with responsibility.

This suggests a broader understanding of responsible digital healthcare: ethical practice involves judgement, communication and professional accountability as well as compliance with rules. It also extends the innovation focus of Module 3 by asking students to consider privacy, consent, safety and human needs when developing or using digital solutions.

Student reflections

The student reflection questions were optional and were answered by 18 of the 23 students who completed the quantitative questionnaire (78.3%). The findings below therefore reflect the experiences and views shared by these 18 respondents.

What students considered most important

Among the 18 students who responded, recurring themes were privacy, data security, ethical responsibility, informed consent, confidentiality and human dignity. Several responses also linked responsible technology use with empathy, communication and support for older people.

Preparedness to use digital technologies responsibly

All 18 students who answered this question said they felt more prepared to use digital technologies responsibly in healthcare. They linked this preparedness to stronger understanding of privacy and data protection, trustworthy information, informed consent, confidentiality, ethical risks and professional responsibility.

Area for further strengthening

All post-module means were 4.00 or higher. The lowest AFTER mean concerned explaining basic ethical principles related to digital-health technologies (4.00), despite a substantial gain from 2.87 (+1.13).

A useful refinement would therefore be short ethical cases in which students identify the principle involved and explain how it should guide a healthcare decision, strengthening the move from recognising ethical issues to applying ethical reasoning.

Overall assessment of Module 4

Module 4 provides strong positive evidence of usefulness: the overall mean increased from 3.18 to 4.24, AFTER scores were higher for all 18 outcomes, and 91.3% of students showed a higher overall AFTER score. The strongest developments concerned informed consent, ethical awareness, balancing innovation with responsibility and professional accountability.

Student reflections reinforced this pattern, with privacy, data protection and responsible technology use emerging repeatedly and all respondents to the final reflection reporting greater preparedness to use digital technologies responsibly in healthcare.

Recommendation for future use

Use short ethical cases in which students identify the ethical principle involved and explain how it should guide a healthcare decision.

4. Cross-module analysis and recommendations

Across all four modules, students reported higher competence after completing the OERs. The overall pattern was:

Table 11 Competence review per modules

Module	BEFORE	AFTER	Difference
Module 1	3.24	3.98	+0.75
Module 2	3.82	4.39	+0.57
Module 3	3.18	4.27	+1.10
Module 4	3.18	4.24	+1.06

These figures should not be used to rank the modules, particularly because Module 1 used a different pre/post design. They are nevertheless useful for identifying broad patterns.

4.1 Learning gains were largest where baseline familiarity was lowest

The largest perceived gains were repeatedly found in areas with relatively low BEFORE scores.

Examples include:

- **digital health entrepreneurship:** 2.53 → 4.16, **+1.63**
- **social incubators and their role in innovation:** 2.70 → 4.00, **+1.30**
- **basic stages of Design Thinking:** 2.77 → 4.12, **+1.35**
- **basic ethical principles in digital health:** 2.87 → 4.00, **+1.13**
- **inclusive design and digital literacy:** 2.97 → 3.88, **+0.91**

Social incubators were among the least familiar concepts at baseline, although digital health entrepreneurship had an even lower starting score.

The pattern is educationally important: students benefited most in concepts that were genuinely unfamiliar at baseline, suggesting that explicit conceptual teaching remains necessary where learners do not yet have a usable framework.

What this means for theoretical content

The data do not support removing theoretical content. Some of the strongest gains occurred in concepts students initially understood poorly, including Design Thinking, entrepreneurship, incubation and digital-health ethics.

For future projects, the more efficient principle is to provide the minimum theory needed to understand a new concept and immediately apply it in a task: less detached theory, but not less knowledge.

4.2 Empathy and communication: high baseline, complex competence

Module 2 had the highest baseline overall (3.82), with especially high starting ratings for respect and understanding (4.27), differences in health habits and lifestyles (4.19), and the importance of empathy for communication and trust (4.14). Smaller numerical gains in these areas must therefore be interpreted partly in light of high starting scores.

This should not be interpreted as evidence that empathy and communication require less attention; they are a *conditio sine qua non* for inclusive healthcare. Self-assessment cannot distinguish fully between genuinely high



competence, confidence based on limited experience and overestimation of interpersonal skills, making perceived improvement harder to demonstrate numerically.

Future projects should therefore assess and develop these competences through observable behaviour: role-play or authentic scenarios, feedback, reflection and a second attempt. For example, students could explain a patient portal to an older person and receive feedback on clarity, pace, language, listening and adaptation.

4.3 What the four modules suggest about learning design

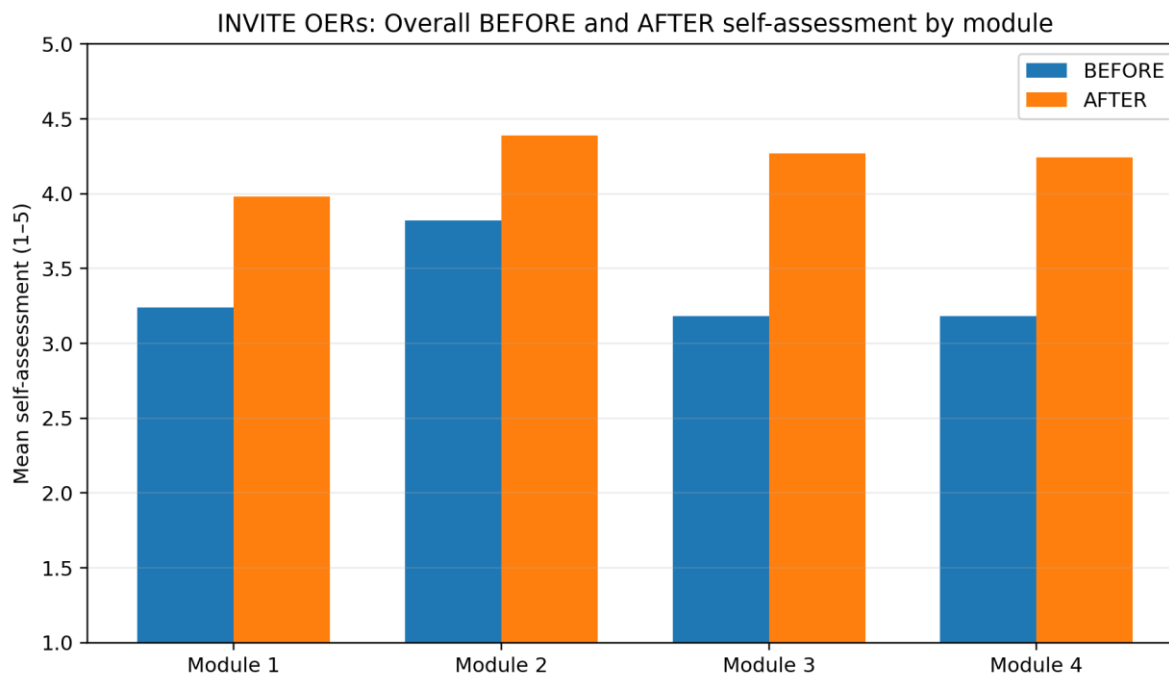
There is a useful distinction emerging between two types of learning outcomes.

1. Unfamiliar concepts benefit from concise explicit teaching

Large gains in digital health entrepreneurship, Design Thinking, social incubators, digital-health ethics and inclusive design suggest that unfamiliar concepts benefit from concise, explicit teaching before application.

2. Familiar human skills need experience more than explanation

Students already knew that empathy, respect and communication were important. The educational challenge is therefore less to explain why these skills matter and more to create situations in which students must demonstrate them. In short: teach unfamiliar concepts; practise familiar-but-difficult skills.



Note: Module 1 uses unmatched group-level pre/post data; Modules 2–4 use paired retrospective BEFORE–AFTER ratings.

Figure 9. INVITE OERs: Overall BEFORE and AFTER self-assessment by module

Summary of overall module means. Module 1 uses unmatched group-level pre/post data; Modules 2–4 use paired retrospective BEFORE–AFTER ratings.

4.4 Recommendations for future projects

Based on the results across all four modules, the following recommendations are proposed.

1. Use baseline knowledge to calibrate theoretical input

A short baseline assessment can distinguish concepts students genuinely do not know from competences they already recognise. Unfamiliar concepts should receive concise, explicit teaching, followed immediately by application. The aim is not to eliminate theory, but to use it at the point of need.

2. Treat empathy and communication as practical competences, not only attitudes

Because students may already agree that empathy and communication are important, future OERs should spend less time explaining why they matter and more time practising listening, adapting language, checking understanding and responding to insecurity or frustration.



3. Use performance-based evaluation for interpersonal skills

Combine self-assessment with structured role-play, peer or facilitator feedback, simple behavioural rubrics and, where feasible, feedback from real or simulated users. This would strengthen evidence of actual communication and patient-centred behaviour.

4. Increase authentic practice with digital-health tools

Practical use remained somewhat less strong than conceptual understanding. Future projects could include simulated telehealth interactions, patient portal demonstrations, app tasks, step-by-step support for an older user, digital consent scenarios and data-sharing decisions.

5. Keep Design Thinking strongly user-centred

Module 3 results support continued emphasis on unmet needs, user involvement, testing, accessibility and age-friendly design. Students should experience first-hand that a technically good idea can still fail if it does not respond to real users.

6. Use ethical dilemmas rather than ethics as abstract content

Short cases can integrate ethics, communication, empathy and digital competence. For example, students can decide how to respond when a patient agrees to use an app without fully understanding what data will be shared.

7. Design modules around competence progression rather than subject areas

The INVITE sequence - understand the technology, understand the person, develop a solution, act responsibly - provides a useful model for future learning pathways and may be more meaningful than isolated subject blocks.

8. Assess fewer things, but assess the important things better

Future evaluations could use fewer self-assessment statements and a small set of complementary measures: short pre/post knowledge questions, an applied task or simulation, observed communication, one focused reflection question and a confidence self-assessment. This would provide richer evidence while reducing questionnaire burden.



9. Prefer practical depth over task quantity

Student feedback, particularly from Module 2, favoured practical and interactive activities while some students asked for fewer or less repetitive tasks. Future OERs should prioritise meaningful practice over volume of activities.

4.5 One overarching lesson

Students need theory most where they do not yet have a conceptual map. They need practice most where they already believe they know what to do.

Low baseline familiarity with entrepreneurship, incubation, Design Thinking and digital-health ethics justified concise conceptual teaching. By contrast, high self-ratings for empathy and communication do not necessarily equal demonstrated ability, so these competences require practice and observation.

Determine the need → teach only what is genuinely new → practice what is difficult → observe performance → reflect → practise again.