The older the better? Are younger Norwegian adults losing ground on basic numeracy skills?

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Results from the OECD survey of adult skills, 2012 brought good tidings for Norway. The average numeracy score for the Norwegian adult population lies well over the OECD average. However, a closer look at the age skill profile shows that while older Norwegians score well over the OECD average for their age group, younger Norwegians score around the OECD average. Comparing these results to results from an earlier study of adult skills, conducted in 2003, suggests a downward trend in numeracy proficiency for the younger generation. We discuss recent school reforms as a possible cohort effect influencing this trend.

In recent years, results from international surveys of student and adult competencies have functioned as powerful tools in the education debate, often creating a mood of crisis with demands for urgency in action. Policy makers use the results of such surveys to argue for large-scale reforms and initiatives in education. Norway is one of many countries where these results have had a clear impact on policy (Breakspear, 2012). These policy reforms create new and demanding situations for teachers, but positive effects on student learning are not always evident. While one may question many aspects of these testing schemes, these surveys sometimes reveal trends that raise concern and which demand endeavors of explanation. It is one such trend; the apparent relative poor performance of younger Norwegian adults on tests of numeracy proficiency, that is the subject of this article. A loss of skill in these younger cohorts contributes to a loss of skill on a country level and changes the age skill profile for the Norwegian population.

The research questions considered in this article are as follows:

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- What do analysis of results from OECD survey of adult skills 2012, (PIAAC) and from the Adult, literacy and life skills survey, 2003 (ALL) suggest regarding the trend in the numeracy skill level for the younger Norwegian age groups, 16–30 years?
- What are the features of the cohort effect of school reforms in the period 2003–2012 that may contribute to the trend in numeracy skill level for the younger age groups?

In this article, we firstly present the international tests, discussing the concept of numeracy employed. We then turn to the analyses of data from PIAAC and ALL, with particular focus on the younger age groups. We allude briefly to data from the other Nordic countries. Finally we move to a discussion of age, period and cohort effects that may contribute to explain the trends observed, focusing on recent school reforms.

Numeracy as measured in the international surveys

Numeracy is a contested concept but there is some general broad agreement. Evans, Wedege and Yasukawa (2013) describe numeracy as a bridge between mathematics and society. Bennison (2015) defines numeracy as the ability to cope effectively with the mathematical demands of life. The OECD defines numeracy as the ability to use, in a critical manner, mathematics in a range of contexts (OECD, 2012). Numeracy is sometimes termed mathematical literacy or quantitative literacy. When we refer to and analyse the OECD data in this paper, we rely on the OECD definition of numeracy and report the related measurements, while fully acknowledging the limitations and conceptual challenges with this approach.

Why measure numeracy? Research suggests that high proficiency in numeracy is empowering and profitable for the individual (Geiger, Goos & Forgasz, 2015). Adults demonstrating high proficiencies in numeracy and literacy are much more likely to be in good health, to be employed, to have higher earnings and to take part in community life (Bynner & Parsons, 2006; Garcia-Retamero, Andrade, Sharit & Ruiz, 2015; Parsons & Bynner, 1997, 1999; Tout, 2014). Other research links literacy and nume-racy skills to national economic growth and welfare (Willms & Murray, 2007).

While there is general international agreement on the need to develop a numerate population, there are different approaches to obtaining this goal. Undoubtedly, most focus is on formal education, as in general, those adults with more formal education obtain higher scores on tests of numeracy and literacy proficiency (Desjardins, 2003; OECD, 2013a).

Education systems employ different strategies. In South Africa, numeracy is a separate school subject while in Australia, numeracy goals are included in all subject curricula (Geiger et al., 2015). In Norway, numeracy is one of the five basic skills, integrated in curricula in all subjects (Ministry of Education and Research, 2007).

Results of surveys of adult skills infer that proficiency in numeracy may develop both negatively and positively throughout life. Performance on numeracy tests peaks around the thirty year age group. Proficiency is correlated with both the level of participation in the workforce and the type of employment. In all countries, adults in occupations involving complex skills obtain higher scores in numeracy (OECD, 2013a).

The international surveys

In this article we refer to data from two surveys, specifically: the *Adult literacy and life skills survey*, 2003 (ALL), and the *Programme for the assessment of adult competencies*, 2012 (PIAAC). We argue that comparisons can be made between the surveys.

Both PIAAC and ALL employ the term numeracy, and both surveyed around 5000 adults in Norway, evenly distributed across the age group 16–65 years.

The definitions employed in these two surveys are similar. In PIAAC, the definition of numeracy is as follows:

> [...] the ability to access, use, interpret and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life.
>
> (OECD, 2012, p. 75)

In ALL, the definition of numeracy was:

> Numeracy is the knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations.
>
> (OECD and Statistics Canada, 2005, p. 5)

The PIAAC survey was designed to link psychometrically to ALL in the domain of numeracy (OECD, 2013a, b). This strategy was intended to validate comparisons, allowing for inferences about changes in age skill profiles both within and between countries (OECD, 2014). Items used in ALL and PIAAC were prepared by a group of experts, well known in the field of Mathematics Education (OECD, 2014). Approximately 60 % of the assessment items in PIAAC were drawn from the previous survey. This practice is pragmatic in that it is both time and cost saving. In terms of reliability it may be argued that the practice allows for comparison of responses and scores. However in relation to the claim that numeracy is context and situation dependent, reproducing contexts through identical tasks is a practice that raises questions. Both the ALL and PIAAC surveys employed a 500 point scale. The scale reflects six levels of overall proficiency. In PIAAC there were 56 numeracy tasks with difficulty values that range over the proficiency levels. These tasks cover the range of mathematical tasks that adults encounter in daily life. The testing and scoring procedures are not designed to allow for assessment of performance within particular areas of mathematical content (OECD, 2014).

The overall OECD average population numeracy score in ALL was 268. The overall average numeracy score in PIAAC was 269 (IDE data analyzer). This score is a rather crude measure and belies the variations within populations.

Method and data

Age, period and cohort effects or a combination of these, serve to explain variations in scores within populations. Age effects relate to chronological age, that is, how people change, as they get older. These effects relate both to physiological age and to the subsequent exposure to social norms, and to certain social influences that accompany aging. In general, after peaking around the age of thirty years, numeracy scores fall, first gradually and then more sharply with age. The poorer performance of older groups may reflect fewer opportunities to maintain and develop numeracy skills. (Desjardins & Warnke, 2012) Cohort and period effects are those effects brought about by social factors outside the control of the individual. These include effects such as physical environments, economic, social, cultural and technological conditions. Cohort effects touch a group of individuals born in a particular year or era. For example, a law introducing compulsory schooling may have a positive effect on skill gain for particular age groups. Period effects affect all at a certain time, for example, an economic downturn or upturn in a country would affect all groups in the population. (Desjardins & Warnke, 2012, p. 14) Cohort and period effects are confounded and difficult to separate statistically (Glenn, 1976).

In this paper we consider changes in the age skill profile of the Norwegian population in relation to numeracy. Such country specific analysis of change in age skill profiles has normally two purposes. The first is to identify aging effects, considering if particular cohorts gain or lose skills over the lifetime and the second is to assess if a country appears to gaining or losing skills over time (Desjardins & Warnke, 2012). Our analyses focus on the second purpose, we examine how particular age groups contribute to the national skill base, as depicted in PIAAC and compare this to how the same age groups contributed in the earlier study ALL.

Earlier research has undertaken similar comparisons of data from the *International adult literacy survey*, 1994–1998 (IALS) and the *Adult literacy and life skills survey* (ALL). Desjardins and Warnke (2012) identified countries where there seemed to be a significant skill loss for a particular age group over time or for a particular cohort. They conclude that there are indications that changes to education systems may contribute to decline in foundation skills for particular age groups. Cascio, Clark and Gordon (2008) also compared data from IALS[1] and ALL to examine the age skill profile in the United States. While US teenagers score poorly in relation to other rich nations, the scores of older groups, for example, those in the late twenties compare favourably to other nations. They argue that this trend may be explained by a broad comprehensive education followed by expanded access to university education, typical of the US. In their data, Norway displayed a similar pattern to the US with a large differential in performance between the 16–17 year olds and the 26–30 year olds, favouring the latter group. In regards to methodology, they conclude that the use of cross sectional data while adding noise did not bias estimates of the true age skill profile. Using data from IALS and ALL, Willms and Murray (2007) created synthetic cohorts to study primarily literacy skill loss in adulthood for various demographic groups in Canada. They also compare Canada to Norway. Both countries display significant skill loss over lifetime but loss is not homogeneous in the population. Post-secondary education, the amount of reading at work, and stable employment all have a positive impact on the stock of literacy skills and reduce the magnitude of skill loss.

The data in this study

The PIAAC data for all participating countries, with the exception of Australia, is freely available in several formats from the OECD webpages. Statistics Canada maintains the ALL data. The international data explorer (IDE) and the international database analyzer (IDB data analyzer) are tools developed by the IEA specifically to analyse data from these international surveys. These tools were used to analyse the data in this paper. To construct the age skill profile we divide the population into age segments. These segments represent 5 year spans, with the exception of the first age group, 16–19 years and the last group 60–65 years, (16–19, 20–24, 25–29, etc.).

PIAAC data – good news for Norway but …

The Norwegian population, as a whole, scored a mean of 278 points on the numeracy scale in the PIAAC survey, ranking number 6 among the OECD countries. The Norwegian mean score of 278 points was significantly lower to the score of only two other countries Japan (288 points) and Finland (282 points). This mean Norwegian score was significantly higher than OECD mean score of 269 points. (OECD, 2013). Figure 1 shows the age skill profile for the numeracy scores, dividing the population broadly into 5 year age bands for both Norway and the OECD. Each age band includes approximately 500 persons.

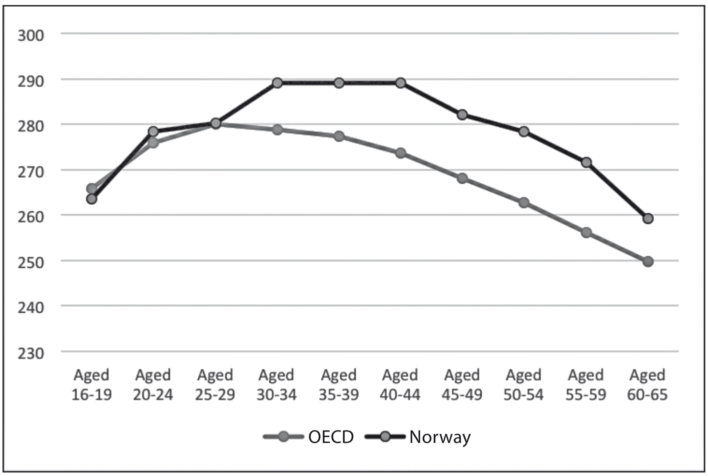

Figure 1. *Mean numeracy scores PIAAC, OECD and Norway (IDE)*

The graph in figure 1 indicates that the performance of each of the three younger Norwegian groups, covering the 16–29 year age groups in the population, is very similar to the OECD mean score. All other age groups lie significantly over the OECD mean score. For the OECD the scores peak in the 25–29 age group and then decline first gradually and then more rapidly with increasing age. In Norway, there is a dramatic increase in the mean numeracy score between the 25–29 year age group and the 30–34 year age group. The scores first begin to decline in the 45–49 year age group, thereafter following the OECD pattern, though they continue to lie well over the OECD average.

The immediate question is why is there a discontinuity in the pattern for the population at age 30 years? Extrapolating backwards one would perhaps expect the younger groups to lie over the OECD average. In fact, Norway has the dubious distinction of being one of seven countries where the age cohort, 16–24 years, scored under the mean for the whole country population in the numeracy domain (OECD, 2013). Norway was one of the countries where the disadvantage of the young was greatest (OECD, 2013).

We can also consider the international ranking for the different age groups. Table 1 shows the mean score and ranking for age groups, for both Norway and the OECD. The younger age groups seem to have lost the competitive edge of their elders. We conclude that the overall above average performance of the Norwegian population in the numeracy domain in PIAAC was a result of the above average performance of the older groups in the population. The significant increase in the numeracy scores, which occurs at the 30 year age point and continues over the population, is of interest.

Table 1. *Mean numeracy score and group ranking OECD/Norway*

Score	Age group									
	16–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–65
OECD mean	266	276	280	279	277	274	268	263	256	250
Norway mean	264	278	280	289	289	289	282	278	272	259
Norway rank	14	12	10	4	5	3	3	2	3	7
d score	-2	2	0	10	12	15	14	15	16	9

Regarding the distribution of the population across proficiency levels, analysis of the data shows that there was no significant difference between Norway and the OECD when considering the proportion of adults in the lowest or highest performing levels in the 3 lowest age groups (16–29 years). For all other age groups, with two exceptions, Norway had significantly fewer in the lowest levels and significantly more in the highest levels. The two exceptions were the lowest performers in the 35–39 year age group and the highest performers in the 60–65 year age group. In these two cases there was no significant difference between Norway and the OECD.

PIAAC in the Nordic countries

It is of interest to digress slightly to take a brief look at the age skill profiles in the other Nordic countries. Figure 2 shows the age skill profiles for the PIAAC numeracy data for the Nordic countries. We see that the 16–19 year age group in both Denmark and Sweden score around the OECD average. However, in these countries, the following two age groups (20–24 years and 25–29 years) quickly gain ground and lie significantly above the OECD average, with Sweden outperforming Denmark. Finland outperforms the other Nordic countries in all the 5 year age bands from 16–40 years. Interestingly, the performance of the Nordic countries converges from age 35 years; all older age groups in all countries lie significantly over the OECD average.

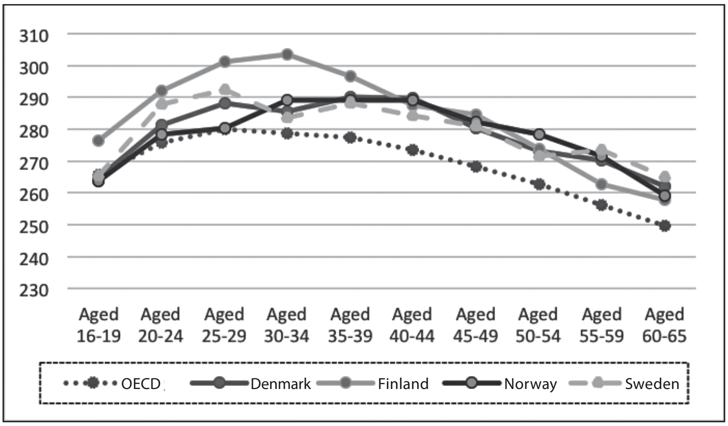

Figure 2. *PIAAC numeracy profiles Nordic countries*

Evidence from the ALL survey

Returning to Norway, the PIAAC data suggests that numeracy performance for the younger Norwegians may have declined dramatically over the last 9 years. If such a trend is real and continues, then the overall numeracy scores for the Norwegian population would be expected to fall in surveys in the coming years. Research on the importance of numeracy skills suggests that such a development could have serious consequences for individuals and for society as a whole. To investigate this seeming discontinuity in the PIAAC scores at the 30 year age group we refer back to the 2003 survey of adult skills , ALL.

Six countries participated in both the ALL 2003 and the PIAAC 2012, surveys. Norway was the only Nordic country participating in ALL (OECD and Statistics Canada, 2005, 2011). As discussed earlier, all attempts were made to make the surveys suitable for comparison. However, it should be noted that of the six countries participating in both surveys, only Italy displays an upward trend. In the other five countries, the average overall numeracy scores were significantly lower in PIAAC than in ALL. The Norwegian mean numeracy score in PIAAC was 278 points, 6 points lower than in ALL (284), possibly because of the drop in performance of the younger cohorts. The OECD mean numeracy score in ALL was 268 points compared to the 269 points in PIAAC. Figure 3 shows the Norwegian mean scores profiles in numeracy from both PIAAC and ALL and the OECD numeracy means from PIAAC. The OECD profile for ALL is not available but we would expect a similar profile to PIAAC. It should be noted that in ALL the youngest cohort was defined as 16–20 years compared to 16–19 years in PIAAC[2]. The comparisons are therefore not perfectly overlapping but we consider the comparisons usable given the clear patterns in the scoring.

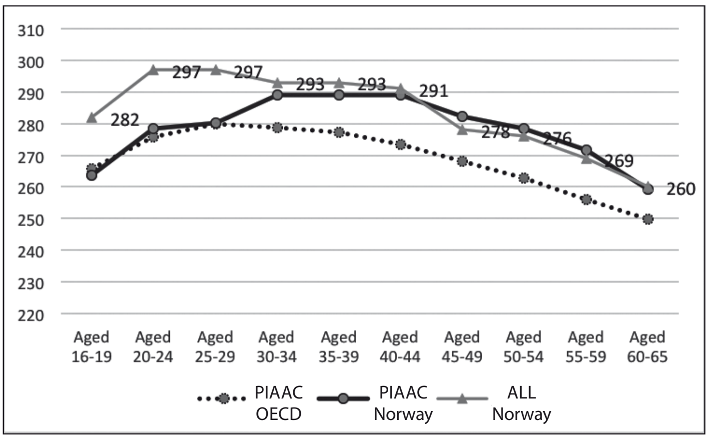

Figure 3. *Age skill numeracy profiles, PIACC and ALL, Norway/OECD*

Considering the Norwegian scores in ALL, two of the three youngest cohorts perform well above the average for the whole population. Scores begin to decline from 30 years. In PIAAC, the scores picked up at this age. The graphs suggest that the over 30 age groups maintained the above OECD average performance in PIAAC while the performance of the three youngest year age groups (16–30 years) has fallen to lie just on the OECD average. All age groups in the Norwegian sample, excepting the oldest group lay well over the OECD mean score of 268 points.

Another interesting observation concerns the youngest cohort in ALL. The youngest cohort in ALL 2003 (16–20 years) is represented in PIAAC 2012 by the 25–29 year age group. Given the general pattern of development of numeracy scores, it would be expected that this group increase their score from the 282 points obtained in ALL in the intervening years. However, the group only manages to maintain their ALL score achieving 280 mean points at age 25–29. This is the only ALL cohort which behaves unexpectedly in terms of life cycle development.

Table 2 shows both the average scores and the distribution across performance levels for the youngest cohorts in ALL and PIAAC. A consideration of the proficiency levels confirms the trend observed in the age skill profiles. We observe an increase in the percentage of the population at the lowest levels of proficiency in numeracy from ALL (10,6 %) to PIAAC (14,9 %).

Table 2. *Norway ALL/PIAAC proficiency levels youngest cohorts/whole population*

Age group	Survey	Level 1	Level 2	Level 3	Level 4/5	Mean score (s.e.)
16–65	ALL	10,6	29,6	41,5	18,4	284 (1,0)
	PIAAC	14,5	28,4	37,4	17,4	278 (2,8)
16–20	ALL	12,9	28,8	41,5	16,8	282 (2,8)
16–19	PIAAC	19.2	38,4	35,3	6,3	264 (2,8)
21–25	ALL	5,9	22,8	42,8	28,4	297 (2,4)
20–24	PIAAC	14,5	27,7	39,9	16,8	278 (2,8)

Note. Level of proficiency given as % of cohorts

We observe from the table that the youngest age cohort in ALL had a mean score slightly, but not significantly, below the result for the total sample of Norwegian adults participating in ALL, while age-cohort 21–25 scored around 12 points above the Norwegian mean score. These large gaps in mean scores are confirmed when we consider the percentages of respondents within Level 1 and 2 on the numeracy scale; 42 % in the youngest age cohort versus 29 % for those between 21 and 25. When comparing the percentages for the same age cohorts scoring on Level 3 and above in PIAAC, we find the same pattern; the age group 16–20 includes approximately 58 percent on these levels outperformed by 71 percent in the age group 21–25. Table 2 displays a similarly large difference in numeracy scores between the two youngest age cohorts in PIAAC. This follows the OECD mean scores and is the expected pattern. Both age cohorts display a significant drop of approximately 18 points in their mean score compared to ALL. (Note the Norwegian population as a whole dropped 6 points from ALL to PIAAC) The mean score for the 20–24 age cohort is the same as the mean score for the whole population, of 16–65 years old in Norway. The mean score for the youngest cohort 16–19 years is 264 points, 14 points below the population average of 278 points. We conclude that the analyses of the adult skill data indicate a loss of skill for the youngest cohorts in the period 2003–2012.

We note that the results of other surveys PISA and TIMMS have received some attention in Norway. These surveys may suggest a more optimistic future. PISA had mathematics as the main focus area in both 2003 and in 2012. In both years, the Norwegian 15 year olds scored around the OECD average demonstrating stabile performance (Kjærnsli & Olsen, 2013). Analysis of TIMMS is also more optimistic (Grønmo et al., 2012). However, in a recent report prepared for the OECD, Gal and Tout (2014) warn against comparison of PISA and PIAAC pointing out several issues with methodology. In addition while PISA and PIAAC may share a similar definition of numeracy, they are not necessarily measuring the same competencies.

In the next section we comment briefly on possible age and period effects affecting this trend before turning to discuss school reforms as a cohort effect that may have influenced the observed findings.

Discussion

Presentation of the PIAAC age numeracy skill profile for Norway (Figure 1) suggest that the Norwegian population demonstrates roughly the expected pattern, in regard to the numeracy scores over the life span. Scores first improve with age then decline, first gradually and then more rapidly. However, we note certain anomalies. The most unexpected is the relatively poor results of the three youngest cohorts, resulting in pronounced discontinuity in the graph. The Norwegian school system has been described as "patient" in that students have a tendency to catch up over time (Lødding, Markussen & Vibe, 2005) but the PIAAC results contrast to the ALL results suggesting that a skill loss for the youngest age groups. Both the peak and the first signs of skill decline in the Norwegian population occur later than in the OECD data, the scores between 30 and 45 years are relatively stable.

In the period between 2003 and 2012, Norway has experienced a period of stable economic growth and high employment. It is not easy to identify obvious specific period effects that would contribute to the performance pattern.

School quality – a cohort effect

The quality of schooling has a major impact on the development of literacy and numeracy skills. Changes in the schooling system are a recognized cohort effect, affecting cognitive skills in groups in the population (Cascio, Clark & Gordon, 2008; Desjardins, 2003). It is therefore of interest to consider changes in the schooling system when discussing skill loss and skill gain on a national level.

Since the end of the second world war, Norway has introduced a number of school reforms (Myhre, 1992; Rønning, 2011; Telhaug, Mediås & Aasen, 2006). Table 3 details the major reforms, their scope and curriculum influence.

Table 3. *Modern post war Norwegian school reforms*

Phase	Year	Reform introduced	Structure & Scope
1	1959	Folkeskoleloven (Law on primary school)	Opened for 9 years schooling: comprehensive schooling
1	1969	Lov om grunnskolen (Law on mandatory schooling)	Compulsory school extended to 9 years: comprehensive schooling
2	1974	Mønsterplan av 1974 (M74) (The 1974 Curriculum guidelines for compulsory education)	No structural changes: emphasis on values, pupil centered pedagogy
2	1987	Mønsterplan av 1987 (M87) (The 1987 Curriculum guidelines for compulsory education)	No structural changes: less centralized curriculum, local responsibility
3	1994	Reform 1994 (R 94)	All students awarded right to three years upper secondary education: courses reduced from 111 to 13, vocational courses restructured
3	1997	Reform 1997 (L97)	Primary school extended with one year, earlier school start. Extensive reform in all areas of curriculum for primary & lower secondary
3	2006	Kunnskapsløftet (KPR 06) (Knowledge promotion reform)	Strengthening of basic subjects, Norwegian, Mathematics and Science. Extensive reform from primary up to and including upper secondary

Broad considerations

Telhaug, Mediås and Aasen (2005) analyse the development of the Nordic model of education and identify three phases of development in the post-war period. In general, the reforms in the period up to 1970s in Norway and in the other Nordic countries concerned the promotion of the social democratic state, though providing access and equality in education. In this period, the so called Nordic model of education was recognized and respected internationally. In this connection, it is interesting to note the general convergence of the numeracy results for the older groups in the Nordic countries. In the second period, 1970–1980/85 international influences set the focus on individual emancipation and local school development. In the third phase, in the more recent decades, the Nordic model has become less important. Trends such as globalization, free markets, and international comparisons have exerted greater influence over school philosophy and development. Direction has turned to the "output" of educational activity and management by "output" rather the management by "input" which characterized the first period.

Telhaug et al. (2006) suggest that the Nordic education system has lost its unique identity and overall sense of social purpose. Antikainen (2006) refers to the recent strong neo-liberalistic influences and the economic integration across Europe that is leading to more integrated and standard education systems. Isolating and identifying the effects of and connections between broad philosophical and historical trends in the schooling system and student learning is a difficult task, given the less tangible nature of these trends. However research has verified that the pervading foundation philosophy inherent in the system will influence the praxis of those working within the system. One may ask if this loss of identity has affected student learning more specifically.

Reforms relevant to PIAAC

The different age groups participating in the PIAAC study have attended school under different reform systems. The two oldest groups in the population did not necessarily have access to 9 years of schooling. All groups under 35 years of age have had access to 3 years upper secondary education through Reform 1994. Analysis of the PIAAC data confirms that the groups with the highest number of years of formal education lie between the ages of 25–45 years.

When considering the three youngest cohorts, two reforms are most relevant. These are *Reform 1997* and *Knowledge promotion reform 2006*, both curriculum reforms. School reforms are generally introduced step wise, especially in upper secondary. This enables students who have, for example, completed one or two years of upper secondary to complete under the old system.[3] By considering each year group, it is possible to determine the course of schooling and to identify which years of schooling come under which reform. Figure 4 relates the introduction of the various reforms to the three youngest cohorts in PIACC and the two youngest cohorts in ALL. The youngest cohort in ALL, 16–20 years, corresponds to the 25–29 year old cohort in PIAAC (born 1983–1987), and is the only ALL cohort whose schooling was influenced by Reform 1997. Adults in this cohort were exposed to three or six years of the Reform during their schooling. The 20–24 year old cohort in PIAAC experienced a schooling characterized by change. Some started their schooling under the pre-reform period, were introduced to Reform 1997 and then entered the Know-ledge promotion period to complete their schooling. Others started under Reform 1997 and completed under Knowledge promotion. These adults had between 6 and ten years under Reform 1997 and between 0 and 6 years with Knowledge promotion. The youngest cohort in PIAAC began their schooling under Reform 1997 (3–6 years) and then continued under Knowledge promotion (7 years).

Figure 4. *PIAAC and ALL cohorts – Reform 1997 and Knowledge promotion*

Born	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Age PIAAC	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Age ALL	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7
Age 1997	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
School grade 1997		12	11	10	9	8	7	6	5	4	3	2	1						
Nr. yrs Ref.97	0	0	0	0	0	3	3	3	6	6	6	10	10	8	7	6	5	4	3
Age 2006	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10
School grade 2006										13	12	11	10	9	8	7	6	5	4
Nr. yrs K06	0	0	0	0	0	0	0	0	0	0	0	3	3	5	6	7	7	7	7

This unrest in the curriculum may have influenced the PIAAC results for the three youngest groups. It has been claimed that it takes 10–15 years before an initiated plan is fully instituted and that Reform 97 was not given sufficient time to work (Haug, 2004) before it was replaced by the Knowledge promotion reform. In the next section we consider the main intention, implementation and evaluation of the two most recent reforms with specific focus on the mathematics curricula.

Reform 1997

Reform 1997 was developed over a relatively short period. The syllabi in mathematics sought to create close links between school mathematics and mathematics in the outside world, an intention which should in theory, support the development of pupils' numeracy competencies. A new domain "Mathematics in everyday life" was introduced alongside the traditional domains of Numbers & Algebra, Geometry, Information processing and Graphs & Functions. Everyday life situations should form a basis for the teaching of mathematics (Mosvold, 2006).

Plans were detailed and the stipulated working methods which emphasized communication, teamwork, experimentation, problem solving and practical application the underlying learning theory being constructivist in orientation (Hagness, 1997). Evaluation of the reform at school level suggests that these working methods were, in general, neither accepted nor implemented. Teachers reported that the new plans were "fine" but that they did not use them. Teachers continued their practice largely as before. The detailed and many goals in the syllabi served only as an irritation. (Alseth, Breiteig & Brekke, 2003; Klette, 2003). Textbooks offered little support (Mosvold, 2006). It is generally concluded that the intentions of the curriculum were not carried out (Alseth et al., 2003).

Another difficult element in the syllabi was the focus on pupil's responsibility for own learning. This focus led in many cases to teachers adopting a passive or facilitator role in the classroom and in some cases being overly positive to students' academic contributions. The dominant activity in classrooms was individual work (Klette, 2003).

In general there was considerable variation in implementation at school levels. The schools that achieved most were those who viewed the reform as a common project involving the whole school (Haug, 2004). The implementation lacked the necessary external support tools. In-service training of teachers was weak and it is questionable if teachers had the education to understand the new plans. Transfer pedagogy was reinforced rather than replaced by the envisaged ambitious activity orientated work and teacher professionalism was weakened (ibid).

In intention, the reform was expected to strengthen numeracy skills. The PIAAC results suggest that the reform worked against its intention in regard to the development of numeracy competencies. A weak implementation strategy combined with a short duration of action period may offer some explanation.

The Knowledge promotion reform

The Knowledge promotion reform (KPR), the most recent reform was introduced in autumn 2006. The reform covers primary, lower secondary and upper secondary education and training. In a status report, Lødding et al. (2005) provided a bleak picture of the subject of mathematics in Norwegian schools just before the introduction of the Knowledge promotion reform. Alluding to the comparatively weak results of Norwegian students in international tests, such as TIMSS and PISA, they point to limitations and frailties in the structure and content of the curriculum, which allocates relatively few hours to mathematics and fails to emphasis main ideas and themes. They claimed that both pre-service and in-service Mathematics and Science teachers are poorly qualified and are given few opportunities for professional development.

It was into this discontented climate that the KPR was introduced in 2006. The reform placed increased focus on basic skills and knowledge promotion through outcome-based learning. In the subject curricula, *numeracy* is named as one of the five basic skills to be integrated and adapted to each subject. Competence goals are clearly stated at all levels in the teaching plans. (Ministry of Education and Research, 2007)

Knowledge promotion has been more favourably received and supported in schools and school districts than Reform 1997. School leaders have embraced and rigorously instituted the quality appraisals and testing systems. As a management reform, the reform is considered successful.

The syllabus in mathematics is less detailed than in Reform 97 but the so called competence goals are clearly stated. The responsibility for organization and working methods is handed back to the teacher (Saabye, Fors & Kongstein, 2011). On the classroom level, it is claimed that teachers are more aware of the basic skills but that this awareness has not had consequences for their teaching. Working with these basic skills has been left to the individual teacher and not seen as a joint school project (Aasen et al., 2012). Teachers in mathematics suggest that this focus on basic skills comes at the expense of depth and progression in understanding of the foundation concepts in mathematics (Ramboll, 2011) and that the syllabus in mathematics fails to link the basic skills to the competency goals (Dale, Engelsen & Karseth, 2011). There are also indications that the gaps between high and low achieving students have widened (Utdanningsdirektoratet, 2012).

Again, despite an emphasis on basic skills and numeracy in every subject the PIAAC survey results suggest a decline in basic skills rather than an improvement.

Lindbekk (2012) claims that the academic effect of these reforms has been minimal because of inbuilt contradictions. The detailed plans are in contradiction to the liberalistic pedagogy. Dello-Iacovo (2009) maintains that the implementation of reforms is hampered by insufficient resources, conceptual ambiguity and conservative resistance. The goals of the new curriculum frequently conflict with teacher, student and parental goals.

Conclusion

In this paper, we have compared results from two international surveys of adult skills. The analysis of the PIAAC data together with the data from ALL suggests a significant change in age skill profile related to numeracy proficiency for the Norwegian population in the period 2003–2012. The younger cohorts appear to be underperforming, resulting in a skill loss for the Nation. If this observed skill loss is real and continues in the same pattern, Norway will in the future lie around rather than above the OECD average in numeracy. This may result in a loss of competitive economic advantage for the Nation as a whole and will most certainly have negative consequences for individuals in regards opportunities in the labour market and general wellbeing. Why then are numeracy skills falling?

We have drawn attention to one element of the recognized cohort effect of schooling. Schooling systems aim to improve basic skills in populations. The younger age groups in Norway have been exposed to two major curriculum reforms in the period under investigation. Both reforms have introduced an increased focus on foundation skills and mathematics in everyday life into the mathematics syllabus. This attention to and enormous investment in improving basic skills does appear as yet to have reaped results, if one considers the statistics in this paper.

However, quality of schooling is not only dependent on structure and curriculum. The quality of teaching is a factor which should be considered in this debate as is the more intangible loss of identity and shift in philosophical orientation that has affected Norwegian schooling system in the last few decades.

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Notes

1 In IALS quantitative literacy was included in the literacy scale

2 ALL: 16–20, 21–25, 26–30 years
PIAAC: 16–19, 20–24, 25–29 years

3 Reform 1997 was introduced in 1997 in grades, 1, 2, 5 and 8. In 1998 the reform was introduced to grades, 3, 6 and 9. In 1999, the final stage the reform was introduced in grades 4, 7 and 10.
In 2006 *Knowledge promotion* introduced a new curriculum for grades 1–9 and grade 11; in 2007 new curriculum for grades 10 and 12; and finally in 2008 for grade 13.

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