Teaching Technical Content in Higher Education: A Comparative Analysis of Two Different Teaching Approaches

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The Barcelona Conference on Education 2024
Official Conference Proceedings

Abstract
Modern technology, such as automation and learning analytics, can positively impact education by enhancing opportunities for both teachers and students, promoting self-reliant learning, and improving the efficiency of the teaching process. However, earlier studies have also found that there are many teachers who are not eager to adopt new technologies in their teaching for various reasons, such as fear of unsuccess of trials or lack of capabilities to integrate tools into the teaching. In this paper, we are interested to study whether automation of teaching will provide benefits or not. We aim to provide an analysis of teaching technical content in automatized manner in higher education through a comparative case study. The case study includes Power BI teaching in two ways, the classical way and the automated way.

Keywords: Higher Education, Business Intelligence, Online Teaching, Automated Teaching, Learning Analytics

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Introduction

Due to fast technological development and digitalization, the current educational processes in higher education institutions emphasize the need for innovative ways to organize teaching. For example, teaching of demanding technical content for students can benefit from automation. Previous studies have suggested that automation can positively impact education by enhancing opportunities for both teachers and students, promoting autonomous learning, and improving the efficiency of the teaching process. However, earlier studies have also found that there are many teachers who are not ready to accept and adopt new technologies in their teaching for various reasons, such as fear of unsuccess of trials, lack of capabilities to integrate tools into the teaching, and lack of motivation or resources.

In this paper, we aim to provide a realistic picture of teaching technical content in an automatized manner in higher education through a comparative case study. The case study includes Power BI teaching in two ways, the classical way and the automated way. The classical way includes learning materials, lecture videos and traditional assignment, and the automated way includes specific training videos and automated teaching through virtual exam that has questions both about the training processes and the results. Through this case study the paper provides answers to the following research questions: 1) How does students' studying differ in the two comparable ways? and 2) Is automation possible in the light of the study results?

Theoretical Background

New technologies are nowadays integrated more into teaching practices to enrich instructional strategies and improve the quality of teaching and learning (Hatamleh & Hatamleh, 2024; Lee, 2018). There are several motivational factors behind this trend, but according to previous studies teachers are motivated to use emerging technologies in teaching especially due to pedagogical and pragmatic reasons, such as desire to gain more efficiency in teaching, and due to external imperatives, such as the demands caused by the development of technology and knowledge-oriented economy and recruiting organizations (Backhouse, 2013).

Even though expectations in new technologies for educational purposes are high (Wong, 2013), there are both negative sides and positive sides related to the trend of integrating technology in teaching. In overall, the benefits of integrating technology into education are rather widely recognized, leading to efficiency and improved education quality (Frank, 2006; Hatamleh & Hatamleh, 2024). A rather recent study of higher education students found that the implementation of technologies in class encouraged engagement especially in constructive and activity demanding activities, and in this way was positively impacting learning outcomes (Wekerle et al., 2022). Furthermore, the use of different kinds of education technology in higher education settings equips teachers with innovative tools, enriching students' learning experiences and maximizing competency especially in more mathematical and engineering subjects (Urban, 2015). In the light of this, teaching of technically demanding content such as Power BI could benefit from automation through modern technology.

However, there are also challenges, such as the need for technical skill acquisition of the teachers (Frank, 2006; Hatamleh & Hatamleh, 2024). Challenges in integrating technology into teaching exist also purely due to the lack of access to relevant technologies (Bećirović,

2023; Wong, 2013). Furthermore, as new technologies have revolutionized educational practices, they also challenge the traditional roles of teachers and students (del Carmen, 2013). It is also noteworthy that the use of technology in education raises also ethical issues related to teachers, students, schools, and software companies (Akcay, 2008) that need to be considered when developing and implementing these technologies.

To overcome the different kinds of challenges, various types of professional development programs have been suggested to improve teachers' pedagogical understanding and the integration of innovative approaches into their teaching practices (Hanewald, 2014). As the successful use of technology in the classroom depends primarily on teachers, professional training should be provided to enhance their competence and confidence in integrating modern technology into teaching.

In conclusion, the integration of new technologies in teaching has shown promising results in enhancing the teaching-learning process, motivating educators, and improving the quality of education. Technology-supported environments for personalized learning aim to create a functional learning environment for the student, tailoring instruction to meet individual needs (O'Donoghue, 2009). However, challenges such as technical skill acquisition need to be addressed to fully leverage the benefits of technology in education. Challenges in integrating new technologies into teaching include many things, such as need for support, motivation, relevant know-how and capabilities, and access to necessary tools (Bećirović, 2023).

Comparative Case Study

In order to analyze how technology integration into teaching affect the students and the learning outcomes, we carried out a comparative case study. We taught Power BI, a business intelligence tool offered by Microsoft as a desktop program and a cloud service, with which business information can be collected, analyzed and reported as interactive visualizations, to our higher education students in two different ways – the classical and the automated way. In following Figure 1 the key issues of these two pedagogical ways are summarized.

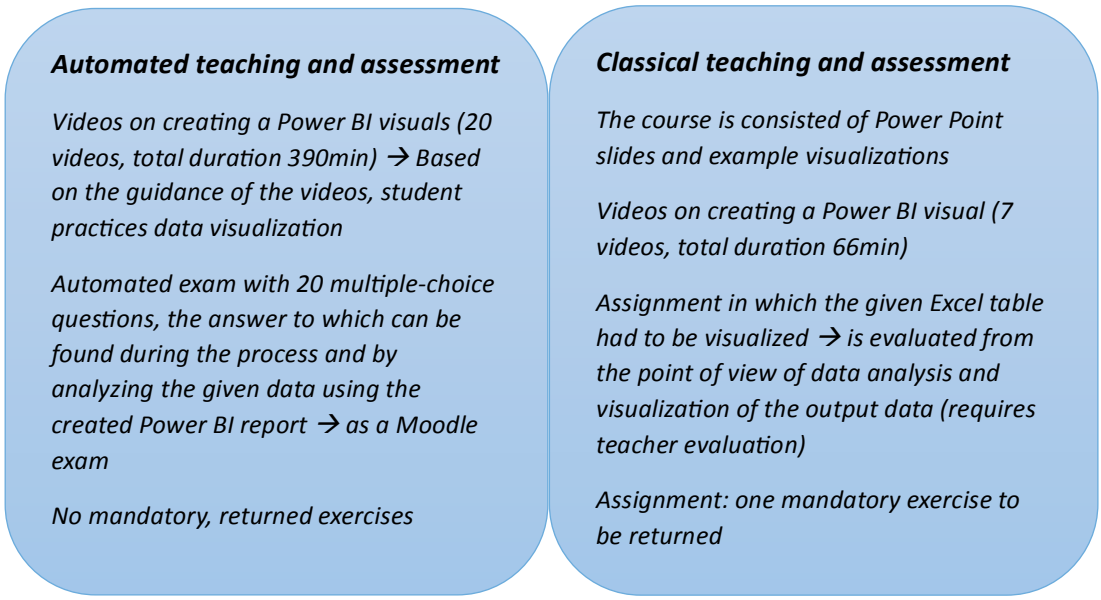

Figure 1: Teaching of Power BI in Two Ways

Total length of the videos in classical teaching course was 66min and in automated teaching it was 390min. Number of students in the classical teaching course was 64 and in the automatic course was 36.

The task to be evaluated in classical teaching was an assignment in which you had to create your own visualization of the given data. In automated teaching, assessment with a Moodle exam, where the correct answers to the statements can be found in the data provided using Power BI. In automated teaching, tasks are divided into small parts, so there is no need to manage the whole at the same time or create your own solutions "from scratch".

When automating teaching, it is not possible to commission a larger task in which the student should build and develop their own solution to a given problem.

Key Empirical Findings

The learning analytics data of these two courses enables us to analyze how does students' studying differ in classical and in automated ways. The data reveals for example how much time each student spend in watching videos in these two varying course implementations. In automated teaching, videos were watched more at the end of the course. The peak of the classical teaching was placed just before the return of the training work, but viewing was not so clearly focused towards the end of the course.

If we look more carefully the video viewing in relation to the total number of videos and the number of students (as a percentage), classical education looks at a higher proportion of the total video offering. Proportionating is needed in order to take into account the different number of students and the length of the videos. See the Figures 2 and 3.

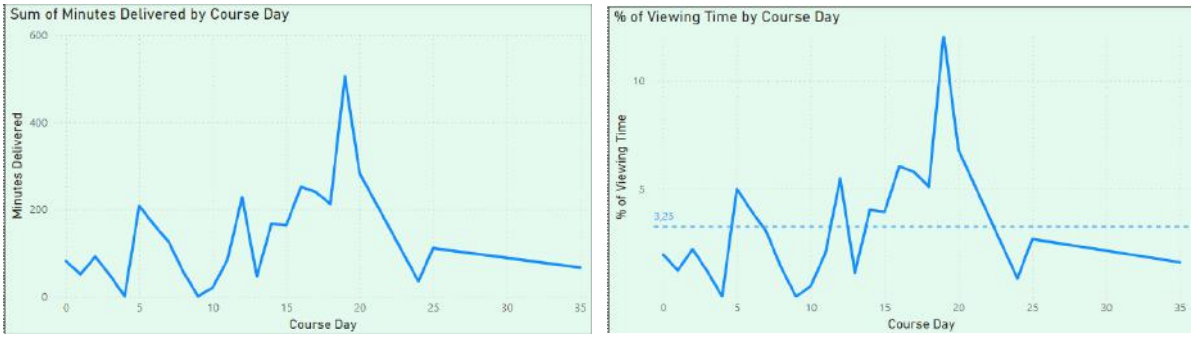

Figure 2: Video Watching Time in Classical Teaching, Watch Time in Minutes on the Left and Relative to Total Video Supply and Number of Students (percent) on the Right

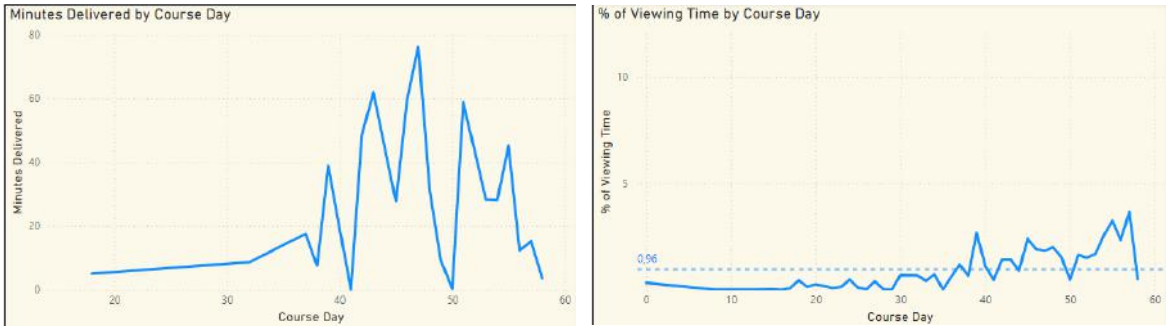

Figure 3: Video Watching Time in Automated Teaching, Watch Time in Minutes on the Left and Relative to Total Video Supply and Number of Students (percent) on the Right

In the classical teaching course, videos had a clear role to play in providing basic information, and after that, the assignment was carried out as independent work. In the beginning of the automated teaching course, the videos were related to hands-on activities and that's why they were mainly watched while the students were actually making the exercises. Furthermore, traditional teaching course videos were clear lecture videos, and the videos of the automated teaching course were more like wondering type of videos recorded as one take, where the teacher himself opened the data being processed for the first time and started thinking about what could be made of it and how. So at least if the students had basic skills of PowerBI, they were able to skip the video and at least watch most of the time at double speed. In other words, this partly explains the relatively small number of views and the emphasis on viewing towards the end of the automated teaching course.

The popularity of videos obviously varies according to the perceived importance of the student. This explains the high variety and in overall, there is no clear most interesting video in either of the teaching methods (see Figure 4).

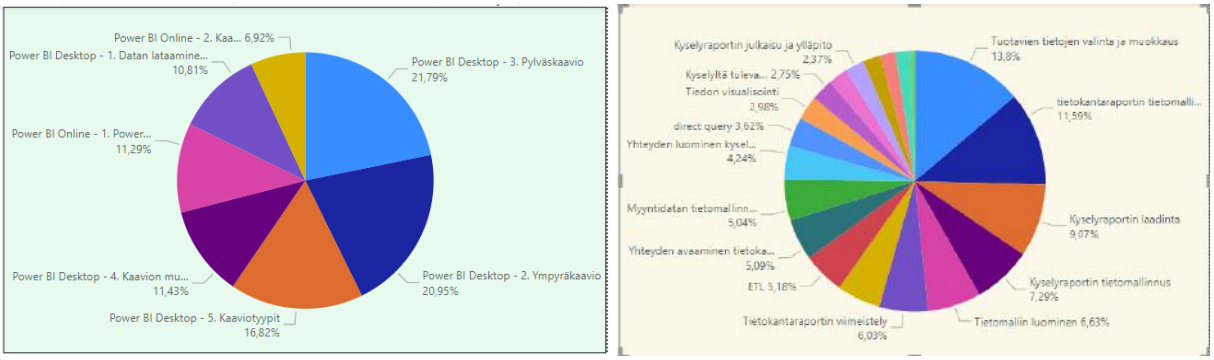

Figure 4: Relative Watch Times of Videos: In Left Classical Teaching course and In Right Automated Teaching Course

When more carefully analyzing the views of the videos on a video-by-video basis, the results show more variation (see Figure 5). In the following figures some of the video names/topics are in their original language (Finnish) as they were in the original system were the videos were provided for the Finnish students.

Video	Duration	Minutes Delivered	Sessions	Average Viewing Time	Average Viewing Time per Viewer
Power BI Desktop - 1. Datan lataaminen ohjelmaan	5,15	350,15	85	4,12	6,48
Power BI Desktop - 2. Ympyräkaavio	11,37	678,43	71	9,56	12,80
Power BI Desktop - 3. Pylväskaavio	14,37	705,68	62	11,38	16,04
Power BI Desktop - 4. Kaavion muodostuminen	7,23	370,16	67	5,52	8,61
Power BI Desktop - 5. Kaaviotyypit	9,05	544,72	69	7,89	11,59
Power BI Online - 1. Power BI-raportin julkaiseminen pilveen	9,90	365,60	52	7,03	10,16
Power BI Online - 2. Kaavion luominen	9,27	224,12	35	6,40	7,47
Total		**3 238,86**	**441**	**7,34**	**51,41**

Figure 5: Classical Teaching Course Video Viewing (Total Watch Time, Views, View Duration, Student Watch Time)

Video	Duration	Minutes Delivered	Sessions	Average Viewing Time	Average Viewing Time per Viewer
tietokantaraportin tietomallinnus	51,58	957,21	58	16,50	30,88
Tuotavien tietojen valinta ja muokkaus	42,47	1 139,48	64	17,80	31,65
Kyselyraportin laadinta	40,47	748,94	47	15,93	25,83
Tietokantaraportin viimeistely	31,87	497,70	39	12,76	19,91
Kyselyraportin tietomallinnus	27,80	602,13	47	12,81	20,07
Tietomallin luominen	26,23	547,64	29	18,88	23,81
Tiedon visualisointi	21,85	245,82	18	13,66	15,36
ETL	17,93	427,79	36	11,88	16,45
direct query	15,97	299,15	33	9,07	13,01
Yhteyden luominen kyselyn tuloksiin	15,53	350,33	38	9,22	13,47
Tervetuloa	15,03	448,39	48	9,34	14,01
Kyselyraportin julkaisu ja ylläpito	14,70	196,14	23	8,53	10,32
Myyntidatan tietomallinnus	13,72	416,37	49	8,50	12,25
Yhteyden avaaminen tietokantaan	10,60	420,68	62	6,79	10,79
Tietomallinnus - DAX	10,43	151,61	19	7,98	8,42
Kyselyltä tulevan datan muokkaus	9,63	227,04	41	5,54	8,41
Raportin luominen kyselyn pohjalta	9,08	199,44	28	7,12	8,67
kyselyn luominen osa1	6,22	180,59	36	5,02	6,69
kyselyn luominen osa2	5,48	157,68	32	4,93	6,31
Paikallisen tiedoston käyttö	3,43	44,29	14	3,16	4,43
Total		**8 258,40**	**761**	**10,85**	**168,54**

Figure 6: Automated Teaching Course Video Reviewing
(Total Watch Time, Views, View Duration, Student Watch Time)

When looking at the viewing of individual videos by calculating the watch time of the video in relation to the total number of videos and the number of students, it can be seen that in automatic teaching course individual videos were viewed relatively less than in classical (see Figures 7 and 8 below). The sum of the percentages is not 100, because it is proportional to the number obtained if all students completely watch all the videos.

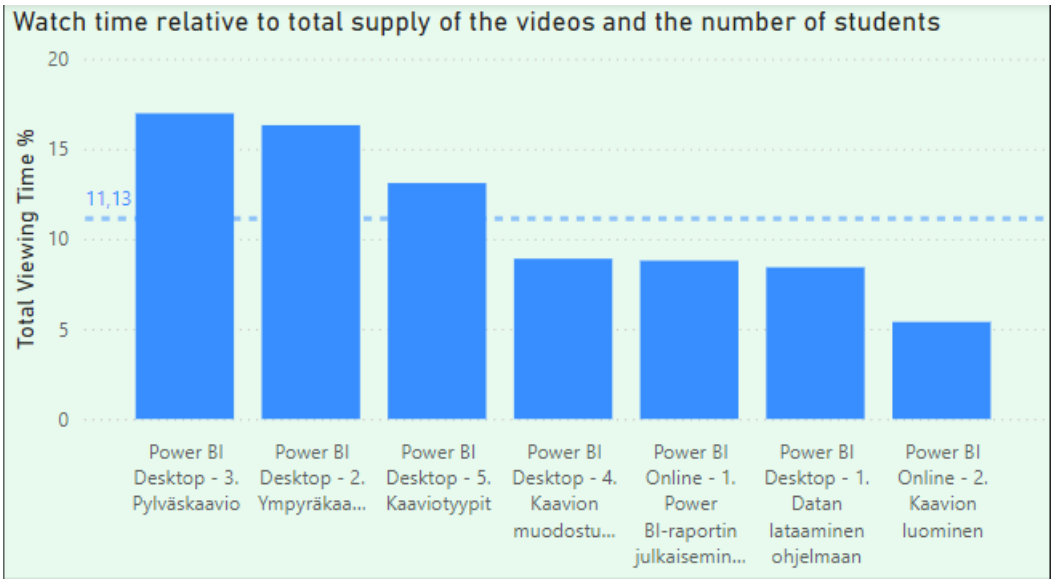

Figure 7: Watch Time Relative to Total Supply of the Videos and the Number of Students, Classical Education (y-axis=video watch time as a percentage of the product of total video supply and number of students)

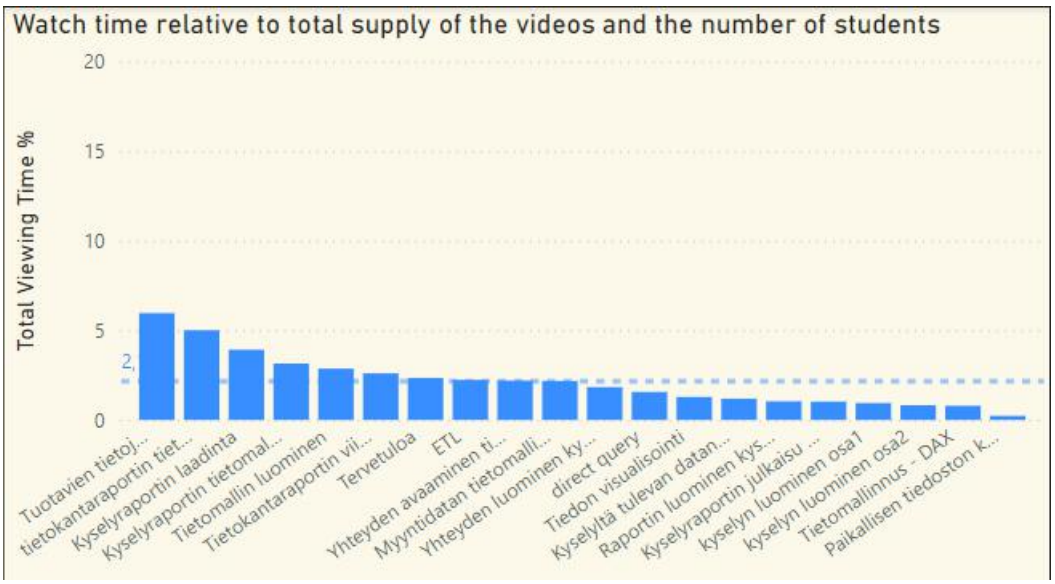

Figure 8: Watch Time Relative to Total Supply of the Videos and the Number of Students, Automatic Instruction (y-axis=video watch time as a percentage of the result of total video supply and number of students)

There are big differences in how students watched videos (see Figures 9 and 10 below). In classical teaching, a larger share of the total number of the videos was looked through than in automated teaching on a student-by-student basis. In automated teaching, there was only one student who watched all the videos completely. So the number of videos doesn't have to be huge in automated teaching neither in terms of number or total duration of the videos.

Student	Videos Viewed	Count of Sessios	Minutes Delivered	Viewing Time %
1d901c72-7a91-4ac3-8e25-b0bc01356d47	7	19	102,30	154,99
336a73f5-94fb-4cd7-b0b9-b0b10094e6cc	7	8	76,33	115,66
391cbf86-c254-425f-a0af-b0d900a49016	7	7	73,89	111,95
537d1d85-123f-4dec-a479-b0b101343673	7	10	80,13	121,40
556a7ce4-6915-42e0-bd82-b0b10141ac3d	7	20	118,15	179,01
56f932e1-1e59-464d-bde1-b0ad00a8e31c	7	8	80,22	121,54
56fa894a-118c-4da5-929d-b0ab0104f37b	7	7	73,63	111,57
60565201-bc79-48a4-addf-b0ae009bfc94	7	15	45,96	69,64
75088ffb-7cec-44c7-b9a2-b0d801331d56	7	11	68,88	104,37
82e849a1-7493-49d6-b909-b0bf00b541ea	7	7	31,87	48,29
9bb06043-e55d-45a1-b597-b0ad009344b8	7	10	68,55	103,86
9d892c89-5076-44b9-8640-b0af005a00c4	7	8	52,07	78,90
a0361551-19d8-4962-af2d-b0b200cbd698	7	29	162,15	245,68
a8d037e4-8905-43e2-ac20-b0cc00c9bd76	7	11	85,59	129,68
ae4d92e4-1d8a-484a-a1c9-b0e300d422e4	7	7	66,34	100,52
af98321a-860a-4fc4-b4c8-b0c001003e2c	7	7	66,34	100,51
b0a3fb22-6658-4329-b232-b0b000d61735	7	7	59,12	89,58
b3d1e793-17a6-4942-bb83-b0d300c8ed24	7	7	66,34	100,52
b8dd2f3b-8afb-40f8-8a1e-b0ac00f2ebc9	7	9	82,29	124,69
d8b45808-110d-4d9a-91fd-afbd010544e5	7	14	104,95	159,02
e379461c-e4ed-4b77-b7de-b0cb0115ae02	7	14	159,94	242,33
51cb822e-32b3-4a3c-b133-b0d10119beac	6	7	58,01	87,89

Figure 9: Watching of Videos in Classical Education (cookie, how many different videos were watched (max 7), how many views, total viewing time in minutes, percentage of all videos viewed)

Student	Videos Viewed	Count of Sessios	Minutes Delivered	Viewing Time %
56fa894a-118c-4da5-929d-b0ab0104f37b	19	21	341,94	87,68
8af6c152-16e3-4e35-99ed-b10700e70b87	19	29	309,80	79,44
a8d037e4-8905-43e2-ac20-b0cc00c9bd76	19	26	276,47	70,89
d235f6d9-5077-4ba8-9d89-b130015f26f3	18	26	362,40	92,92
8bde619f-137a-43b1-a332-b12a00d64f0a	17	25	176,12	45,16
9bb06043-e55d-45a1-b597-b0ad009344b8	17	40	301,21	77,23
f4110651-ca37-47cf-8cdc-b12d00d51fba	17	38	233,22	59,80
0fe0406e-db98-401b-827d-b12f0134f0fa	16	28	188,59	48,36
23adf547-3e0d-43d3-8c46-b0c7007fd72f	16	24	515,45	132,17
8ec7d57d-fb7c-49f9-8ff2-b0bd00b792ae	16	22	204,59	52,46
9637725c-950b-4319-a37d-b14b00cb478d	16	18	218,47	56,02
77b0f20b-ab8c-4ecb-a3c4-b0ac006227c9	15	26	332,25	85,19
82e849a1-7493-49d6-b909-b0bf00b541ea	15	20	208,51	53,46
9d892c89-5076-44b9-8640-b0af005a00c4	15	20	227,12	58,24
a2184330-0d66-4246-b787-b0b201429096	14	27	192,38	49,33
b8dd2f3b-8afb-40f8-8a1e-b0ac00f2ebc9	14	17	187,79	48,15
36317441-63aa-4029-8b2c-b14300c63e2f	13	16	329,63	84,52
556a7ce4-6915-42e0-bd82-b0b10141ac3d	13	14	134,56	34,50
c9ac18cd-399d-4d15-9897-b10c016effa6	13	29	197,73	50,70
e5d46b18-a144-467c-8cc4-b1360146e00c	13	13	173,33	44,44
f9ac5868-d617-45bf-9f78-b1280060ff9c	13	23	214,65	55,04

Figure 10: Watching of Videos in Automated Teaching (cookie, how many different videos were viewed (max 20), how many views, total viewing time in minutes, percentage of all videos viewed)

When we analyze the measured learning outcomes of these two course types, we are able to answer to the second research question: Is automation of teaching successful in the light of the results?

When comparing the scores obtained for the assignment in classical teaching with the scores obtained in automatic teaching, the results are shown in following Table 1.

Table 1: Learning Outcomes in Classical Teaching and in Automated Teaching

Max 20 points	Classical teaching	Automatic teaching
Average performance score	17,66	14,98
Average score max. Points	88%	75%
Passed students (relative to number of students that viewed course videos)	100%	80%

Although the scores are not directly comparable due to the difference in assessment tasks, it is easier to get a good grade in classical teaching, both based on the number of points and the number of graduates.

Since in the classical teaching course the assessment was based on a given assignment, you could easily do the assignment without getting to know the lectures any further, if you already had previous Power BI skills. Or you could order it from someone who knew how to do it. It is interesting that altogether 63 students had watched the videos in the classical teaching course and 64 completed the course.

In automated teaching course, student needed to watch the videos in order to be able to produce a report with some of the exam answers. Some of the questions were related to the processing of the problem at hand and a few were more general. The questions for the exam were drawn from a set of questions. There were three attempts with a forced 24h break in between. There were a lot of questions in the exam that had to be given a number or text answer, so guessing was not enough. Of course, correct answers, and, also ready-made Power BI files, could have been shared in some forum to other students. However, judging by the exam results, not very much was done in this way, luckily.

In the future in the automated teaching course, teacher could think about whether the answers could be personalized somehow. That is, the student would have to enter their date of birth in some Power BI question and that information would also be known in the Moodle exam.

Conclusions

In this paper we have studied the deployment of technology in teaching by implementing Power BI course in automated way and in less technological way, thus in classical way. Previous studies on technology deployment in teaching have suggested that the use of new technologies in education has significantly impacted student engagement, teaching practices, and personalized learning. While there are challenges in integrating new technologies into teaching, they offer numerous benefits for enhancing student engagement and learning outcomes. However, ethical considerations related to the use of technology in education also need to be carefully addressed.

Based on the empirical data, we can conclude that in classical teaching students were returning to the videos near the deadline of the assignment, but in automated learning the majority of videos were viewed according to students' own timetables. Furthermore, taking automated course does not automatically mean guaranteed points for the student. In this case in both courses the students viewed the videos quite actively. But it is important to keep in mind that there has to be a clear reason for the student to view the video. In overall, creating automated course takes more time and needs some planning and technical skills, but has a great pay back during the implementation.

When planning automated teaching, it is necessary to think about how to support not only the learning of the student but also enthusiasm of the student towards to taught subject. If the chosen technical solution is not well taught it can leave to a frustration. This can rather easily happen e.g. in the case of automated programming online courses, where the code has to be entered directly into the evaluation widget. For these, the answer must be given exactly in the required form. So, for example, spaces that have no effect on the operation must be exactly in the same place as in the model solution, and then the student comes across a situation where one thing is asked in the assignment but another in the model answer. This takes quite a lot of student's enthusiasm for studying away, because instead of studying the subject, the student has to struggle with finding exactly the same coding method as in the model solution.

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