Is Online Teaching Dead After COVID-19? Student Preferences for Programming Courses

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***Abstract*—The COVID-19 pandemic precipitated an unprecedented paradigm shift in higher education, compelling swift adaptation to online teaching methods. Consequently, the merits of remote education, including increased flexibility and geographic independence, were emphasized. At the same time, however, the problems associated with distance education became apparent, such as the lack of networking, collaborative learning, and social interactions. This situation led to detrimental effects on student motivation and learning outcomes in team-oriented software engineering courses.**

To address the dichotomy of learning preferences, one potential solution proposed is the simultaneous offering of online and onsite instruction. However, such a proposition presents substantial logistical challenges, necessitating additional resources, labor, and organizational overhead. This research paper presents a case study conducted during an introductory programming course, which serves as a precursor to a comprehensive, practical software engineering course. Upon easing of COVID-19 related restrictions, the instructors offered both online and onsite versions of this course and obtained student feedback through interviews to draw a comparative analysis.

The study outcomes provide crucial insights into students' preferences with respect to learning modalities in higher education, particularly within the software engineering discipline. The results indicate a predominant preference for the onsite version of the introductory course. Reasons attributed to this preference include enhanced social interactions, greater enjoyment, and increased motivation, thus highlighting the irreplaceable value of face-to-face education.

***Index Terms*—higher education, online learning, onsite learning, software engineering, capstone course**

I. Introduction

The COVID-19 pandemic instigated unprecedented rapid changes across universities globally, necessitating a swift transition from in-person to online modes of learning [1]–[4]. Prior to the pandemic, the United States already exhibited a trend towards digital education, with nearly 70 % of higher educational institutions acknowledging online teaching as a crucial component of their prospective strategies [5].

However, the pandemic-induced exigency expedited the digital transformation process, accomplishing in mere days what typically requires months or even years [1], [4], [6]. Therefore, some researchers state that this contemporary education was rather "emergency remote teaching" [1], [3], [7]. It lacked careful design and evolution, which are fundamental pillars in effective online teaching [1], [3]. This resulted in amplified stress levels and a reported decline in academic performance among students [3], [4], [8].

Online learning encompasses the utilization of multimedia, technological devices, and the Internet as pedagogical tools, with a particular focus on replacing in-person meetings with online equivalents to facilitate learning [1], [2], [4], [5], [9]. Implementing online learning, however, comes with its own set of logistical challenges and costs. For instance, pre-existing onsite methodologies may not necessarily translate effectively to a remote teaching context, requiring additional preparation time for course development [1], [2], [5], [10], [11].

Other fundamental prerequisites, such as a stable, high-quality Internet connection, may present additional hurdles for some students [1], [7], [9], [11]. Instructors may find it challenging to identify students who are disengaging or isolating themselves within a digital context, a concern more readily addressed in an onsite setting [12]. It takes a lot of will power to reach out to someone via call or text in comparison to simply going over and talking to the person [13]. The potential for academic misconduct also rises in an online environment [1], [2], [10].

Despite these challenges, online education offers advantages including flexibility and the ability for students to self-pace their learning [1], [2], [4], [11], [14]–[17]. This is especially beneficial for students with physical disabilities or care-giving responsibilities, enabling them to integrate their academic pursuits within their daily routines [2], [14]. Furthermore, students residing in unsafe neighborhoods can participate in evening classes without compromising their safety [14]. The perception of online learning has evolved significantly in light of the pandemic, with increasing numbers of educators and students recognizing its potential[1], despite previous criticisms.

This research paper presents a case study aimed at uncovering student preferences regarding online and onsite learning in higher education and their underlying motivations. While

[1]https://edtechmagazine.com/higher/article/2020/04/how-university-faculty-embraced-remote-learning-shift

much of the existing research has primarily focused on the efficacy of online education, our study seeks to provide an in-depth analysis of students' perceptions and opinions. We begin with a review of the existing literature on online education, followed by a detailed explanation of the study design, research questions, methodologies, and participant demographics. The findings are then presented and discussed, culminating in a set of recommendations for future courses based on the identified student needs and perceptions of an ideal introductory programming course.

II. Related Work

Zhang et al. examined the feasibility of online learning replacing traditional classroom learning, mentioning that several issues, such as frustration or confusion, may arise due to failing technology or poor design choices [11]. This may also occur when students lack control over the online tool. Looking for a fact within a long video can be time-consuming and nerve-wracking, whereas, most of the time in an onsite course, the teacher would provide the answer almost immediately. Therefore, they constructed a prototypical virtual mentor *"Learning By Asking"*, an interactive and flexible online tool for creating an E-Classroom. They conducted two studies where they assigned students randomly to the onsite and online courses. In the end, the average score of the online students was significantly higher. The reason is that students cannot participate in a lecture again and often do not ask for repetition, which is easily done in the online setting by rewinding and re-watching until they understand the content. For this reason, Zhang et al. noted as early as 2004 that multimedia and internet technologies are catalyzing the transformation of knowledge delivery and that online teaching *"is becoming a real alternative to traditional classroom learning"* [11]. However, they found no significant difference in students' satisfaction levels. In contrast, the study in this paper focuses on the personal preference of students regarding online vs. onsite teaching.

In 2015, Tichavsky et al. published a paper in which they analyzed students' course preferences [17]. They further took into account whether students did or did not have any online learning experiences. The results show that most students of both groups prefer face-to-face courses. Without any prior experience, 67% of those students stated they prefer onsite teaching, 29% preferred a combination of both while only 4% preferred online learning. In the group with experience, more are fond of online learning (20%), but nevertheless, 48% prefer traditional onsite teaching. The results in this paper support these findings.

In total, 56% favor fact-to-face courses, and 13.6% entirely online ones. Their motives for preferring traditional learning are generally speaking the same. Issues related to interaction are the most common ones (92%), where instructor interaction is mentioned the most, followed by motivational aspects (47%) and familiarity (20%). The frequency only differs significantly in three categories. Students with experience name lack of interaction negligibly less. The ones without any online learning expertise mention more often that they can concentrate better in the traditional setting and prefer it due to familiarity.

Another case study took place in Florida and targeted individuals aspiring to become insurance agents [14]. They first have to attend a mandatory pre-licensing course. The researchers compared the traditional onsite courses with an online course constructed by the OnLine Training Institute (OLT), all having the same instructor. The online course participants achieved the highest cumulative grade point average mean and were most successful at cognitive learning. Part of the reason was the fact that the instructor-to-student ratio was different: onsite instruction used a "one-to-many" ratio (1 instructor : X students), while online instruction used a "many-to-one" ratio (X instructors : 1 student) making the comparison somewhat invalid. The teacher's responses were not spontaneous but formal and structured. A common benefit was that when the instructor asks a question, everyone can respond, unlike in traditional classrooms where often only one student gets the chance.

In 2018, Dumford and Miller conducted research on whether online learning is associated with student engagement, which is a predictor of students' learning and development [10]. They concluded that this might promote quantitative thinking, while other types of engagement such as collaborative learning, student-faculty interaction, and quality of interactions are more likely to be positively influenced by onsite instruction. The same holds for discussions with diverse other students. The researchers state that the anonymity of online classes could be a limiting factor. A student may not realize how much a course member differs from themselves and therefore cannot benefit from the diverse interaction. The study in this paper did not focus on the diversity of the interaction but on the students' preferences.

A case study in the context of vocational education and training did not find any differences between onsite and online students concerning their perception of task value, which is linked to learning engagement, grades, and course completion [15]. The study in this paper shows clear differences in a software engineering course in a university context.

Online learning requires greater focus, additional motivation, maturity, and self-discipline to be successful [3], [5], [10], [11], [14], [15], [17]. This might be the reason why individuals stated that online learning is not fitting for every student [11], [14], [15]. In some disciplines like medicine, the application of online learning is more difficult, for example, due to the necessary hands-on practical experiences like direct-patient interaction [1].

However, in some fields like social science and humanities, there is proof that online teaching can be effective [1]. The same applies to the sector of computer science because Schmiedmayer et al. organized a course across and with three different universities distributed all over the world [12]. The course focused on software engineering with Internet of Things (IoT) applications in a global setting.

III. Course

An essential part of the informatics program at the Technical University of Munich (TUM) is to participate in a practical course. One of them is the iPraktikum [18], which is based on the chaordic learning approach [19]. Students get the opportunity to experience hands-on software development for real industry customers within an agile environment [20], [21]. Generally, the focus lies on iOS development, but projects can have additional, individual requirements, such as utilizing machine learning or augmented reality. The students who apply for it range from inexperienced bachelor's students to sophisticated master's students with profound knowledge gained during their years-long study. That causes the challenge of providing enough room for everyone to grow and ensuring enough base knowledge for the participants to properly work together. To achieve this, every student has to take part in an intro course where they learn the programming language Swift and get to know the basics of iOS development.

We investigated the students' preferences regarding onsite vs. online teaching in the context of the intro course of the iPraktikum. Traditionally, the intro course takes place onsite. Since the summer semester of 2020, the pandemic forced the design and application of online-only teaching. To host all the online learning resources, including lecture recordings, slides, and exercises, the online-only concept utilizes the open-source learning platform Artemis[2], which provides students with instant feedback based on automatic tests and static code analysis [22], [23].

In the winter semester of 2022, when the COVID-19 restrictions allowed it again, one intro course took place onsite and another one online. Therefore, students had the freedom to choose between attending the complete three-day mandatory onsite intro course or taking part in the online self-paced one. The following sections describe both options in detail and Figure 1 visualizes them.

The schedule of the onsite course shown in Figure 2 was released 14 days before its start on 10th October 2022. The self-paced online course was open from 5th September 2022 until 6th October 2022.

a) Option A: Three-day onsite intro course: In these three days, the students get insights into a variety of topics. The onsite intro course takes place in a reserved room within the university, where every participant has access to Wi-Fi and an external monitor. Students, who do not own a MacBook, which is required for iOS development, can lend one for the duration of the course. The participants get a place in a random row, which fosters interaction and exchange among students [12]. Each row consists of eight to ten students and has a dedicated tutor who helps them if questions arise. Different speakers present the topics, and three projectors installed in the room ensure that the displayed slides are visible to everyone.

Some sessions include live coding, where students and the tutor solve a programming exercise together. At the end of each day, new homework in the form of a programming

[2]https://github.com/ls1intum/Artemis

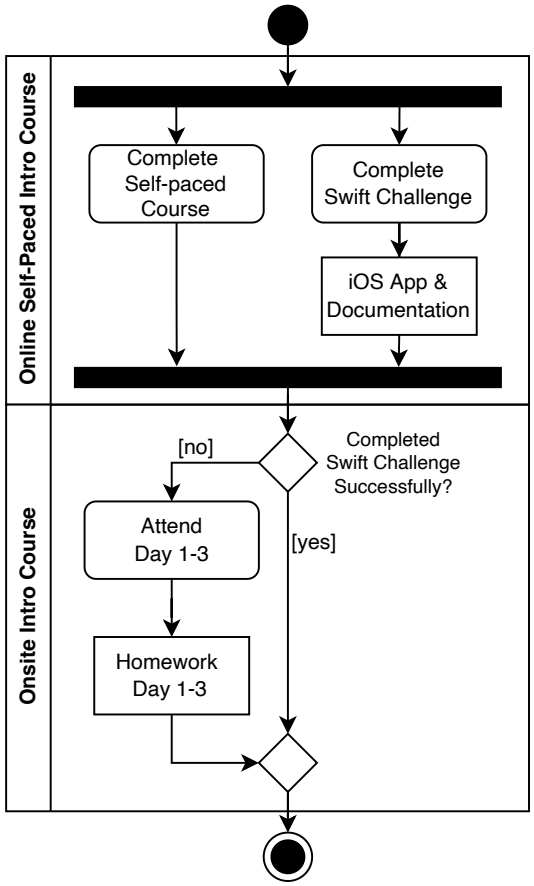

Fig. 1. UML activity diagram visualizing the two different options to complete the intro course.

Fig. 2. Timetable of the onsite intro course. The online self-paced course uses the identical distribution of sessions (Swift 1-3, App 1-3) and their contents.

exercise is released. To pass the intro course and qualify for the iPraktikum, students must finish all homework successfully by the 20th of October. Automatic test cases offer some support and if the submission takes place before the deadline, tutors give feedback on errors or unfulfilled requirements. Before and after the lectures as well as on the weekend, tutors are available to be consulted in person at the university or via Slack[3]. The timetable in Figure 2 marks these slots as *Lab Time*.

b) Option B: Online self-paced intro course: Students have the alternative to participate in the online self-paced intro course hosted on the learning platform Artemis. It utilizes the same distribution of sessions and covers the same topics as the onsite intro course. One month before the onsite one, students can teach themselves with the help of prerecorded educational videos from tutors and the same programming exercises with automatic test cases as used in the onsite course.

In general, no tutors are available to answer questions in this option. Only asynchronous communication via Slack is possible. All of the lectures and exercises are optional. What matters is successfully handing in the Swift Challenge, a self-written iOS app including documentation that fulfills each stated requirement and therefore covers all the learned concepts. Furthermore, each student has to take part in an interview to verify the authenticity of the submission. This option is beneficial for students with Swift experience as they can save time by not repeating already well-known basic concepts.

IV. Evaluation

This section presents the evaluation in the form of a case study performed during the intro course of the iPraktikum in the winter semester of 2022. We outline the research questions, research method and describe the participants.

A. Research Questions

The following research questions set the base for designing the interviews and surveys. The motivation behind RQ1 is to find whether the organization of intro courses is a reasonable effort. RQ2 and RQ3 help to determine which intro course type the students of the iPraktikum prefer and their rationale.

RQ1 Do students value an intro course?
RQ2 What are the main aspects influencing students' preferences towards online or onsite learning?
RQ3 Which version of the intro course do students prefer?

B. Research Method

We conducted interviews and two online surveys to find scientific answers to the research questions. The purpose of the interviews was to validate and refine the questions of the first survey. It covered the self-paced online course evaluation and their reasons for (not) participating in it. The second survey's goal was to evaluate the onsite intro course.

a) Interviews: To gain insights into why some students did not participate in the self-paced online course and their general opinion of different intro courses, we randomly reached out to 20 students and asked them to participate in a short interview. This qualitative analysis served as a basis for Survey 1, which evaluated why the students did not take part in the online intro course. The interview guide included ten open-ended and some closed questions, excluding follow-up ones to further investigate their sentiments. We conducted individual semi-structured interviews to give participants freedom in their answers but to still have a comparable basis for discussion, which is common practice in case studies [24]. Additionally, all interviews were video calls to make them feel as comfortable as possible and to not elicit a feeling of examination. The interviews took place during the exam retake phase, which is another reason to conduct them online to reduce the expenditure for participants [25]. Researchers claim that face-to-face interviews are only slightly more effective than online video calls [26].

b) Survey 1: Self-paced online course: This online survey addressed the remaining students who did not participate in the interviews. It started with some general questions and then, based on the previous responses, included questions about the self-paced online education and the challenge, either to evaluate them or to provide reasons for not participating. For the evaluation, we asked them general questions and some to measure their intrinsic and extrinsic motivation to compare the results with the survey examining the onsite course. We used a 7-point Likert scale [27], questions from the Intrinsic Motivation Inventory (IMI)[4] as well as from the Motivated Strategies for Learning Questionnaire Manual (MSLQ) [28]. At the end of the survey, participants had the chance to give recommendations within a text field.

The questionnaire adjusted if someone did not participate in the online self-study intro course. It then displayed questions with a 5-point Likert scale about their reasons for not participating, where the interviews formed the basis. The choice for a 5-point scale (1: totally disagree, 5: totally agree) rested on the fact that the displayed motive either was or was not a reason for them. There was no need to differentiate answers in a finely granular manner. However, we still wanted the participants to maintain their freedom while answering. Therefore, the value 3 was coded as neutral and there was the possibility to specify other reasons in a text field. The arrangement of questions was random to avoid impacts from the previous question onto the next.

c) Survey 2: Onsite course: For the second online survey, we used the 7-point Likert scale and the same method explained in b). To evaluate the whole course and every aspect of it, we included sample questions from the University of

[3]https://slack.com

[4]https://selfdeterminationtheory.org/wp-content/uploads/2022/02/IMI_Complete.pdf

Wisconsin-Madison[5] and the University of Berkeley[6], which also contain some open-text questions.

C. Participants

In total, 70 students participated as developers in the iPraktikum in the winter semester of 2022, to be precise 42 bachelor's and 26 master's students, as well as two exchange students. We informed them about the case study via Slack, E-Mail, and during the onsite intro course.

As the survey was voluntary, different numbers of students participated in each survey or even section. The exact amount of participants is explicitly stated for each part of the questionnaire in Section V. For the interviews, interviewees had to sign a document for their consent of participation including a privacy protection statement. We conducted the interviews on the 3rd and 4th of October 2022, and their length varied from 11 to 18 minutes.

We asked for their permission to record them, and everyone agreed. The two online surveys were hosted on the community version of the open-source survey tool LimeSurvey[7]. In every data collection process, we clarified that the participation is voluntary, their answers will be anonymous, and they will not affect their grades.

V. Results

In this section, we display the findings of the case study within the iPraktikum of winter semester 2022. The first finding regarding the online intro course is that only eight started the programming exercises. Solely five students uploaded code and therefore actively participated in at least one out of 20 possible exercises. We cannot measure who watched the videos provided on Artemis, but this makes only 7.1% engaging in the online exercises. Of all students, four (5.7%) submitted the challenge. Everyone passed the interview successfully and two of them used the programming exercises on Artemis to practice the required concepts. Another student only had a look at the programming tasks whereas the remaining student already had much experience in Swift.

In the interviews, we talked to six bachelor's (I1, I2, I3, I6, I7, I8) and two master's students (I4, I5), all studying computer science. Everyone stated to be excited about the onsite intro course. Having an intro course, in general, is important for six of the interviewees (I2, I3, I4, I5, I6, I8), whereas three (I2, I3, I6) even said that it is quite important. I7 appreciated the offer of an intro course. Besides, three articulated that they like the concept while naming the mandatory aspect (I1, I8) or even the boot camp style (I2).

Another question concerned the aspects of the onsite intro course the students looked most forward to. *"Meeting new people"* (I1, I2, I3, I4, I5, I6, I8), *"learn"* (I1, I2, I3, I5, I7, I8) and *"tutors/possibility of asking questions directly"* (I2, I3, I4, I8) were the most common answers.

[5]https://assessment.wisc.edu/best-practices-and-sample-questions-for-course-evaluation-surveys/

[6]https://teaching.berkeley.edu/course-evaluations-question-bank

[7]https://www.limesurvey.org

We further acquired insights into their reasons for choosing the onsite course. Figure 3 displays the most common results.

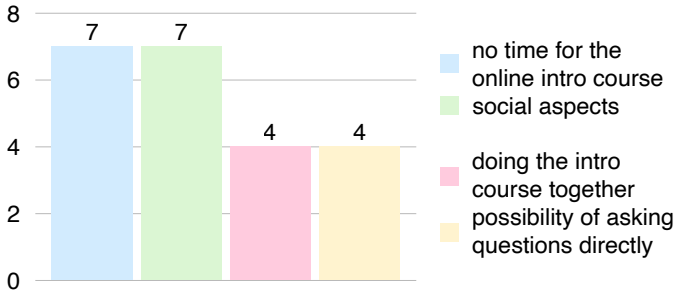

Fig. 3. Interviewees' most common reasons for not participating in the online self-paced course offer and challenge.

I1 explicitly mentioned that they thought the onsite one was more recommended by the instructors. I8, who already had some Swift experience, claimed that the challenge consumes a lot of time, as well as

> *"I don't think that skipping three days of the onsite course are worth it. I will do the exercises just because I want to, it's the way I learn. But personally, I wouldn't do it just to skip three days because three days is not that much, and you learn actually a lot and meet new people, which is also important." - Interviewee 8*

We asked six (I1, I2, I3, I4, I7, I8) interviewees if they would still join the onsite course if it was optional, and all of them said yes. To gain insights into whether online learning is in general an option for them, we let them imagine their perfect self-paced online course and asked them if they would still choose the onsite one. Only I3 disagreed, favoring the online intro course. I2, I4, I5, and I6 would still prefer the onsite course. I1, I7, as well as I8 would start seeing online as a viable option but still missing the social aspects of meeting and interacting with other students. Another finding was that four of them (I1, I3, I6, I8), representing 50%, stated they would use the self-paced course to prepare themselves for the onsite one. I3, I6, and I8 (37.5%) mentioned that if they had the time, they would still join the onsite course even if they successfully solved the challenge. One of them said:

> *"I am mostly coding on my own, that is just the way I can concentrate better, and I find it easier for me but ... since I just didn't have the opportunity to do this with other people because of Corona, now I think I am open to new ways of learning. [...] I don't mind going there even if I have passed the challenge before that. I don't expect to learn programming there [...], I just want to go there and enjoy it, and then the things that I need to learn, I'll do it on my own." - Interviewee 8*

In the first survey, due to the small number of participants in the self-paced course and the challenge, only three students answered the questions of the corresponding evaluation sections. The data is, therefore, not representative and will not be examined here any further. However, one aspect is applicable: Two out of three students responded that they took part in the self-paced course to prepare themselves for the onsite one.

Following the emergence of these findings, the primary emphasis shifted toward investigating the reasons behind students' aversion to online learning and their motivations for abstaining from participation. Subtracting eight interviewees from the total amount of students, 36 students (58%) participated in the first survey, and 22 (35.5%) completed it.

The first section deals with the self-paced course offer, which 24 students filled out. In the beginning, we checked whether they even had a look at the lectures and exercises on Artemis. Only five students did. Follow-up questions revealed that they did not feel overwhelmed by the amount of content. They did not find the exercises or lectures boring or the exercises unclear.

Table I summarizes the findings regarding their reasons for not participating in the self-paced online course. The order of responses follows the percentage of how many students agreed or completely agreed with the statements on the 5-point Likert scale. This applies to all numbers and percentages unless otherwise stated.

In the open text field, we received feedback that macOS could not be virtualized, that the concept of everyone being allowed to participate in the online course was not understood, and that one person was under stress at the time. Besides, we asked them if they would be *"very interested"* in participating in a self-paced course concept that takes place onsite or that has more social aspects, like working on exercises together in a small team. 25% agreed with the first and 41.7% with the second concept.

In the next section of the first survey, we covered solely the Swift Challenge, a self-programmed app that fulfills all the requirements and is essential for passing the online intro course as described in Section III.

In total, 20 students filled it out, and eight of them had a look at the requirements, which are more than the five students who had a look at the learning material on Artemis. We asked these eight students if they felt overwhelmed by the requirements, three agreed, and if the challenge seemed very hard, where two agreed. No one agreed with the challenge seeming very boring, five even totally disagreed with the statement. Once again, we examined why they did not participate in the challenge, which Table II displays. In the open text field, we received no further reasons.

Inspecting the influence of COVID-19, we asked if the pandemic had a huge impact on their decision. In total, 75% disagreed, including 35% who totally disagreed. Only one student totally agreed with the statement, the rest, representing 20%, remained neutral. Moreover, 50% stated that even with the perfect self-paced online intro course they would still prefer the onsite one.

The upcoming findings are represented via the 7-point Likert scale, 4 being a neutral option. When stating *"agreed"*, we grouped the votes from 5 to 7 and the same applies for *"disagreed"* (1-3). We additionally examined the impact of duty and included the statement *"If the onsite intro course was also made optional, I wouldn't join it"*. The result shows a mode and median agreement of 1 and respectively 3. In percentages, 22.7% agreed, whereas 68.2% disagreed. Furthermore, we explored the advantages of online learning and inquired about the significance of study location or individual time autonomy for the respective individuals. For the latter one, five students representing 22.7% remained neutral, three disagreed (13.6%), the remaining 14 students (63.6%) agreed, and five of them even totally agreed (22.7%) with the statement.

The results for the importance of studying location independently are similar: two students disagreed (9.1%), six remained neutral (27.3%), 14 students agreed (63.6%), and again five of them totally agreed (22.7%) with the statement. The general expression *"For me, having an intro course is very important"* received an agreement of mode 4 & 5 and a median of 5, with six neutral answers (27.3%), four disagreeing (18.2%), and twelve agreeing (54.5%).

In the second survey, 37 participants filled out the first section. The overall rating, ranging from scores of 1 (very bad) to 10 (very good), achieved an average score of 7.6, a mode of 8, and a median of 8. 89.2% of the students are satisfied and rated the course with a 7 or higher. 40.5% rated the course difficulty as *"appropriate"*, 45.9% as *"hard"*, and the rest (13.5%) as *"too hard"*. Regarding the pace of the course, 24.3% gave the feedback *"appropriate"* whereas *"fast"* and *"too fast"* each got 37.8% of the votes.

From this point on, we used a 7-point Likert scale that reaches from *"not at all true"* (1) over *"somewhat true"* (4) to *"very true"* (7). Their intrinsic motivation was high concerning enjoyment (mode: 7, median: 6) and importance to do well (mode: 7, median: 7). However, the feeling of being under pressure was high (mode: 7, median: 6), and their competence feeling leaves room for improvement (mode: 5, median: 5). The tutors were very helpful (mode: 7, median: 7) and very quick (mode: 7, median: 6). The statement *"I got to know a lot of fellow students"* received modes of 4 & 5 and a median value of 5.

The students expressed the need for more breaks in between (mode: 7, median: 5) and some thought that the sections were time-wise too short (mode: 4, median: 4). Also, the course's workload and requirement appropriateness received a mode and median of 4. But the lecturers provided opportunities for interactive participation within the sessions (mode: 7, median: 6), and the course organization was in a manner that helped understanding the underlying concepts of Swift (modes: 6 & 7, median: 6). After all, feeling prepared for the iPraktikum got a mode as well as a median of 6.

In the second section, with 34 participants, the statement *"I would not participate again if the onsite intro course was made optional"* received a mode and median of 1. In the open answers text fields, all students stated that their expectations of

TABLE I
SURVEY 1: REASONS FOR NOT PARTICIPATING IN THE SELF-PACED ONLINE COURSE

Reason for not participating in the self-paced online course, N = 24	**students who agreed**
I think I will enjoy the onsite intro course a lot more.	66.7%
I think the onsite course will prepare me a lot better for the iPraktikum.	58.3%
I think I will exert myself a lot more in the onsite course than in the self-paced one.	50%
I prefer having a live teaching event over self-paced learning.	50%
In the onsite course, there are tutors who can immediately answer my questions and help me.	45.8%
I think I will learn a lot more in the onsite course.	41.7%
I had no time for it.	41.7%
I prefer learning together with people a lot.	33.3%
I am tired of online teaching.	33.3%
I easily get distracted at home.	25%
I prefer having a fixed timetable for my studies rather than having to plan it by myself.	25%
I think that learning in the onsite course will be a lot easier.	25%
I saw no benefits in participating in the self-paced course.	20.8%
It was in the lecture-free period.	16.7%
I think that the onsite course will be a lot more relaxed.	16.7%
I am already very experienced in Swift.	8.3%
I would rather watch videos about the topics on YouTube because they are way better.	0%

TABLE II
SURVEY 1: REASONS FOR NOT PARTICIPATING IN THE SWIFT CHALLENGE

Reason for not participating in the Swift Challenge, N = 20	**students who agreed**
I had the impression that the onsite one is more recommended by the instructors.	75%
I wanted to get to know people during the intro course.	70%
I prefer the onsite course because of the social aspects.	70%
I had the impression that I will have more benefits when participating in the onsite course.	65%
I prefer having a live teaching event over self-paced learning.	50%
I had no time for it.	45%
The challenge was described as very hard.	45%
Due to the interview and the possible failure after all the effort.	35%
Because of retakes.	30%
I am tired of solving online exercises at home.	25%
The challenge seemed to be too much effort in comparison to the first three onsite days.	25%
It is simply easier to sit for three days in the onsite course rather than participating in the challenge.	25%
It was in the lecture-free period.	20%
I was too lazy to inform myself about the challenge.	20%
I would have had a FOMO (fear of missing out) about the first three onsite days.	20%
I saw no benefits in participating in the challenge.	10%
I didn't know early enough about the details of the self-paced option to be able to integrate it into my plans.	10%
I noticed too late that I had this option.	5%

the intro course were fulfilled and appreciated most often the atmosphere, tutors, and other students as well as the provided Macs and that they learned a lot.

> *"Yes, my expectations were to learn Swift with cool people around me what was exactly what the course was. I especially enjoyed the vibe: Many excited students in one room learning together from other students." - Survey 2 participant*

The primary points of critique center on the workload, the level of individual pressure experienced, and the pace of the course. Afterward, we asked them to name one to three specific things which especially helped to support their learning. From the 33 answers we got, *"tutors"* were named 25 times, eleven times *"programming exercises"* and eight times *"slides"*, as well as six times *"other students"*, and four times *"homework"*. Moreover, we wanted to gain insights into the strengths of this course. *"Tutors"* were mentioned 17 times, the *"organisation/structure"* six times, it being *"practical"*, the *"slides"*, as well as the *"exercises"* each five times. Although we have received constructive feedback for improvement, due to its specific nature, we will not examine it within this work.

VI. FINDINGS

In the following, we discuss the findings and highlight the most important deductions, from which we derive suggestions for other intro courses in the conclusion.

> **Finding RQ1:** Students value and enjoy an intro course that prepares them for the iPraktikum.

All respondents were enthusiastic about the course. 75% consider an intro course important. In the first survey, ad-

ditional four people totally agreed with it (18.2%), and in total 54.5% voted 5, 6, or 7, therefore stating that it is rather important. But the modes are 4 and 5, and the median is 5 because many (27.3%) remained neutral. When we asked whether they would not participate in the onsite intro course if it was made optional, the mode and median of agreement in the first survey was 1 and respectively 3. However, in the second survey, both turned into 1, which suggests they value the onsite intro course even more after attending it.

The students appreciated having the option to choose between two intro courses (mode: 7, median: 6.5). Besides, the overall rating of the onsite intro course is high, 89.2% evaluated it with a 7 or higher, with 10 being the maximum. Combined with the fact that they enjoyed the intro course (mode: 7, median: 6) and only two failed it, this indicates that students successfully acquired the required knowledge to participate in the iPraktikum because they passed the intro courses. Nevertheless, they had fun and valued the time spent because even without mandatory attendance, most of them would still join it.

> **Finding RQ2:** Enjoying the onsite course, communication from instructors, social aspects, and lack of time beforehand are the main reasons influencing students' decisions.

A total of 50% who answered the survey responded that they prefer having a live teaching event over self-paced learning. 66.7% stated that they think they will enjoy the onsite intro course a lot more. In the second survey, their assumption of enjoying the onsite one was proven to be right (mode: 7, median: 6). Moreover, 50% stated that they think they will exert themselves more in the onsite intro course than in the online one.

These results align with Tichavsky et al., who also name motivational factors as a frequent reason for preferring face-to-face learning [17]. Less than 21% stated that they saw no benefits in participating in the self-paced course or the Swift Challenge. Thus, most students are aware of the advantages of online learning. However, 50% replied that even with the perfect self-paced course offer, they would still prefer the onsite one. Further, 65% answered that they had the impression of having more benefits when participating in the onsite one. Nevertheless, the results indicate that the advantages of online education, such as not being restricted to a specific time or location when studying, are also important to most of them (63.6%). All of these findings indicate that, from a student's perspective, the online course cannot compensate for the benefits of the onsite one.

Only 7.1% of all students solved at least one exercise on Artemis, which is a relatively low amount. From those who answered the specific sections of the first survey about their reasons for not participating in the online self-paced course, only 20.8% had a look at the lectures and videos and 40% at the requirements of the challenge. A significant portion of individuals did not engage with the online intro course. It seems like the students do not perceive the two courses as equal, but rather see the online course as an enhancement of the onsite one. This impression is derived from the interview answers, where half of the students stated that they would rather use the self-paced course to prepare themselves for the onsite one. Three of them would still join the onsite course even if they solved the Swift Challenge successfully. More evidence lies in the evaluation of the online offer, which we excluded due to its limited sample size. However, it is noteworthy that two-thirds of the participants indicated that they enrolled in the self-paced course to use it as a preparatory tool for the onsite course.

Most students decided against participating in the online offerings due to other reasons than the self-paced online course content or the challenge itself.

A huge impact on their decision was the way of communication the instructors chose to present the two options. 75% reported perceiving a bias from the instructors in favor of the onsite course, which affected their choice. Additionally, 58.3% thought that the onsite version will prepare them better for the iPraktikum, and 41.7% assumed they would learn more, which might be the reason for the unequal perception of the two courses. Furthermore, 45% were intimidated by the way the challenge was presented, they perceived it as *"very hard"*. However, this is not the case when using the self-paced material on Artemis. This impact is a limitation of this study because it affected the students' choice negatively towards online learning. Nevertheless, this is only a part of the aspects why the students prioritized the onsite over the online intro course.

One of the other reasons was the general presence of social aspects (70%), to be more precise meeting new people (70%), preferring to learn together with others (33.3%), and having tutors to answer their questions (45.8%). All of these benefits are not present in the online intro course. *"Tutors"* were named the most in the second survey when we asked them about the strengths of this course and what helped to support their learning. Even *"other students"* were mentioned in the latter one. This strengthens the statement that the online course cannot compensate for the benefits of the onsite one because students value them more, explaining why some students would rather participate in both than miss out on the onsite one. This is consistent with the article by Onyema et al., where they state that *"technology [...] cannot replace the important effect of face-to-face interactions by students and teachers"* [9]. Also, Zhang et al. found that *"e-learning environments cannot create the real life on campus"* [11]. Tichavsky et al. attribute it to the *"physical aspect of human interaction. Electronic interaction, no matter how frequent, may not be filling that aspect of the students' needs for social interaction"* [17]. In their study, the supposed dearth of interaction in general and especially the absence of teacher interaction was named for disliking the online course [17], which coincides with the findings.

We realized the importance of social aspects pretty early due to the interviews. Therefore, we asked in the first survey whether they would be *"very interested"* in taking part in a self-paced course with social aspects, like for example, working together in a small team. From those who answered the question, 41.7% agreed with the statement. Dumford and Miller also recommend this approach, because *"technology lacks a human component"* [10]. This illustrates the impact of social elements and the students' desire and request for them.

> *"In the Corona time, most of us noticed that it just isn't really the same when you are online even with face-to-face video communication, because humans are just wired that way."* - Interviewee 1

A basic requirement for participation in the online intro course is that a student has enough free time during the lecture-free period. It was another issue that prevented some to take part in online learning (41.7%) and the challenge (45%). While 30% answered that retake exams were a cause for not solving the challenge, only 20% indicated not completing the challenge because it took place in the lecture-free period. Even fewer (16.7%) named the conduction of the online intro course during the lecture-free period as a reason for not engaging with the Artemis content. Therefore, one of the main reasons for not taking the online intro course was having not enough time for self-study, rather than being bothered by the fact that it is in the lecture-free period. Apparently, this is altogether fine for most students.

> **Finding RQ3:** Students prefer the onsite over the online programming intro course.

The study hence suggests that students prefer the onsite programming intro course if they have the choice. This finding is not generally applicable to any course format. However, other researchers come, in their respective contexts, to the same conclusion: Students favor face-to-face learning [3], [4], [11], [16], [17], [29].

To evaluate if the findings have a long-term value, we explicitly asked the students whether the COVID-19 pandemic had an impact on their decision for taking the onsite intro course. As a result, 40% disagreed, further 35% totally disagreed, solely one person agreed, and the others remained neutral (20%). Only 33.3% stated that being tired of online learning made them choose the onsite intro course. These findings suggest that their opinion will not change and are, therefore, also applicable in the future. What further strengthens this assumption is the fact that the participants are in different stages of their studies, which means that most students have experience in online and onsite learning. In addition, studies conducted before the pandemic come to the same conclusion [11], [16], [17], [29].

There are other studies that suggest just the opposite. Hamdan and Amorri's study serves as an example, in which students tend to rate online approaches more positively than regular face-to-face learning [2].

VII. Limitations

The limitations are structured based on Runeson and Höst's categorization [24]. *External limitations* of this study include the small sample size of students from a single university. An intro course with a longer duration (i.e., 1-2 weeks) may yield different results than the three-day intro course evaluated in this paper. Therefore, the study results have limited applicability to any other introductory course design. Only students who meet the prerequisites of the course can participate. Their preference might differ from students who do not fulfill the course requirements. In addition, the data consists of subjective feedback and is consequently prone to error.

A threat to *construct validity* is that the study participants may have misunderstood the proposed questions. Further, some students only realized that the online course provides exactly the same Swift content as the onsite one because of the surveys, which shows a wrong perception of the participation mode. Finally, the instructors' way of communicating and therefore biasing the students' choices is an additional factor.

VIII. Conclusion

The main contributions of this research paper encompass a case study and a set of practical recommendations for educators involved in organizing introductory programming courses. The conducted case study accentuates not only the instructors' perspective but also underscores the importance of students' viewpoints in shaping the curriculum. The study elucidates students' pronounced preference for an onsite version of an introductory course when given the option between onsite and online modalities.

The results underline the indispensable role of social aspects in students' learning experiences, as well as the profound influence of instructors' communication methods. Consequently, we advocate for a comprehensive and detailed presentation of concepts to ensure a solid understanding across all participants. We recommend a neutral advertisement and presentation of both onsite and online course options, alongside providing ample opportunities for social interaction. If feasible, we suggest the engagement of tutors to aid students. These recommendations hold equal importance for online settings, underpinned by our findings of increased interest in online courses incorporating social elements such as team collaboration. This is consistent with the work of researchers such as Tichavsky et al. and Dumford and Miller, who emphasize the significance of high social presence in online courses [10], [17].

When resources permit, we recommend the implementation of an introductory course. The modality — onsite or online — can be determined via early-stage surveys, thereby aligning with students' preferences while optimizing resource allocation. In light of our findings, the default recommendation is to conduct the introductory programming course onsite.

In the context of the iPraktikum course, our study suggests that the online model may not be suitable. Therefore, future iterations of this course will be offered onsite exclusively, reducing organizational overhead while aligning with students' preferences, as shown in our case study. However, it should be noted that for other courses or different course formats, online instruction may still be pertinent.

For future research, we propose a cross-sectional study encompassing a larger sample size across multiple courses and universities to derive more universally applicable results. Alternatively, a longitudinal approach, re-evaluating the same context each semester with different cohorts of students, can provide valuable insights specific to the context. This approach would further elucidate preferred learning modalities, tailored to specific contexts.

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