Is it the computer's fault that the results are wrong? A case from the Norwegian Ministry of Education and Research.

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Abstract

Cheating has occurred throughout history, from falsifying information and results to presenting biased data. While few people would use correction fluid to "fix" their accounting books or forge a check, it seems somehow easier to cheat using a computer. The "cheating" can be hidden within a computer program and performed in such a way that nobody will notice. Even if the discrepancy between the manipulated results and the real world is detected, the complexity of computer systems often enables plausible explanations. In fact, computers often make it possible to manufacture the desired results without the risk of being called a cheat.

This discussion is based on a case study, using data from the Norwegian Ministry of Education and Research. Every year, the ministry presents a report on the state of Norwegian higher education. The 2011 report shows a dramatic increase in the percentage of students who gained Bachelor degrees compared to previous years. This is politically important. The government has already been criticized for the large high-school drop-out rates, and clearly does not want a similar situation for higher education. Good numbers in this regard may be a means to stop the debate before it has started.

As this article shows, however, the ministry has used creative calculation techniques and a very selective and biased inclusion of which data to use. Data errors are also a part of this scenario. An important question is why the institutions do not react to data that is clearly not representative.

Keywords: cheating, falsifying, computer, statistics, education.

To err is human, but to really foul things up you need a computer." –Paul Ehrlich

Computers and errors

Technology users run the risk of following procedures, but ignoring the meaning of the results. A well-known error of calculation involved the construction of the Norwegian Sleipner platform, a production and processing offshore platform to be used in the North Sea. On August 23, 1991, the concrete walls of the platform's hull collapsed, sending the $700 million structure to the bottom of the sea, luckily without any loss of life. Later analysis showed a flaw in the design: due to a rounding error in a finite element approximation, the stresses were underestimated by 47 percent (Jakobsen and Rosendahl, 1994; Selby & Collins, 1997).

The history of computing is littered with similar cases. One example is the Wall Street crash of 1987, when a fall in stock prices triggered automatic sell orders that resulted in panic and a 22.6 percent fall in the DOW index (MacKenzie, 2004; Mitchell & Netter, 1989). Other examples including space rockets exploding; patients receiving excessive dosages of drugs; and telephone, power, and banking systems failing for days on end.

Cheating with computers

People have always cheated with numbers, in business, sports, research, and other areas. Modern examples include Enron, WorldCom, and the current Greek debt crisis. It is interesting to ask whether computers have made cheating easier. The black-box nature of the computer increases the distance to the original data and to the calculations. Users often accept the results because they assume that the computer always makes correct and unbiased calculations. The distance to reality that computers offer can be used for any type of cheating.

Enron created a large set of daughter companies, some offshore, where it could hide its debt, allowing the parent company to show profits. Creative use of "mark-to-market" accounting, where the expected profits on a contract ("fair value") was put on the books immediately, made it possible to overestimate income. For six years in a row, *Fortune* named Enron "America's most Innovative Company." The company's stock price was $90 in 2000, but the company filed for bankruptcy a year later. Today, Enron has become a symbol for bad accounting practices.

WorldCom built its business model when the telecom industry was deregulated. By the end of the 1990s, WorldCom was the second largest telecom operator in the United States. However, the company was severely affected by the dot-com bubble, lower prices in the telecom sector and a merger with Sprint that was blocked by authorities in the EU and the US. In order to avoid a fall in stock prices, WorldCom employed illegal accounting methods, carefully at first, but later in a more widespread manner. By keeping expenses off the books, such as the part of the income from a telephone conversation that was to be forwarded to other operators, and by inflating proceeds, the company managed to present a picture of profitability. In 2002, however, the U.S. Securities and Exchange Commission (SEC) initiated an investigation that led to WorldCom's bankruptcy.

Likewise, Greece used a number of creating accounting practices to present a better picture of its state finances to the EU community. With the help of Wall Street, Greece managed to hide several loans as "currency transactions." This became apparent during the global financial crisis and Greece currently has a very high debt-to-GNP ratio. Even after several financial packages from EU to save the situation, Greece still faces an uncertain financial future.

Many people do not consider it especially serious to break the law through a computer. Anti-theft campaigns from the software and the entertainment industry, which date back to Bill Gates' "Open Letter to Hobbyists" in 1976, have referred to illegal downloading as theft. Gates message – "… most of you steal your software" – is identical today's message: "You wouldn't steal a DVD." Educational institutions encounter similar problems. Many students are heavily involved in plagiarism and see nothing wrong with it. Part of the reason for this could be that the distance to the person whose work is being copied is not as close as it is in the "real world" (Maurer et al, 2006). Many institutions have also seen an increase in cheating at exams (Curran et al., 2011). Etter et al. (2006) said that "information technology has lowered barriers to cheating."

Exploiting complexity

The complexity of computer systems can lead to errors, but can also be utilized to achieve the desired results. While few people are willing to use correction fluid to change results on paper, it seems easier to exploit the complexity of the system. There are many possibilities: one can improve data, massage data or use creative definitions.

Improving data

The simplest method would be to enter "good" numbers into the system. There are indications that this is done in many schools in Norway, where teachers are pressed to produce improved preliminary grades so that the school will get good rankings. While the final result comes from a final exam, which is often graded nationally, preliminary grades may be used to gain media attention (Gravaas et al., 2008). This type of behavior also occurs in higher education, presumably, especially at institutions that do not have enough students or are trying to compensate for a general low quality level of candidates.

The literature includes abundant examples of cheating with data. For example, renowned South Korean researcher Hwang Woo-Suk was able to report in *Science* that his research team had managed to clone a human embryo. This was seen as a great breakthrough in stem cell research until it became clear that the research was based on falsified data. In an article published in *Lancet,* the Norwegian dentist and medical researcher Jon Sudbø claimed that ordinary painkillers could reduce the risk of oral cancer for smokers. These findings were also shown to have been based on fraudulent patient data.

Massaging data

One means of cheating involves carefully selecting the data that goes into the calculations. Enron did this by moving debt to offshore companies, which Greece did when it referred to loans as currency transactions.

Since all calculations involve a set of assumptions, these assumptions can be adjusted to suit the needs of those making the calculations. For example, consider a business that has asked its employees to evaluate the corporate executive. Assume that employees in division A and B are generally positive, while those in C are negative. Further assume that slightly more than half of the employees in A and B answered the question, and slightly less than 50 percent in C did so. To improve his ratings, the executive could choose to consider only the positive results from A and B, but this would be considered cheating. However, the executive would achieve the same results by only accepting data from divisions in which more than 50 percent of employees provided an answer. Such an administrative decision could be hidden in a footnote in the final report.

When the Ministry of Education[1] presents the number of courses passed according to plan, it can show excellent results for the previous year. For example, students passed an average of 85 percent of planned courses. What the results do not say is that students' plans are updated every term. Students who fail and drop out of programs will not be a part of these statistics. Also, a student who has problems following a program has the option of only planning for a few exams in the next term.

Creative calculations

The Ministry of Education's 2011 report on higher education shows the percentage of students who succeeded in finishing a B.Sc degree within the allotted time. This is important data. In Norway a new reform for higher education was passed in 2001, the main aim of which was to get more students through the various programs in the allotted years (three years for a bachelor's degree and five for a master's). To achieve this, universities and state colleges streamlined programs and intensified tutoring. The reform has been criticized for focusing too strongly on quantity – that is, the number of students in the programs – than on quality. Politically, it is important to present good numbers here, and the numbers in the Ministry of

[1] Tilstandsrapport for høyere undervisningsinstitusjoner 2011, Kunnskapsdepartementet.

Education's 2011 report are indeed excellent. The report shows that 86 percent of the students who enroll have a bachelor degree three years later. Some institutions can even present numbers close to 100 percent.

The 2011 report presents data from 2007 to 2010, while the previous report covers 2006 to 2009. What is also astonishing is the improvement from the 2010 report to the 2011 one. For example, Norway's largest university, the University of Oslo, had a 25 percent rate in the first report, but 85 percent in the latter. On average, the percentage of students who succeeded increased from 31 percent to 87 percent in one year!

The 2011 report offers a clear method for calculating these percentages, based on "the students' date for starting and ending a program within each institution"[2] (Statistics Norway, the central body responsible for Norwegian society's statistical needs, uses a similar definition). For students who took the normal three years to complete their bachelor's degrees, the 2010 report stated that the "percentages are calculated based on the number of students who received their degree within the end of the normal time [2009] … and the number of students who started on a program [in 2006]". In other words, they divide the number of students who received a bachelor's degree in 2009 by the number that started in 2006. While this may provide a rough estimate of the percentage of students who received a bachelor, it does not say anything about how many took three years to do so. Students who received a B.Sc in 2009 may have started much earlier than 2006. This is what Aristotle called a circular argument or a logical fallacy. Here, the Ministry of Education expects that students will take three years for a bachelor's degree before trying to calculate the numbers that use three years.

We know that the success rate of up to 100 percent is not credible, nor is the dramatic improvement from the 2010 report to the 2011 report. To investigate this, we followed students from 2007 to 2010 at Molde University College, a state college with approximately 2000 students. According to the ministry report from 2011, the success rate for this institution is 88 percent. In fact, according to our calculations, the correct number is 43 percent, ranging from 27 percent (programs in social sciences) to 67 percent (nursing programs). We have reason to believe that these numbers are representative of other institutions. For example, the School of Economics at Bodø College (now University of Nordland) can report a success rate of 42 percent, which is nearly identical to that of Molde University College.

We asked the ministry to comment on these disparities. In an e-mail, the ministry said that it does not follow students from the start of a program to the end, so the "numbers say nothing about how many fail in higher education." However, the ministry has more than one opinion on this. In April 2011, the Minister of Higher Education, Tora Aasland, referred to the 2011 report by saying that "[this] provides good numbers with which to assess the situation [of failure]."

Statistics Norway can present data on how many years it took students who received a bachelor's degree from their first encounter with higher education until they gained their degree. Only 42 percent managed to accomplish this in three years. This percentage is based on more than 20,000 students, and is consistent with the data that we have presented for Molde University College and Bodø College.

Ålesund University College operates with an astonishing percentage of 99.2, which implies that of the 243 students who were admitted in the fall of 2007, 241 received a bachelor's degree in 2010. In other words, only two failed, did not follow normal progression, changed school, became pregnant, went on a backpacking trip to the Far East, etc. However, our

[2] This citation and the others in this section are translated from Norwegian.

investigation shows that this percentage is caused by a data error. Due to conversion from one student administrative system to another, all students admitted prior to 2007 were entered as if they had started that year. It is natural to assume that some of the other incredible percentages are caused by the same event.

It should be simple to calculate the correct percentages. All Norwegian educational institutions register data on students, such as courses taken, grades and degrees. This data is exact, since it forms the basis for printing transcripts. In addition, nearly all institutions use the same computer system and all students have a unique national ID. Therefore, it should be quite simple to design a program that follows each student through the educational system and can present reliable and accurate numbers of how many succeed.

Discussion

This case study has shown that the Ministry of Education in Norway has presented quite unrealistic numbers about how many students manage to receive a bachelor's degree within the anticipated three years. In the 2010 report, it is quite clear that the way this number is computed is erroneous. The ministry's 2011 report, which runs to more than 300 pages, does not comment at all on this dramatic improvement from 2010 to 2011. When we investigated the data for a few institutions, there were large discrepancies. In addition, the data offered by Statistics Norway does not conform to the numbers provided by the Ministry of Higher Education.

Based on this, it is reasonable to ask a number of questions:

1. Why did the ministry not comment on the huge differences in the numbers between the 2010 and 2011 reports?
2. Why did it omit details regarding the definitions it used in the 2011 report?
3. Why did it not comment on the exceptionally good numbers in the 2011 report?
4. Why have the institutions not attempted to correct numbers that are clearly incorrect?

It is difficult to give a professional answer. However, attempting a psychologically-based argumentation, it seems natural to assume that the answer to the first three questions is that the ministry does not believe in their own numbers. Another plausible explanation is that they present the numbers without taking notice of what they say, but such an explanation would indicate a lack of respect for the bureaucracy.

Since these reports are circulated to all institutions, and since they define a background for evaluating and for planning, each institution would be expected to make an effort to correct the wrong numbers. If this data is not corrected, it could influence decisions that are made, or – perhaps worse – not made. The answer to question 4 could be that each institution is so focused on having good key indicators that it has no apparent wish to correct the numbers. As an executive at one college, in charge of study programs, said, "We know that the way we compute these numbers is wrong, that there is a correct way, but we will continue using the formula that gives the best percentage." The complexity of the systems seems to be behind everything; an excuse for all to accept overly good numbers. The investigation into the major financial scandals indicates the same thing; many had incentives to believe the numbers, even when it became apparent that they could not be true. Perhaps we need a campaign based on the ideas from the entertainment industry: "You wouldn't use correction fluid to fix the printout."

These numbers, as they appear in the ministry reports, are important key indicators (Parameter, 2007) for the situation in higher education in Norway. This is also seen from the large effort that has been made to collect and present the data. If the numbers were correct,

they would show that everything is working quite satisfactorily. One cannot expect better results than nine out of 10 students who start a bachelor's course receiving a degree within three years. Such numbers could show that the critics were wrong, that the 2001 reform has succeeded, and that everything is well in higher education.

As we have shown, however, the real numbers are much worse, with perhaps only one in three students managing to gain a degree within three years. These numbers have political consequences. Is it satisfactory to have an educational system in which students take so long to get a degree? Is it acceptable for higher education to produce a large numbers of drop-outs, who use time and money on a degree that they never get?

The ideas from New Public management about key indicators demand that these are at least correct. John Seddon's book on systems thinking in the public sector (Seddon, 2008) showed how "bureaucracy and red tape" leads the official sector down the wrong path and how the cost of reporting can be formidable. This is also true in the present case. The educational institutions consume extensive resources reporting everything to the Ministry, with some institutions even having a separate office solely for such tasks. Seddon says that "there is an additional cost because the changes mandated by the bureaucracy are the wrong things to do." It is unclear whether this is the case here. Perhaps it is just the opposite, that the excellent numbers allow the institutions and the politicians to relax and not address a set of complex problems, such as discussing whether everybody should have access to higher education.

We have seen that cheating with a computer is not unusual and, in the context of higher education, could even be described as common. Every year, students are expelled for cheating at exams. Perhaps this lack of ethics has gone all the way to the top – to the ministry? When the discrepancy between the correct numbers (one in three) and the official numbers (nine out of 10) is so large, it is natural to suspect cheating. Of course, no one has actually *changed* the numbers that came out of the computer; instead, the data and formulae that have been used are those that offer the desired results.

Allegations of cheating are serious and should not be taken lightly. Another plausible explanation is that the ministry neither understands the data nor the definitions. However, if it has acted in good faith, it cannot have any clear understanding of the sector it has been set to govern. The conclusion, therefore, must be that the Ministry of Higher Education in Norway is incompetent, and this is a claim that we do not presume to make here. The ministry already received severe criticism in the media for these numbers for its 2010 report. Therefore, one would have expected it to be more careful in the next report. Neither has criticism of the 2011 data in major Norwegian newspapers resulted in any recall of the report.

A reasonable explanation is that the ministry has looked for methods and data that can provide positive values for these key indicators, hoping that channeling these numbers through a complex computer system will cause some of the responsibility for correctness to fall on the system itself. It is like a student trying to hide plagiarism by translating the copied text from one language to the other.

Conclusion

The complexity of computer systems in terms of the amounts of data, the structure of data, and the algorithms, leads to a situation where one loses direct contact with the data. This again offers the possibility of presenting incorrect information, either as a consequence of errors or by deliberately adjusting the results. At the same time, it offers participants an excuse to accept positive data, even if it is clearly wrong.

This paper has used two status reports from the Ministry of Higher Education in Norway. Both of these reports have key indicators that are clearly misleading, showing a near-to-ideal situation of students' success in achieving bachelor degrees. The reality is quite different.

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