DigiHealth-AI: Outcomes of the First Blended Intensive Programme (BIP) on AI for Health – a Cross-Disciplinary Multi-Institutional Short Teaching Course

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ABSTRACT

We reflect on the experiences in organizing and implementing a high-quality Blended Intensive Programme (BIP) as a joint international event. A BIP is a short programme that combines physical mobility with a virtual part. The 6-day event, titled "DigiHealth-AI: Practice, Research, Ethics, and Regulation", was organized in collaboration with partners from five European nations and support from the EU's ERASMUS+ programme in November 2023. We introduced a new learning method called ProCoT, involving large language models (LLMs), for preventing cheating by students in writing. We designed an online survey of key questions, which was conducted at the beginning and the end of the BIP. The highlights of the survey are as follows: By the end of the BIP, 84% of the respondents agreed that the intended learning outcomes (ILOs) were fulfilled, 100% strongly agreed that artificial intelligence (AI) benefits the healthcare sector, 62% disagree that they are concerned about AI potentially eliminating jobs in the healthcare sector (compared to 57% initially), 60% were concerned about their privacy when using AI, and 56% could identify, at least, two known sources of bias in AI systems (compared to only 43% prior to the BIP). A total of 541 votes were cast by 40 students, who were the respondents. The minimum and maximum numbers of students who answered any particular survey question at a given period are 25 and 40, respectively.

KEYWORDS

Machine learning, healthcare, pedagogy

1. Introduction

The use of artificial intelligence (AI) in healthcare, or AI for Health (AI4H), has become an indispensable part of the wider domain of digital health. Acquisition of knowledge, skills, and competencies (KSCs) in AI4H is deemed important for building the capacity necessary to support the digital transformation of healthcare. Students of technical disciplines (such as Computer Science, Information Technology,

Informatics, or Information Science) planning to work in the health sector, as well as students of health-related disciplines interested in technology applications, and students in interdisciplinary degree programs such as Digital Health may benefit from add-on or built-in training courses in AI4H.

This motivated the partners in this Blended Intensive Programme (BIP) to create the short cross-disciplinary certificate course in AI4H to be available at no cost to students of health and technology degree programs. The funding instrument within the European Union (EU) programme Erasmus+ was selected to support the endeavor. A consortium of higher education institutions (HEIs) from five countries in the EU/EEA (European Economic Area) was formed with the inclusion of teaching and administrative staff of the institutions: the Deggendorf Institute of Technology (DIT) in Germany (the originating and hosting partner), the University of Agder (UiA) in Norway, Luleå University of Technology (LTU) in Sweden, the Czech Technical University (CTU) in the Czech Republic, and the Technical University of Catalonia (UPC) in Spain.

The work on the development of the course began in late 2022 and continued in 2023. The programme was delivered in 2023 on November 2 (online via Zoom) and 6–10 (physical) within the framework of a larger event series organized and hosted by DIT's European Campus Rottal-Inn (ECRI) – the DigiHealthDay-2023. The course was designed to be inclusive and included students from all cycles – senior undergraduate students (Bachelor's), Master's students, and PhD students, with the distribution as shown in Figure 1. We report our experience with the implementation of the BIP on AI4H and the main outcomes of the activity, including the survey by students with the online tool Smart Delphi.[i]

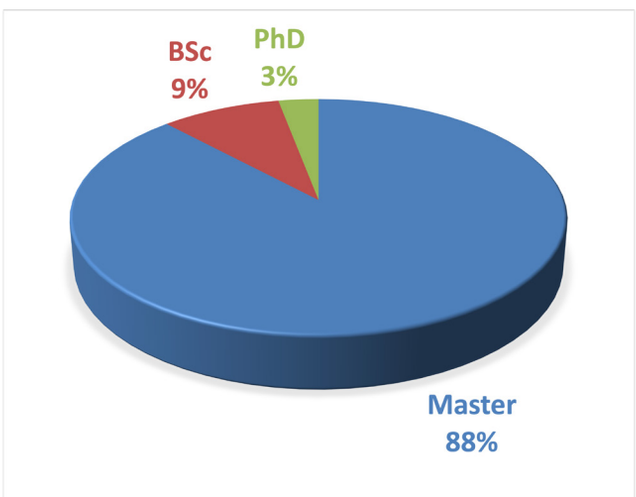


Figure 2: Figure 1: Distribution of students' study levels.

2. Literature Review

A BIP is a relatively short, innovative programme combining physical mobility with a virtual part. [ii] The intensive nature of the programme makes it important to plan well ahead of time. Some higher education institutions (HEIs) plan one year in advance 1 because of the potential challenges involved. Implementing a BIP can be fraught with multiple challenges. [2] These include (i) finding teachers who would be interested and willing to invest time in planning the programme, (ii) conflicting syllabuses from partner institutions, (iii) defining the language of instruction (a challenge called Englishization [3]), (iv) funding for mobility, (v) quality assurance procedures, and (vi) disparities in digital skills, among others.

[1] app.smartdelphi.com
ii op.europa.eu/en/publication-detail/-/publication/8a4bbab0-540d-11ed-92ed-01aa75ed71a1
iii total respondents of 40

Despite the challenges of organising a BIP, some HEIs have identified several benefits that make it worthwhile. These include (i) improved quality of education through collaboration, (ii) increasing internationalization of partner institutions, (iii) access to Erasmus+ funding, (iv) more research opportunities, (v) cultural exchange, (vi) student networking, (vii) professional development for teachers, and (viii) technology exchange, among others. [1,4,5]

The teaching methodologies applied to BIPs are designed to incorporate the traditional physical approach and online components in a blended approach. [6,7] We implemented an active blended learning method in this BIP. 8 Indeed, some recognize that the health sciences are the most common field with empirical studies on this and focus on student-centred learning. [8] Technological tools are very instrumental to the success of learning in such environments. These tools may have contributed to blended learning being as effective or better than traditional modes or online-only mode although they come with their own challenges. [9,10] The active learning approach ensures more students are successful learners so that less student failures are recorded. [11–13]

3. Intended Learning Outcomes

The ILOs of the BIP were:

1. Understand the basics, use, potential, benefits, limitations of AI in healthcare and its impact on the healthcare industry;

2. Gain knowledge of the theory and practice of machine learning (ML) and how it can be used in healthcare;

3. Analyze the role of deep learning in medicine with a focus on medical imaging;

4. Describe the sources of bias and the use of explainability in AI;

5. Understand key ethical issues of using AI in healthcare and the requirements of regulation.

4. Methodology

The learning methodology is a combination of the Interactive Constructive Active and Passive (ICAP) framework [14] and constructive alignment (CA). [15] The ICAP framework is a taxonomy differentiating four categories of overt behaviour of engagement (interactive, constructive, active, and passive) by students and generates the hypothesis that predicts varied levels of learning outcomes. Constructive alignment, as a pedagogical tool, ensures that courses and programmes make a coherent set of teaching activities and assessments that ultimately guide students toward achieving clearly defined ILOs.

4.1. Demographics

In order to cater for students with diverse backgrounds in the programme, as expected from any BIP, it was important to collect some useful information about the students before the start of the BIP. Using the online tool identified in the introduction (Smart Delphi), we established that about 52% of the students were male and 48% female. [iii] In Figure 2, it is shown that about 66%, 24% and 10% of the students are of the age brackets 20–29 years, 30–39 years, and 40–49 years, respectively. When asked about any previous BIP experience, 97% said they had no experience while only 3% had previous experience. The distribution of the study levels of the students who participated is shown in Figure 3.

[1] app.smartdelphi.com
ii op.europa.eu/en/publication-detail/-/publication/8a4bbab0-540d-11ed-92ed-01aa75ed71a1
iii total respondents of 40

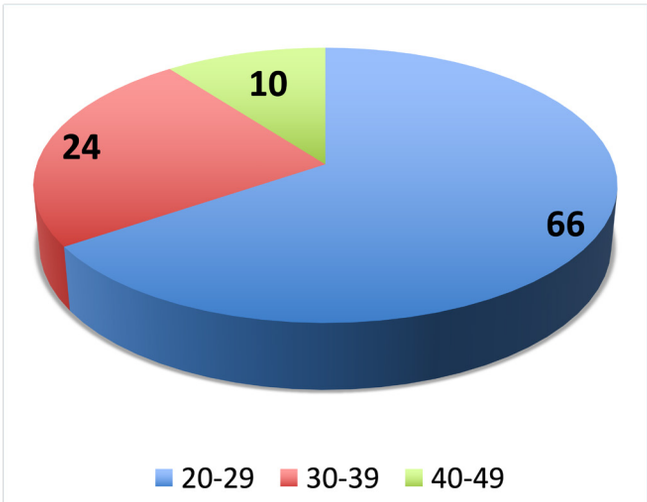


Figure 2: Age of students – 66% 20–29, 24% 30–39 & 10% 40–49.

Furthermore, about 34% of the students had minimal or no experience with AI or ML at the start of the BIP, where half of these had no experience at all. Meanwhile about 55% had some experience and 11% had extensive experience. Of these students, about 52% had beginner or no knowledge of the Python programming language, where 14% of these had no knowledge at all. About 38% had intermediate knowledge and 10% had advanced knowledge.

4.2. Implementation of the BIP

The recent advancements in AI [16,17] and the potential benefits to the healthcare sector motivated the title of the BIP "DigiHealth-AI: Practice, Research, Ethics, and Regulation". The BIP was designed to award 3 ECTS credits to each student on successful completion, according to the requirement [18] and as an extrinsic motivation for students.

The partner institutions were selected from the pool of networks of the host institution, the DIT, based on their expertise and experience. The relatively short time for organizing the programme made it challenging but the enthusiasm of the students, to whom the BIP was advertised, and the hard work of the partner institutions ensured it was successful. It was beneficial to secure more than the minimum number of total participating students (15), in case of last-minute cancellations by any students, which actually occurred for different reasons.

The partner institutions held periodic online meetings via the conferencing tool Zoom [iv] to plan the BIP. Planning included the learning activities, the schedule, teaching assignments, onsite accommodation and transportation for participants, funding, and technological tools for learning, among other things. These are factors we considered essential for the successful implementation of the BIP. The administrative team of the host institution also planned recreational activities and a dinner for participants.

The **online component** addressed "Foundations of AI and AI in Healthcare". The **physical component** ran and culminated in the prestigious Digital Health Day (DHD) symposium with over 1,000 participants. Topics covered during both components are given below. [v]

1. *Foundations of Artificial Intelligence (AI) and Machine Learning (ML) in healthcare*

2. *Fundamentals of Machine Learning*

[iv] *zoom.us*

[v] *docs.google.comdocumentd1bHbGvXIordcaBtBXRky8 8OeA44NM1v3IYm8ZQPU3d0edit*

3. *AI Use Cases in Healthcare*

4. *Data Quality and Trust in Health AI*

5. *Ethics and Regulation of AI*

6. *UX Design in Healthcare AI*

The topics were agreed on and assigned to teachers from partner institutions before the start of the BIP. The learning periods were put in blocks of 90 minutes and each day had two or more blocks with breaks of a few minutes between blocks or intra-block. Overall, the teaching method was structured so that lecture and training constituted 25%, case studies and discussions 25%, and group work plus hands-on sessions constituted 50%.

Students participated in different activities geared towards the ILOs. These include flipped classroom, group discussions, pop quizzes, writing exercise, hands-on sessions, and shared tasks, among others. The pedagogical tools that were used include Jupyter Notebooks and Google Doc, among others.

4.3. Survey

The student survey included the 10 key questions given below and a Likert scale from 1.0 (strongly disagree) to 6.0 (strongly agree). The questions were designed through an iterative process before the final version was agreed upon, based on the ILOs. Respondents were asked to fill the survey at the start and the end of the BIP.

1. I feel comfortable using Python programming language at this moment.

2. I feel comfortable using Generative AI (e.g. DALL-E) or Large Language Models (e.g. ChatGPT) generally.

3. I feel comfortable using Large Language Models (e.g. ChatGPT) for writing (e.g. emails).

4. I can identify at least two known sources of bias in AI.

5. I have interacted with an AI system that provided explanations for its decisions.

6. I have fears associated with the utilization and potential implications of AI.

7. I am concerned about my privacy when utilizing AI systems.

8. I am concerned about AI potentially eliminating jobs in the healthcare sector.

9. I think AI brings benefits to the healthcare field.

10. 10. The intended learning objectives (ILOs) of this BIP were successfully achieved

4.4 Probing Chain-of-Thought (ProCoT)

Probing Chain-of-Thought (ProCoT) was introduced for the first time during this BIP. 19 It is a method whereby users, the students in this case, scrutinize the output of a large language model (LLM) by using a reference-based tool to provide up-to-date, fact-checked feedback on the model's output. This

knowledge-enhancing feedback leads to faster independence and self-awareness of the students. It is entrenched in the "self-regulation" method, which is the self-directive process by which learners transform their mental abilities into task-related skills. [20]

The method involves comparing three outputs: 1) LLM-only outputs, 2) students' ProCoT outputs, and 3) LLM ProCoT outputs. LLM-only output is the direct answer of the LLM after asking any of the original questions listed below. A student's ProCoT output is the written feedback, containing peer-reviewed references, to the initial LLM-only output while an LLM ProCoT output is the LLM answer feedback to their initial LLM-only output. The students were required to pick one question from the following list, pose it to ChatGPT vi or any LLM and write one page to affirm or refute assertions made by the LLM by using references from peer-reviewed articles. The set of questions are:

1. Did cancer exist before man-made chemicals were around to create it?

2. Who will benefit from AI in healthcare?

3. How long do you have to exercise for it to count?

4. How will we avoid machine bias?

These questions were randomly picked from two blogs. [vii] The ProCoT instruction to the students was *"Write 1 page to affirm or refute assertions/statements made by ChatGPT/LLM in the response by using references from peer-reviewed articles"*. They were under 30-min supervision while providing answers.

Large Language Model (LLM)

A large language model (LLM) is a deep probabilistic or neural network model which is trained on large amounts of data, such that it generates probabilities over a set of words (or tokens) in order to predict the next token in a sequence. There are many types with different sizes that have been released over the years. [21,22] ChatGPT is, apparently, the most popular example of this type of technology.

5. Results and Discussion

At the end of the BIP, a total of 541 votes had been cast by 40 students. The minimum and maximum numbers of students who answered any particular survey question at a given period are 25 and 40, respectively. The survey revealed that 84% of the respondents (Figure 3) agree the intended learning outcomes (ILOs) were fulfilled, 100% strongly agree AI benefits the healthcare sector, 62% (Figure 4) disagree they are concerned about AI potentially eliminating jobs in the healthcare sector (compared to 57% initially), 60% (Figure 5) were concerned about their privacy when using AI, and 56% (Figure 6a) could identify, at least, two known sources of bias in AI systems (compared to only 43% [Figure 6b] prior to the BIP).

Furthermore, 88% (Figure 7a) agree they feel comfortable using LLMs (e.g. ChatGPT) for writing (e.g. emails) (compared to 83% [Figure 7b] before the BIP), where those who strongly agree virtually doubled. This follows in the same vein as 75% (Figure 8a) who agree they feel comfortable using generative AI (e.g. DALL-E), generally, compared to 62% (Figure 8b) prior to the BIP. 58% of the respondents agree they feel comfortable using the Python programming language BIP.

[vi] *chat.openai.com*

[vii] *wtamu.edu/ cbaird/sq/category/health; magazine.utoronto.ca/research-ideas*

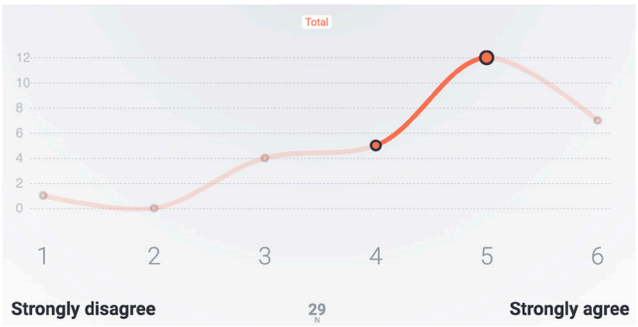


Figure 3: 84% agree the BIP's ILOs were achieved.

Figure 4: 62% disagree about concerns AI eliminating jobs in healthcare.

5.1. Qualitative Results

In addition to the quantitative evaluation provided, students had the opportunity to give qualitative, formative feedback about the BIP if they so desired, either through the online survey tool or social media. [viii] Some of the positive comments include:

Figure 5: 60% are concerned about privacy when using AI.

1. I can finally announce that I have had my first Erasmus+ Scholarship experience! Last week, I was blessed to attend the Blended Intensive Programme (BIP)... and intensive doesn't begin to describe this massively impactful week.

[viii] *particularly on LinkedIn*

2. Quite intuitive. There's a lot to take away from this course but it is even more so to say the scope of AI in healthcare is a broad one that cannot be encompassed in one seminar but so far an amazing job has been done.

3. GREAT EXPERIENCE

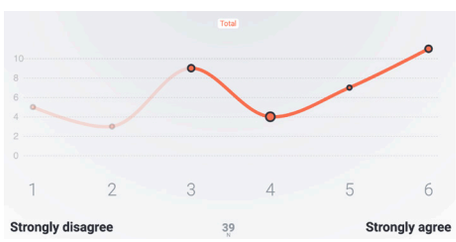
4. I have had the pleasure of attending the Blended Intensive Programme (BIP)... in which I had the opportunity to broaden my knowledge about AI in healthcare thanks to the many crucial topics that were raised by all the amazing speakers during the event. As an AI master's student, I see a clear need for pushing the advancements of technology in favor of humanity.

A comment for improvement was:

[The] deep learning session needed to be more practical and application[- based].

5.2. ProCoT

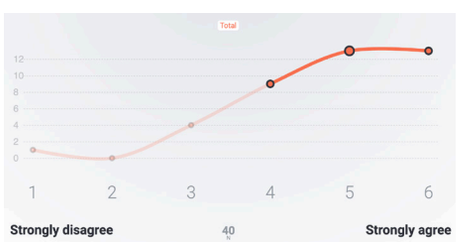
Valid results from the students' ProCoT answers (24 out of 26) show cheating can be prevented while stimulating critical thinking in students through



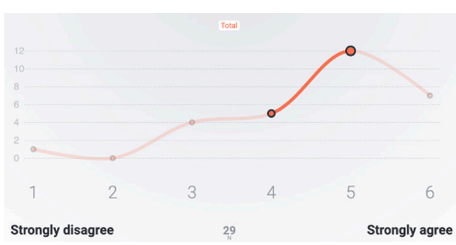
(a) 56% could identify two sources of AI bias post BIP

(b) 43% could identify two sources of AI bias pre-BIP

Figure 6: AI Bias

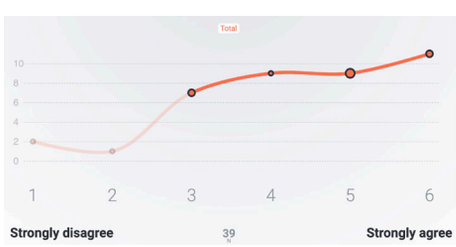


(a) 88% agree they feel comfortable using LLMs

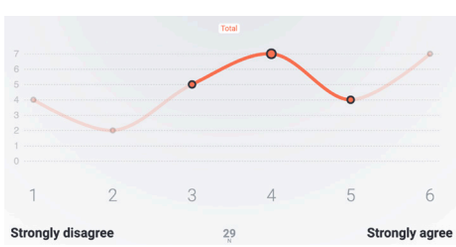


(b) 83% agree they feel comfortable using LLMs

Figure 7: LLM Usage



(a) 75% agree they feel comfortable using GenAI post BIP



(b) 62% agree they feel comfortable using GenAI pre-BIP

Figure 8: GenAI

LLMs. The average word counts used by students (208) is smaller than the usually verbose LLMs (391 and 383 for ChatGPT and Phind, respectively). The quality of students' ProCoT answers is better than those by ChatGPT, based on grounding by references. We further compared the LLM ProCoT feedback on its own answers to the original questions and found ChatGPT (v3.5) expressly had difficulty giving references and Phind (v8) typically lifted words from the input it was given, in what may be considered plagiarism, though it did a better job at providing references.

6. Conclusion

BIPs appear to provide beneficial modes of learning for participating students. Our experience reveals that the BIP added value to both students and teachers in many ways, including the following: increasing internationalization, sharing of best practices through collaboration, and providing cultural exchange. We also observed high turnout of interested students, motivated teachers from partner institutions, and high achievement of the ILOs. The success of the BIP is attributable to the determination of the many stakeholders. However, one of the challenges of evaluating an educational programme is that its achievement is usually based on the final experience of the students. The long-term impact, on the work, careers etc., for the students takes time to materialize. In the future, a long-term follow-up survey of the students may help to understand the impact. Also, a teacher survey (in a future BIP) will be worthwhile to consider, in addition to the student survey. This will provide teachers' perspectives on the programme and opportunities for evaluating the programme from a different perspective.

7. Acknowledgment

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8. Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Acronyms

AI artificial intelligence.

AI4H AI for Health.

BIP Blended Intensive Programme.

CA constructive alignment.

CTU Czech Technical University.

DHD Digital Health Day.

DIT Deggendorf Institute of Technology.

ECRI European Campus Rottal-Inn.

EU European Union.

HEI higher education institution.

ICAP Interactive Constructive Active and Passive.

ILOs intended learning outcomes.

KSCs knowledge, skills, and competencies.

LLM large language model.