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The Mutual Impact of Educational and Information Technologies: Building a Pedagogy of E-learning

Michael F. Christie [1] Fariba Ferdos[2]
Chalmers University of Technology
Sweden

Abstract

Educational technology, as a subset of pedagogy, is the sound use of any technology to support and improve learning. Information technology, on the other hand, focuses more on the digital delivery of information. Technical issues tend to take precedence. In this paper we argue that educational and information technologies cannot be separated. For better or for worse they impact upon one another. When one seeks to improve learning using digital media pedagogical considerations are always an issue. We believe there is a need for a conscious pedagogy of e-learning. The same fundamental questions that are asked of traditional university pedagogy need to be asked of e-learning but, in addition, the potential for a radically different, more innovative pedagogy has to be explored. E-learning is made possible by a revolution in information communication technology (hereafter ICT). Changes occurring as a result of the revolution continue at an exponential rate. The most obvious change as far as tertiary education is concerned involves the expansion of off-campus courses. E-learning is here to stay both as a support for face- to-face teaching and as the main means of distance education. Good pedagogy can inform and be supported by good ICT. Poor pedagogy can subvert the very point of using good ICT. A combination of bad pedagogy and bad ICT is a disaster for the future of e-learning.

Keywords: E-learning, pedagogy, student centered learning, information communication technology.

Introduction

E-learning, which we define as any form of organized learning that is carried out using digital media, is here to stay. Given the resources needed by institutions, teachers and learners to sustain it, e-learning is becoming established, in the first instance, at the university level. But it is also a type of education that appeals to industry and private companies that believe they can save or make money by offering on-line training in their field. Universities that ignore or turn their back on e-learning do so at their peril. The parable attributed to Jeff Ullman is pertinent here. 'It's New Year's day, 1895. My name is Hans. For seven generations my family has made the finest buttons in the region, using good local horn. Today, I learned that the railroad is coming to our village.

My friend Olaf says that the cheap factory buttons will come on the trains, but they will never compete with my craftsmanship. I think he is right, and wrong. They will come, but they *will* compete with my buttons. I must make some choices. I can become a distributor for the new buttons, or I can invest in the machinery to make buttons and export them, or, closest to my heart, I can refine my craft and sell exceptional buttons to the wealthy. My family's business is dead. I cannot stop the train; I must change' (Wulf, 2003). Selected universities will continue to offer high quality, on-campus education to the wealthy. Most universities however will not be able to ignore the coming of the 'information railway' and will be forced to put their courses online in order to survive. Those that try to sell outmoded courses based on traditional pedagogical principles are likely to fail. Those who are aware of the mutual impact of educational and information technologies and offer pedagogically sound e-learning will succeed.

Pedagogical models

Pedagogy, to quote Mortimer (1999), 'is any conscious activity by one person designed to enhance the learning of another'. While pedagogy can be a personal matter it is more often conceived of as the art or science of teaching; a set of principles and practices to improve learning. Educational technology, the term we use in the title of this paper, can be seen as a subset of pedagogy. It refers to the sound use of any technology to support and improve learning. To avoid confusion we will use the broader term, pedagogy, throughout this paper. Pedagogy, by definition, is well intentioned. But there are competing pedagogies, some culture bound, others locked in a time warp. Their survival depends on their ability to adapt to rapid change in the educational world. The proof of a good pedagogy, whether at the individual or the institutional level, is in the quality of the learning that occurs. Pedagogy that is systematized is more complex and harder to judge than the sort of pedagogy Mortimer refers to. Different types of pedagogy are used in organized learning today and they vary depending on the purpose of the education and the philosophy that informs it. In the west, for instance, compulsory schooling has evolved from a transmission to a more discovery-based model of learning. The pedagogy that characterizes Scandinavian folk high schools is cooperative and, ideally, democratic. Graded assessment is outlawed. In both cases individual teachers and learners are expected to endorse the prevailing pedagogy. When pedagogy is seen to fail at the system level it is not always easy to change, even when there is evidence that the pedagogy hinders rather than enhances learning.

Universities have, until recently, put their faith in a pedagogical model that is characterized by activities such as lectures, tutorials and laboratory work. It is assumed that these activities will take place on campus. An important part of this pedagogy is to test and grade the quality of student learning by means of essays, practical exercises and end-of-course, closed-book exams. The quality of learning that occurs depends not only on the model but on the quality of individual teachers and students. The boring lecturer who mumbles through a confused set of notes can de-motivate the best of students. Similarly a group of unwilling learners can sabotage a well designed and delivered course of lectures. Lecturers, who encourage a surface approach to learning by setting poorly constructed examinations, can breed 'imitation' scholars who neither love nor understand their subject (Sawyer, 1943). This caveat applies throughout our discussion. Until the second half of the twentieth century traditional university pedagogy worked quite well. The reason was that it served a small group of elite students. The nineteenth century 'university

man' who studied the classics in preparation for life as a parson, gentleman or civil servant has been replaced by today's 'university person' intent on becoming a doctor, a lawyer, a chemist, a teacher, a botanist, a journalist, a psychologist or some other professional. As wealthier societies needed and could afford a more skilled workforce the percentage of school leavers who went to university increased from one or two percent in the 1960s to more like twenty percent by the end of the century. Today countries like Sweden hope to send half of their student population to tertiary institutions.

Changes in university demography mean that more and more students need assistance if they are to pass the sort of exams that were set for earlier generations. Both on and off campus there are fewer wealthy dilettantes and far more vocationally oriented students. An on-campus pedagogy designed for an intelligent elite does not suit a mass influx of students. University lecturers already complain of a wider range of abilities, especially in science subjects such as mathematics and physics. In a recent debate article in the *Gothenburg Post* (10 February 2004) seventeen senior academics, including the Rector of Chalmers University of Technology, bewailed the fact that students begin their tertiary studies with an inadequate understanding of mathematics. It is a cry that is heard in other areas. Part of the problem is a lack of preparation in the upper secondary level. But the problem is also due to the fact that today universities compete for students and as a consequence entry requirements tend to become less stringent. It is not very helpful to bemoan the situation and blame high school teachers. Pedagogical reform, for example the constructive alignment of the first year mathematics courses including clearly stated learning outcomes or objectives, would help high school teachers prepare students for university and make first year studies more manageable for the students themselves.

If a broader range of abilities is true of on campus education it is even more the case with off campus or distance education. Online education has great appeal to older, often female students who juggle part-time work with a return to studies. One of the characteristics of e-universities is that the students who enroll in online courses are a very diverse group. We have already mentioned older women but there are also soldiers, company employees, people living in remote areas, as well as younger people continuing on from upper secondary school. The creation of the Open University represented a response to these changing circumstances. But it was not a radical response. Students could work from home but the same pedagogy that informed on-campus education was evident in the booklets, videotaped lectures or instructional CDs they received. The invention of the computer and the rapid development of different types of digital media enabled many universities (including the Open University) to replace expensive and rather cumbersome distance packages with e-learning. The danger is that the sort of pedagogy that has informed traditional on-campus and distance teaching will persist. If current courses are simply digitalized, placed on a university's website and downloaded by bona fide students without a re-think about the most suitable pedagogy for e-learning then the real potential for this new form of learning will be squandered. There are certain pedagogical principles that should inform all types of organized education but at a time when traditional university pedagogy is already under fire, it would be foolish not to develop a particular pedagogy for e-learning. Even in on campus education we have seen that the tried and true pedagogy of the lecture, tutorial, lab and final exam no longer suits the preparation of professionals. It is already being supplemented or replaced by case study, problem based learning, project and practical work, syndicate and small group

learning and individual study on-line. Adapting courses to an online format can challenge and benefit both traditional and non-traditional types of pedagogy.

The future of e-learning

We can assume, that for the immediate future, university e-learning will continue to be based on previously discovered knowledge, that it will rely heavily on text, that it will continue to be divided into academic disciplines, that it will suit some subjects more than others and that e-learning students will be assessed and graded. Given the speed with which ICT is developing not all of these assumptions will hold for very long. Already, as Einstein predicted some years ago, the most important research is occurring at the intersection of traditional disciplines. E-learning could open the door for more cross disciplinary, even completely new subjects. The reliance on conventional text could also be a short-lived hangover. ICT offers the possibility for active, interactive, parallel and hypertext; links and layers; text interspersed with movies, animation, sound bites or streamed lectures. The possibilities are so enormous that it is worth considering some fundamental pedagogical questions. The questions can serve as a checklist for creating a new e-learning pedagogy. In developing any pedagogy we have to ask four key questions:

- What is the purpose of this course or teaching and learning sequence?
- How can we best achieve that purpose?
- How can we know that we have achieved that purpose?
- How can we go on improving current practice

If the purpose is to make learning more flexible so that students, whether on or off campus, can access course material when they need or want to, then it makes sense to put courses or subjects on-line. In an accredited, credentialing system success can be measured best by good grades in a sound assessment schedule. Improving practice can occur by fine-tuning what Biggs (1999) calls the constructive alignment of courses or subjects. Biggs argues for a university pedagogy based on a constructivist view of learning. Students learn best when they construct their own meaning and demonstrate their knowledge and skills by applying them in the solution of new or unusual problems. If proposed learning outcomes, teaching methods and assessment are aligned there is every chance that learning will be enhanced. In today's university a wider range of student talent (or lack of it) demands a pedagogy that is more focused, transparent and facilitative. Traditional university pedagogy contained the implicit assumption that students had to sink or swim. Lack of academic support at university marked the passage from secondary to tertiary education and university students were given the right to miss lectures, neglect assignments and flunk. In e-learning there is a similar emphasis on student responsibility but as on-line students have noted, they often get more immediate help from their teachers via email than their counterparts do on campus.

What differentiates e-learning from traditional on-campus learning is that it is embedded in an ICT environment. There is a mutual impact between pedagogy and ICT. In most of this paper we argue for the need to apply sound pedagogical principles to online teaching. But the media itself suggests and enables new and creative pedagogical approaches. ICT allows for text-mining for example. There is software that will 'read' 250 000 pages an hour 'scanning reams of documents, categorizing information and making links and visual maps' (Jackson, 2004). This

capability suggests new ways of teaching. At the very least it offers the opportunity for experiential learning that was not possible in traditional higher education pedagogy. ICT is a tool for human thought and creativity, including pedagogical creativity. One creative pathway is to analyze what works best in traditional on campus education and utilize that as a model for online innovations. A good university education is characterized by a varied educational and social experience. Students receive information via lectures as well as interact with a mentor and their peers in tutorials. They practice what they had learned in laboratories or through assignments and receive feedback via assessment. The last experience is often the least effective especially if the assessment is summative rather than formative. The potential impact of ICT on online education is that students can have an even more varied experience. Because the learning takes place on the World Wide Web students could access much more information, have more individual contact with teachers, tutors and peers, practice in more diverse ways and be assessed more creatively. An exception of course is the hands on practice that many natural science students get on campus. The pedagogical challenge will be to stream this potential flood of information and make it accessible and knowable. As Jackson (2004) points out '*Information* is not necessarily knowledge, and *knowledge* is not always wisdom'.

A comparison of technologies

There has never been a more powerful aid to teaching than ICT. The invention of the printing press in the west in the fifteenth century revolutionized information technology and by so doing had an enormous effect on university pedagogy. Reading from, summarizing and critiquing a number of books in the same subject shifted the emphasis from a lector's interpretation of precious handwritten copies to a more critical and discursive form of university learning. Oral lessons and discussion were supplemented by private reading. This fact should not be lost on us today when for the most part we will expect students to read on-line material. Books allow for greater mobility and are more pleasant to read from than a flickering screen. Part of an e-learning pedagogy must include the best way to present textual information on-line. We need to ask the same four questions mentioned above each time we decide to post course material on the Internet. The printing press multiplied the number of books in existence but those that were used in higher education were rarely planned or written according to pedagogical principles. There are some excellent eighteenth and nineteenth instructional manuals (especially in botany, ornithology and related sciences) but it was not until the twentieth century that textbooks were deliberately designed to facilitate learning. Instructional design is even more important today as courses are adapted to e-learning format.

ICT will have a far greater impact on e-learning than the printing press had on face-to-face learning. Books are still books, distinguished mainly by color, paper quality, print size and layout. Since the sixties the speed and storage space of computers has doubled every couple of years and the cost, size and power consumption has decreased at about the same rate. Bandwidth has increased a thousand fold in the last decade and Internet traffic keeps doubling every one hundred days (Wulf, 2003). There are millions of websites that have become increasingly sophisticated in terms of the digital media they contain. But as with books, the pedagogical quality of many sites, whose purpose is to inform, is poor. This is true even of some of the free on-line course material offered by large American universities. On-line courses that want to make the most of the

incredible revolution in ICT will not make it without sound pedagogical strategies. Good pedagogy can inform and be supported by good ICT. Poor pedagogy can subvert the very point of using good ICT. A combination of bad pedagogy and bad ICT is a disaster for the future of e-learning.

Today's ICT is so powerful that it could transform traditional educational provision. The rapid growth of off-campus courses using this technology is an indication of things to come. ICT is already creating a paradigm shift from on-campus, teacher-centered education to learner-centered education, where students complete their degrees using home or office computers (Koschmann, 1996). Some universities are already aware of this and collaborate with other universities to patch together degrees based on the particular strengths of each participating university. Such courses are offered via the Internet and use a range of ICT platforms including email, newsgroups, synchronous and asynchronous text and video conferencing. Their courses are often managed using software such as BlackBoard that allows individual teachers or course teams to post messages and grades and gives students access to course notes, results, notices and discussion forums.

'Learner-centered education' in this context is an organizational rather than a pedagogical description. Students may design degrees for themselves from a smorgasbord of Internet courses but the content of the courses remain teacher-centered and directed. This is an example of how easy it is to confuse technological innovation with pedagogical innovation. Transferring a badly designed, badly written and badly assessed course to the Internet does not make it pedagogically better. E-learning, with its access to huge on-line data banks in subjects like history and literature can open the way for innovative pedagogy. Instead of offering traditional courses where, for the most part, information is transmitted e-learning can concentrate on developing subject specific and more generic skills. Archives that were hard to access and usually reserved for doctoral students are now open to all. Even in the sciences electromagnetic experiments can be duplicated or linked to real laboratory equipment and telescopes that are accessed on-line. With a little imagination and sound pedagogy chemistry teachers can run first year courses in which their online students use their own kitchen or garden shed as laboratories.

Dangers and opportunities

The potential opportunity or danger (depending on your viewpoint) is that e-learning enables 'tele-presence'. It can literally displace the on-campus university. Such a paradigm shift in the organization of educational provision may suit government and big business. Both government and industry hope to save large amounts of money on infrastructure costs by making education and training available on-line. There is also much talk in political circles about equity issues and lifelong learning because governments realize that in a rapidly changing economy workers must be able to constantly retrain if they are to stay employable. In another issue of this journal Kargidis et al. present an educational model specifically designed for users who want to continue their studies in order to improve their chances for promotion, hold onto their current job or reposition themselves in the labor market (Kargidis et al., 2003). Government, industry

and some universities see e-learning as a means of doing this. Such optimism is contagious but it begs a number of questions. Will such education delivery be cheaper? Will it be more accessible? Can it or should it replace traditional face-to-face university education?

If the pedagogical quality of new ICT based courses is substandard they may prove to be a false economy. A poorly trained or retrained person could cost a company more money than what it saves on running an in-house course. In answer to the second question it does seem that ICT has improved access for learners in the privileged western world. Whether it promotes accessibility on a global scale is another matter. Developing countries are playing a hopeless game of technological catch up and increasingly sophisticated ICT based teaching and learning material may in fact reduce rather than extend educational accessibility (Christie, 1998). In answer to the third question it seems highly likely that education will be packaged and sold like other products on the global market. Degrees are saleable products, as we already know from the increasing number of universities who charge overseas students high fees. As the number of online courses increase the quality of the product will be judged by the consumer and the old adage, 'buyer beware' will apply. World famous universities have a head start in such a competitive world but there is no reason why large or small companies, with an eye to a profit, could not carve out niche markets for themselves. The Massachusetts Institute of Technology (MIT) recently put its courses on the web for free. Was it an act of magnanimity or an effort to undermine such competition?

What effect will e-learning have on face to face learning? It will certainly make it possible to reduce the amount of such teaching. Which begs another question? To what extent is the physical interaction of learners and teachers pedagogically important? Does learning need to be embedded in a social context for it to be effective? An even more confusing question is how real and virtual interaction differs. Social scientists already carry out research in virtual towns that exist in cyberspace, where people shop, go to school, marry, buy property and have children. Can the virtual university and the virtual classroom provide an alternative form of socialization and networking? These are two aspects that pedagogy of e-learning needs to consider. Will email, chat and video contact be enough to promote these things or is there some intangible but extremely important ingredient missing when one cannot smell, look at, touch or be in the physical presence of teachers and fellow learners?

As with most things the answers to many of these questions depend on individual and institutional aims. If the aim is to simply impart knowledge in well-established discipline areas then e-learning seems to have few drawbacks. It is more difficult however to design online courses that promote the type of generic skills that involve human interaction, especially if those skills include presenting reports in public or reading and responding to body language in a group. In our university one of the generic competencies we aim at is the ability of an engineer to problem solve in small groups, including the sort of face-to-face groups or teams that currently exist in the workplace. One day if engineers work exclusively from behind their PCs or laptops, this argument for face-to-face skills may need revision. We know that online courses cannot replace physical contact but video conferencing goes some of the way and there is scope for pedagogical research and implementation to ensure that when video conferencing is used it is

particularly effective. There are obvious downsides to an exclusive use of e-learning. Because of the cost of updating hard and software it is important that when an institution decides to commit to it the result is an improvement not a deterioration of teaching and learning. Robyn Young (1998) has argued that decisions to introduce computer-mediated courses, particularly distance courses, have to be both strategic and pragmatic. They need to take into account a range of questions and the order in which we ask them will depend on the purpose we have. The questions include:

- Pedagogical questions – will students learn better in ICT based courses?
- Ethical questions – will the teaching and learning experience be fair and equitable and assist both students and teachers to become better people.
- Organizational – will the organization better achieve its aims? These aims can be economic, political and social as well as pedagogical.

In developing pedagogy for e-learning it is important that we ask the four fundamental questions about purpose, method, assessment and evaluation. An essential feature of any pedagogy for e-learning must be that it is forged by teachers and learners together. Teachers and learners share a responsibility for the quality of teaching and learning in higher education and for the continuous improvement of that learning (Bowden and Marton, 1999; Biggs, 1999; Cranton, 1992 and Ramsden, 1992). If they do not accept that responsibility others will, as they did in England and Australia, when a pedagogy called 'competency based learning' was introduced from the top down.

In an investigation carried out for this article the principal author visited twelve universities in Singapore, Australia and New Zealand to compare and contrast developments in online education and ask the questions posed above. It was interesting to see the different degrees of institutional response to ICT. At Nanyang University of Technology in Singapore, wireless connection to the Internet was available across the whole campus; all courses were on the web; and students could access their courses anywhere and anytime, including watching streamed lectures in real time. At Canterbury University, a traditional university in Christchurch, New Zealand, staff took a much more cautious approach and very few courses were fully online. Nevertheless all the universities had invested in some form of learning platform and had begun putting teaching material on the web. The majority of the people who were asked if this had improved their organization responded positively. In terms of money the economic benefits were not always obvious but any university in Australia or New Zealand that neglected online provision risked losing out on the lucrative market in overseas fee paying students. There was also a political benefit as most governments were keen to see e-learning established. In New Zealand the government had funded a large project involving universities and polytechnics that focused on ways in which tertiary teachers could help each other put their courses online. The pedagogical benefits of e-learning were also discussed and here there was a more varied response. One university had carried out a survey and discovered that some of the supposed benefits of online teaching and learning were not as obvious as they had thought. Others, like Charles Darwin University, pointed out that it was not enough to provide the infrastructure. Teachers had to be inspired to work imaginatively with the change over from face-to-face teaching to using the Internet.

Most of the universities visited had opted for commercial learning platforms. The two most common were BlackBoard and WebCT Vista. Commercial learning platforms are interesting in that they have an inbuilt format that assumes education is about providing information, encouraging discussion and testing knowledge and skill development based on the information provided. In that sense the 'medium is the message' (Marshall McLuhan, 2001 edition). Some of the more exciting developments in e-learning that we encountered during our study visits occurred when teachers stretched or shrugged off what could be seen as the pedagogical straight jacket of their particular learning platform. These developments included creative uses of the standard functions as well as technological add-ons that gave the teachers increased scope for innovative instruction or greater quality control. One example was the use of multi media as a diagnostic learning experience in the health sciences. Students watched an online video of a person walking and had to individually and then in teams diagnose the podiatric problems that person had. When students had agreed on a diagnosis the teacher entered into the discussion and in a synchronous forum drew out the correct conclusions.

The response of many of our informants to the second question on equity and access was informative. In universities where there were large numbers of overseas students the fact that lecture notes were available in digital form and in some cases lectures were streamed or recorded was of great help to students with English language problems. At the Southern Cross University in Queensland, Australia, Dr Lee Dunne drew attention to the benefits that online education can have for female students, especially in courses that require group work projects. In her own experience a group of older women used the web to build up a social as well as an educational relationship. They not only helped each other with understanding the course material but they also assisted each other in practical matters. Their geographical location helped. All they were residents of Brisbane, about 100 kilometers away from the main campus, and were able to arrange face-to-face meetings for both work and social purposes. They were so enthusiastic about this development that they invited their lecturer to come to Brisbane and meet with them so they could share with her some of the extra curricula advantages they believed they had got from the course. This experience is worth comparing with that described by Barbara Ewell in an earlier paper published in this journal (Ewell, 2000). An important impact of ICT for the authors' own research and work is that e-learning could benefit women or, for that matter, any minority engaged in group projects. The second author's own experience as a student using online learning material suggests this. Her personal insights are reaffirmed in an investigation carried out by Agneta Göransson at Chalmers. Göransson (1995) quotes a female student who felt that 'When one does group work there are always some guys who try to control everything'. This is not so easy to do with online discussion groups where big voices give way to keyboard speed.

In regard to the final question, 'Will students learn better in ICT based courses' the response of most of those who were interviewed in Singapore, Australia and New Zealand was 'that it depends'. It depends on the sort of key assumptions that Laurillard cites in the final chapter of her book on the effective use of educational technology (Laurillard, 1999 edition). The impact of pedagogy and information technology will be both mutual and beneficial to learning when the infrastructure to support it is developed across the whole institution and done so in a collaborative way. It is not enough to put infrastructure in place and then forget about it. It has to be supported and renewed in a cyclical process that ensures continual improvement. The whole focus of any

major e-learning initiative has to be the improvement of teaching and learning. To facilitate the improvement the courses have to be designed so that the entire learning process is supported. This means the students should not only receive information to digest but be assisted in innovative pedagogical ways to analyze and reflect on it, to discuss it with others, to trial the new knowledge and skills and to be assessed and given feedback on their acquisition of them. At the university level it is important that the academic knowledge and practical skills that the students developed are integrated and experienced as a whole. These key assumptions must underpin the development of pedagogically sound online education.

Conclusion

The potential of e-learning is enormous. But it is also problematical. A timely discussion is needed. What exactly do we mean by e-learning? What sort of pedagogy should drive it? What impact will it have on tertiary education? As technology continues to develop at a fast forward speed, ICT specialists, educational programmers, teachers and learners need to work together. If this does not happen some of the best features of traditional teaching and learning will be wasted and the potential for a new and better pedagogy of e-learning lost. As we implement e-learning we need to critically reflect on our reasons for doing so, examine the ways in which we will employ it, determine how we can know if we are being effective and analyze ways of improving it. There is a potential synergy that exists between pedagogy and information technology. There is a mutual impact. Our challenge in higher education is to understand that impact and to keep pace with it. We must be ready to abandon outdated pedagogies. If problem based learning best suits online education then it is crucial that we embrace it. Most important of all we have to keep an open mind to the extraordinary possibilities that the ICT revolution offers us.

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[1] Dr. Michael F. Christie is an Associate Professor and Coordinator of the Diploma of Teaching at the Center for Digital Media and Higher Education at Chalmers University of Technology, Gothenburg, Sweden. He can be reached at CKK, Chalmers, 412 96 Göteborg, Sweden. Email: michael.christie@ckk.chalmers.se; Phone: +46 31 772 8556 ; Fax : +46 31 772 8585.

[2] Fariba Ferdos is a doctoral student and part time teacher at Chalmers University of Technology. She is pursuing a combined degree in nanoscience and pedagogy and is interested in gender issues at technical universities. She can be reached at Chalmers, 412 96 Göteborg, Sweden. Email: fariba.ferdos@ mc2.chalmers.se; Phone: +46 31 772 1726; Fax: +46 31 772 1540.

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