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The older ones among us remember this from their school days. It was a piece of paper printed in blue that smelled of alcohol, and it usually contained an exercise text or a class test. The technical term for this first copying process in our schools was “stencil printing” and, looking back, it was the biggest media revolution in schools since the invention of the blackboard. The procedure was simple: the teachers wrote or drew what was to be duplicated on a special sheet – the template. This was coated on the back with an alcohol-soluble wax, the writing or drawing was pressed through there, similar to carbon paper. However, an overlying sheet prevented the carbon paper effect from developing immediately, this sheet was only removed when the matrix was clamped in the drum of the copier. If you then turned it, a serial print was started. A single sheet was fed in continuously, the surface wetted with spirit and then guided along under the drum with the matrix. The alcohol dissolved the pigments from the stencil and they reproduced exactly what had been drawn on the stencil on the paper. With each copy, the matrix lost substance, after 250 deductions at the latest it was over. According to Wikipedia, the process was developed by Wilhelm Ritzerfeld in 1923. In 1970 it was widespread worldwide, also in administration, but mainly in the school system. The reasons for the triumph of the "blueprint" were similar to those that led to its demise:

1. The procedure was simple. You only had to know a few simple steps and follow rules in order to implement it effectively.
2. The procedure was safe. If you didn't make big mistakes or if the machine didn't let you down or ran out of alcohol, nothing could go wrong.
3. The procedure was efficient. A high degree of scaling could be achieved with little effort. With an average class size of 35 students, the template could be used up to 8 times.
4. The procedure was immediate. You instantly saw the result of your own presentation, as well as any errors, as if nothing was alienated or encoded, everything was in front of you.
5. The procedure corresponded to the previous way of working of the teachers. You could write by hand, or with a typewriter, or even draw with a pen and ruler, and you didn't have to learn any new or unfamiliar representation techniques.

And just as the better is the enemy of the good, in the 1980s photocopies replaced matrices in schools, because they were superior in each of the points listed here, at least if you didn't get the idea to go beyond the basic functions of the copier, which very few did. With regard to aspect 5, there was even a clearly noticeable repercussion on the working methods of the teachers, which could not only be demonstrated by the increasing use of copy paper in the schools, but also in the morning queues at the (multiple) photocopiers in the schools and in the fact that more and more

teachers have their own photocopiers at home to avoid those lines. With guaranteed fulfillment of success factors 1 - 4, the copying machine offered new possibilities and advantages:

- Copying was much faster than turning the stencil drum, and with each new generation of copying machines it became still faster.
- There was no need to create templates – any A4 sheet of paper could be used as a copy template.
- Colleagues could exchange copy templates easily and without loss.
- You could copy texts, graphics, images and photographs from magazines or books (which also brought the subject of copyright into schools, but was largely ignored).
- The 250-copy limit was lifted—you could make as many copies as you wanted, school year after school year.
- You could enlarge and reduce, make it lighter and darker, copy sections or cover unwanted parts, etc.

Both the introduction of the matrices and the copying machines drew methodical reactions in schools and classrooms. With the student sheets that could be produced and distributed with it, the examination system was simplified, and they also significantly enriched the school teaching and learning processes. Without self-created and duplicated documents, teachers were solely dependent on the textbooks as media. From now on, these could be supplemented, expanded or enriched, which somewhat reduced their power as a "secret curriculum".

Together with the overhead projector, a striking media-methodical dyad finally emerged in the 1980s. Interestingly, his invention is hardly younger than that of stencil printing. In 1927, Trajanus von Liesegang presented a first model that already contained all the essential components of the later devices, which (for reasons of cost) first spread through companies and universities, and then began their triumphant advance in schools in the 1970s. Texts or drawings of any color written on transparent films could be projected directly onto the classroom wall. You didn't have to black out and you could write or show directly on it, quickly switch between one or the other slide. Thus, the overhead projector also fulfilled the matrix's success factors extensively, it fitted ideally into school practice without interfering with it, it supplemented the blackboard without making it obsolete, it could be used easily, directly and without much preparation. Overhead projectors were soon installed in every classroom.

Both as a student and as a student teacher, this media-methodological reality was very impressive to me. No lesson without the copied sheets and no lesson without using the OH projector. These media were extensively discussed, especially in terms of didactics, it was discussed which colors were better suited to the OH projector and which less so, there were also different opinions about the structure and division of copied worksheets, etc. At the time of my legal clerkship, in autumn 1990, a device was added that (initially) put this long-standing dyad into perspective: the personal computer. The stability of the success factors that already apply to the matrices can be confirmed by its implementation by the teaching staff to date, because ultimately it combined the copier and overhead projector with the use of the new end devices

printer and beamer, and also brought a new typewriter with it , which worked in a similar way to the "old" one, but offered better options and was more or less integrated into the "copier".

If you turn to the success factors stated at the beginning and look at them as barriers, it becomes clear why we are not as far away from copy machines and overhead projectors in schools as some here would assume.

Factor 1: Simplicity: Computers are not simple, they are highly complex, require hardware and software know-how; they are constantly developing, and with them end devices, programs and infrastructures; if they do not work, only experts can find out when and how you can make them work again.

Factor 2: Security: Computers have to be operated very precisely and are still prone to failure. If you turn them on, you cannot be sure that you will find them in the state in which you turned them off, and it is possible that students may have influences on them that teachers do not perceive or understand.

Factor 3: Efficiency: With the complexity of the media system, the effort that teachers have to put into it increases, i.e. training, updating, implementation of potential, troubleshooting, etc. This reduces efficiency, because the scaling potential remains the same as with the analog media.

Factor 4: Immediacy: Digital worlds are generally indirect. Even with the promise of WYSIWYG (what you see is what you get), the word processors remained virtualized instruments that the teachers got used to, but still perceived at a distance. Errors in beamer presentations cannot be corrected immediately, instead of documents, data is now stored that is not in folders but on data carriers, etc. Factor 5: Correspondence with the usual way of working: manual writing instruments, rulers, etc. are completely replaced digitally. With the increasing multimedia capability of computers, new demands are being made on teaching that can only be implemented with new working methods. At the end of the 1990s, computerized teaching became a promise for those outside the school and a vague and equally unpleasant demand for teachers.

What is the situation today, 30 years after the advent of computers in schools, in terms of their deployment and use? What is certain is that the copy machines are still there (though not as many), but the last few overhead projectors are slowly being phased out. In the International Computer and Information Literacy Study (ICILS) from 2018, it was found that for German teachers 44.1% of those surveyed use digital media to present information in frontal teaching, to support student-led class discussions and presentations 19.6%, for individual support individual students or smaller groups of students 14.8%, for feedback on the students' work 11.2% and to support student collaboration 10.1% (Drossel et al., 220). However, these percentage values have to be put into perspective with regard to the general use of digital media in the classroom, because the frequency of use determined is significantly lower in an international comparison. Only 23.2% of the teachers surveyed state that they use digital media in general, i.e. every school day, 37% at least once a week. For comparison: in Russia or Denmark, daily use is over 70% (ibid. 215). In addition, more than 50% of the technologies used in everyday teaching are limited to word processing (20.5%), presentation programs (18.3%) and Internet browsers (12.9%). Learning management systems (LMS) such as MOODLE are hardly relevant here at 2.4% (ibid. 218). Here, too, a comparative value: the international average is the everyday use of LMS at 28.2% (ibid.). If one sums up these findings, a sobering picture emerges for 2018: Only about half of the teaching staff uses digital media more than once a week in the classroom, and then mainly for frontal presentations. Digital media implications such as those emanating from LMS are largely ignored, and more sophisticated forms of use are rarely used in order to individualize or differentiate.

The fact that such a contrast is emerging when it comes to LMS can be explained by the success factors for media implementation in our lessons mentioned at the beginning. Learning

management systems such as e.g. MOODLE can only be included to a very limited extent and hardly efficiently as a teaching appendix. These combinations of cloud storage, database, communication infrastructure and control system function, but in any case do require more than just a pragmatic addition to conceptually fixed traditional lessons. All teaching materials must be available in digital form. Teachers and learners must have a functional infrastructure of adequate networks and end devices, these must function correctly, and the users must have the necessary skills. In addition to the first 4 factors (simplicity, security, efficiency and immediacy), factor 5 in particular becomes a barrier here, because working with LMS requires a new idea of teaching in which information, communication and interaction is not only provided digitally, but also spatially and loses its limits in terms of time and personalized learning (with regard to aspects such as differentiation, inclusion or sustainability) is declared the target image. With the consistent transformation to LMS, a teacher also dissolves their usual role towards the learners and has to "reinvent" themselves here. The past Corona years have shown that this can definitely take place, in which the initial lockdowns with distance learning in particular led to unusually rapid development reactions here.

Unfortunately, this does not seem to have had any lasting effect. In the neighboring country of Austria, multi-layered analyzes of the LMS made available nationwide revealed that their use by teachers was very pragmatic and minimalistic and largely ignored the sophisticated possibilities of these systems. On the other hand, it became clear that after the return to face-to-face teaching, the use of the LMS decreased significantly, i.e. there were no "sticky effects". "Teachers who are working with digital technologies for the first time tend to transfer conventional teaching models and materials 1:1 to the digital [...] In contrast to the report by the Norwegian schools, there would not be a nationwide transformation of pedagogy through digitization. Rather, it seems as if in Austria the lessons continued exactly as before, only they were transferred to digital channels for a short time". (Schrenk, 2021, 59). Something similar is reported in a study in the federal state of Baden-Württemberg at 305 commercial schools. Digital technologies are often used here for class management and organization of lessons, video conferencing tools and clouds for sharing files are also used more frequently (due to the pandemic). Occasionally or rarely are presentation software or survey and voting tools used, while the use of more demanding applications such as LMS, virtual reality or simulation programs is hardly worth mentioning (Mayer et al., 2022).

The argumentation up to this point makes it clear that the current efforts (not only in Germany) to reduce the digital backwardness of our schools can only be effective to a limited extent, because here the emphasis is mainly on further training (3rd phase of teacher training). However, the effectiveness of these further training courses is subject in the future to the success factors already identified for the matrix copies, and here – as previously stated – the break with usual practice, usual didactics and usual methodology forms a significant barrier. The fact that the ministries and state institutes mainly rely on further training is due on the one hand to the fact that this can reduce the lead-time for immediate effectiveness in the classroom, and on the other hand to the decoupling of the 1st and 2nd phases of teacher training from ministerial influences. The established control impulses via framework specifications for studies and traineeship are - in relation to the intensities required here - too weak and too long-winded. Ultimately, however, there is only one sensible solution for a consistent, ongoing and motivated digitization of vocational and technical teaching and this must start in the course of study and be continued in the preparatory service. What might that look like?

As already indicated, a viable approach to teaching innovation at the university does not start with the curriculum. The likelihood that this will contain significant specifications for aspects of educational, technical and media-didactic digitization in the area of school or vocational education

and subject didactics is low. Even in the amendments and accreditations that I am currently participating in, no consistent departure is discernible in this regard. Apparently, the topic is largely ignored by those who design or accredit here. So you are largely on your own, or at best you can find fellow campaigners and try to involve as many proactive and innovative colleagues as possible.

Interestingly enough, for me personally, this process began in the third phase of teacher training. Starting in 2018, my work area implemented a Hessen-wide training project (DigiBB), together with the Ministry of Education and the Hessian State Office for Technology Training (HLfT). The focus here was on the technical digitization of vocational teaching. We developed (and are still developing) innovative training formats, piloted them and then handed over the optimized concepts to the HLfT. This took place (and takes place) in waves, starting with the domains of metal, electrical and information technology, followed by the economic, printing and media professions, through construction, wood, etc. through all the essential dual training areas. Two years after DigiBB was launched, a media-methodical training course was held throughout Hesse together with the Technical University of Munich on the subject of “hybrid learning landscapes”. In both formats, the participants had to apply in school teams and were preselected. Both training concepts were equally input- and implementation-oriented, so that the transfer of the new into the existing teaching realities was already prepared in the training. Similar experiences emerged in both formats: Great interest in the new technologies, media, possibilities, use cases, etc. Great commitment on the part of the participants, but difficulties in implementing them independently within the given didactic-methodical framework and hardly any extensive transfer effects on their lessons or schools. Again and again, what was discussed in the previous sections of this essay became clear: the problematic break with established and optimized everyday didactics, both with regard to the implementation of consistently competence-oriented teaching and with regard to the necessary technical and media-methodical digitization.

This perception also gave me unpleasant feedback on my own technology didactic practice, because although this was intensively geared towards consistently competence-oriented teaching, the subject of digitization had largely been left open in both technical and media terms. My attitude was: "Anyone who wants to bring digital content and media here should do so and is very welcome, but there are no specifications or claims in this regard". That was liberal and at the same time opportune, but the difficulties in the further training made it very clear to me how damaging it was in the end. With the arbitrariness that was signaled here on my part, I devalued this important topic and encouraged all those who didn't want to or couldn't adequately deal with the digitization of vocational teaching and sobered those who were innovative and creative here.

To make matters worse, my own teaching was only partially based on digital technologies. Apart from using the campus management system as a communication and data distribution platform, I largely dispensed with digital features, I gave lectures in the classic style and seminars with the usual activation and individualization methods. That was the "didactic double-decker" in inverted form, as digitization was hardly a teaching topic and only a marginal teaching method. Translated for the prospective teachers: "If everything is not so important, let it come to you, do it as you want," etc.

So some things had to be changed and for me this realization came at a time when two processes triggered additional momentum: On the one hand, new study regulations had to be generated for 2023, which allowed me to rearrange, clear out or supplement everything that already existed. On the other hand, the emerging pandemic in 2021 required lectures to be relocated to virtual space, which meant an enormous digital-methodical push for all those who now wanted more than zoom lectures and zoom seminars. When freshly revised, my teaching structure is now

about 20% enriched with digitization aspects, which mainly includes media didactic aspects, but also includes pedagogical and professional aspects. In terms of university methodology, the impact was even stronger: the lecture in the classic sense has been abolished for me, instead I work with inverted classroom concepts, supported by the LMS Moodle. The seminar events are also stored with Moodle, in different conceptual frameworks - depending on the topics and focal points. My practical seminar, in which the students have to develop their own lessons, implements the claim of the consistent "didactic double-decker" most strongly. It is structured as a Hybrid Learning Landscape (HLL) and the students have to develop HLL independently.

Two projects were conducive to this comprehensive transformation, which has now largely been completed after two years: TWIND (technology and business integrated didactics) and Hybrid Learn. TWIND has been implemented as part of the teacher training quality offensive for the last two years in association with the universities of Mainz, Hanover and Schwäbisch-Gmünd. The focus of TWIND is the development, optimization and exchange of digital media packages for the didactics of the 1st and 2nd phase of teacher training in the federal states of Bavaria, Hesse, Baden-Württemberg and Lower Saxony. So far, around 200 media packages have been generated, evaluated and optimized as part of 90-minute teaching units, while an enormous number of explanatory videos have also been produced and everything has now been researched and made available on an openly accessible server. Hybrid Learn is embedded in the National Educational Platform (BIRD) program. A hub for digital teacher training is being created here, sorted thematically but not specified for individual phases or levels of teacher training. In addition to the processes and products of these two projects, which are directly geared towards digitization, the resulting networks at the working level were and are particularly important. This is how an HLL seminar, held jointly with the Technical University of Munich, came about a semester before I switched my methods seminar to HLL. Since this course with students from two distant universities was only possible virtually, it had to be handled digitally by the lecturers (TU Darmstadt and TU Munich). Analogous elements were simply excluded here. Here, too, the students had to develop HLL independently, which they did well and more motivated than irritated by them. When asked in evaluations, the students found that digital media and infrastructures are so naturally anchored in their lives and everyday life that they consider their consistent implementation in the classroom – provided the technological requirements are met – to be just as natural. In this regard, schools are for them (in retrospect) places of preservation of a bygone era, and in fact they report on one or the other internships in which they were able to experience the use of an overhead projector. The teaching units realized in Moodle over 5 - 10 hours, in which high demands are placed on a consistent orientation towards competence, showed that the handling of the LMS is more of an inspiration than a difficulty for the students. In addition, it is already apparent that they think ahead and flank the potential learning paths of the students better and more consistently than in the analogous plans, which is understandable, because a guiding text must be generated in both cases, but with the HLL its structures must also be placed and functionalized in Moodle. The LMS requires a number of considerations and decisions in advance of the teaching process, which are otherwise gladly deferred to its implementation. This is not wrong per se, but reduces the degree of explication of the developed teaching concept. In addition, the students

develop further digital media skills here by creating their own explanatory videos and integrating them into the LMS.

You don't have to be a prophet to predict that this generation of students will start their preparatory service and career with a different digitalization approach than the generations before them. I want to explain this again with the success factors mentioned at the beginning:

Factor 1: Simplicity: For prospective teachers with practical LMS experience, there is no complexity hurdle here. They have also learned that the supposed challenges of digital technologies can also be mastered by them here. Fears of the unknown, technology skepticism or assumptions about excessive demands are foreseeably reduced.

Factor 2: Security: You can assess, create and maintain security in systems that you are familiar with, or you can ensure that the systems are made appropriately secure and stable. Such security can be expected when prospective teachers have already had to move and contribute independently and successfully in digital systems.

Factor 3: Efficiency: Losses of efficiency in digital infrastructures mainly result from a lack of operator skills. Anyone who can operate the systems and knows their possibilities and limits can use them with great efficiency. Digital content can be copied, modified and transformed at will and very easily, digital methods are just as manageable and scalable as the content.

Factor 4: Immediacy: In this aspect, digitization will always have a weak point. It cannot offer the immediacy of analog. However, it must be said that digital mediation has meanwhile become a matter of course in all areas of life; it is usually accepted unnoticed, often – as in games or social media – or even consciously sought out.

Factor 5: Correspondence with the familiar: Here the argumentative circle closes. If what the prospective teachers are used to in terms of teaching development is consistent digital teaching, then a return to analogue teaching in the preparatory service or in the schools would be a break with the usual.

I therefore look positively at the development I have made, although I am aware that it will hardly change anything beyond my scope. Assuming that I am certainly not the only one who acts individually with my approach, I see myself surrounded by a diffuse teaching reality, within my university, but also beyond, which I can hardly perceive and even less influence. Publicly funded projects that address this, e.g. TWIND, are an exception here and again just a "drop in the ocean". Capparozza (2021, 108) describes such a lone wolf approach as technology integration (Foulger, et al. 2020) and contrasts it with a systematic approach as technology infusion. “The Technology Infusion approach aims to enable student teachers to use digital media to teach at the end of their training. This approach includes a course-specific curriculum adapted to the level of development of the student teacher, qualified teachers as well as practical, feedback and reflection phases on the use of digital media. In this approach, the preparation for teaching with digital media is ideally supported by all stakeholders and the entire system [...]” (ibid.) In an empirically well-supported international review study, Capparozza identifies five measures for the curricular anchoring of digital media skills in a technology infusion approach (111 ff): (1) provision of human and financial resources in all topic-related areas of university teacher training, (2) continuous promotion of digital media didactic skills among teaching staff, (3) interlocking of theoretical and practical teaching areas on content and methodological levels, (4) consideration of the heterogeneity of the students in relation to digital skills and interests, and (5) targeted redesign of the curricula in the sense of a collectively coordinated overall strategy. Empirically supported, the essential constructive approaches to systematically implement digitization in teacher training are thus open. If you think beyond the 1st phase, these approaches could also be applied to the

preparatory service or to an integration of the 1st and 2nd phases with regard to the challenges of digitization.

My primary goal in this text was to show that there are simple but serious reasons why the predominantly continuing education-based digitization of vocational teaching is progressing so slowly and that these reasons are less to do with the teachers, but mainly in the first two phases of teacher training. We (I am including myself here) are to a large extent responsible for what the prospective teachers anticipate in terms of teaching reality and ultimately also for how they start their profession and how they will continue their education independently. Constructive approaches to improve here are concrete and empirically well supported from an international perspective.

If you were naïve, you would ask yourself why not have all three areas (at least at state level) just meet and talk about it together? Of course, the cultures of "peaceful coexistence" in teacher training have been established and "proven" for many years, but all those involved are aware of the associated inertia in development and one could not only advance the topic of digitization in a goal-oriented manner with a joint approach, but also take a first step in the direction of a development-dynamic teacher education. Instead, why do the students within a federal state continue to first go through a patchwork teacher training course at their universities, in which, in the supermarket mentality, everyone adds a little so that "something delicious" comes out of it, without an obligatory corrective geared towards an innovative school reality? Why do they continue to fall into a preparatory service in which, as before, the subject leaders say "what's up" and determine future lessons - more or less adaptively depending on the approach - with their individual didactic-methodical preferences from previous decades? Why are young teachers still being forced into an overwhelming and thus highly pragmatic teaching assignment right from the start, instead of setting up professionally equipped and collegial introductory and transitional phases? Why have schools still not established any lesson-focused and thus digitization-related quality management systems in which a meaningful coincidence of equipment waves and personnel development processes could arise? If you turn these questions into proactive approaches, everyone involved will find a wide range of opportunities to advance the digitization of vocational teaching at our schools and to network with the other protagonists. I'm rather skeptical about the lone fighter approaches that have been found so far, and we may then remain at the bottom of the field in the next ICILS study, lagging behind Kazakhstan and Chile. This may seem acceptable to one or the other, but for the next generation of teachers it is an impertinence and is already having an effect as an exclusion criterion for high school graduates when making career decisions. From the perspective of our training partner, the companies and the economy, this development deficit is a warning signal and will hardly promote the acceptance of vocational schools within a dual training system.

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