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Digital Learning Resources, in what Situations do Students Find them Useful?

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Abstract
This paper describes how Norwegian students in upper secondary school evaluate the use of Digital Learning Resources (DLRs) in science, mathematics and Norwegian. DLRs are the most useful in the latter stages of the learning process and are more valued in science and mathematics than in Norwegian. There are small differences between strong and weak students, but our results suggest that there is a positive interest in DLRs among students who are academically weak.

Keywords
Digital Learning Resources, upper secondary school, student perspective, curriculum, science, Norwegian, mathematics

INTRODUCTION
The laptop has become a permanent companion for Norwegian students in upper secondary school. From 2007 all teaching materials, including digital, are free for students at this level. Both politicians and education administrators have voiced their unanimous belief in the pedagogical benefits of implementing Digital Learning Resources in education (Haugsbakk, 2011).

Norway is a wealthy nation with a rather small population; five million. Education is free and Norwegian schools are considered world leading in terms of PC density and Internet access (Krumsvik, Ludvigsen, & Urke, 2011). The education system has a long tradition of being unitary and centralized, but recent reforms have introduced more freedom at the local level with respect to working methods and teaching materials.

The Knowledge Promotion Reform is the latest reform in Norwegian 10-year compulsory school and in upper secondary education (Ministry of Education, 2006). According to this curriculum the ability to use digital tools is considered to be one of five basic skills, and ICT is to be an integrated part of the learning activities in all subjects. The Norwegian research literature on ICT in education has largely focused on the challenges related to the implementation of ICT, and has documented uncertainty about how it can be integrated in learning activities, and a discrepancy between expectations and results (Erstad, 2007; Haugsbakk, 2011).

This paper describes how Norwegian students in upper secondary school use Digital Learning Resources (DLRs) in mathematics, natural sciences and Norwegian. DLRs include both digital tools and online resources to support a specific cur-

riculum, and in this paper we concentrate on the latter. Usually a DLR is designed as a supplement to a printed textbook. “Lokus” is the publisher Aschehoug’s DLR and covers most subjects in upper secondary school. Møre og Romsdal county subscribes to this site for all their students, giving them free access to the site. At the time the survey was carried out (February 2011), other sites in use were free of charge.

In the DLRs there are different types of content: Text, animations, simulations, video, audio, online exercises and links to relevant websites. In some cases, material that was previously found in the printed textbook is now found online. Exercises and solutions are examples of this. Another type of content which is suitable for publishing online is how to use digital tools, as these tools are available in many varieties and new versions are presented regularly.

The DLRs thus cover much of the functionality which in the curriculum is described as "using digital tools". One example from the curriculum demonstrates this:

> Being able to use digital tools in Biology means gathering information and research, taking readings, and working with and presenting the results of one’s own observations. It covers the use of animations and simulations to illustrate and explain scientific material. It also involves evaluating scientific information found on the Internet. (Ministry of Education, 2006)

This paper reports on how students themselves consider their use of DLRs in the subjects Norwegian, mathematics and natural sciences. Are there differences between subjects and between strong and weak students when it comes to whether DLRs support the learning process? We have focused on two aspects of learning outcomes: At which stages in the learning process do DLRs have value and what content in the DLRs results in learning.

RESEARCH METHOD

The main data source for this paper is a survey among students in year 13 in six upper secondary schools in Møre og Romsdal county. The population consists of 860 students and 718 participated in the survey. This gives a response rate of 83 %, which suggests that the results are representative for the current population. Whether they are valid beyond the six schools and outside Møre og Romsdal is a more open question. The county as school owner and each school have some freedom in decision-making, such as adapting curricula to local conditions or budgeting for upgrading of equipment. Yet we assume that national curricula and national examinations contribute to homogenization, which makes our study relevant for students outside the county. Our findings showed only small differences between schools, and this suggests limited impact of the local freedom.

The respondents are around 18 years old and in their last year in upper secondary school. They are in the “Program for Specialization in General Studies” which gives university entrance qualifications. These students have had their own computers throughout their three years in upper secondary school. 43 % are in the “Programme Area for Natural Science and Mathematics Studies” (here called NSM), while the rest mostly belong to the “Programme Area for Languages, Social Sciences and Economics Studies” (here called LSE). In the subject Norwegian all respondents have the same empirical basis, while there are differences in terms of proximity in time to their experiences with science. Students belonging to LSE have vague recollections about their use and the benefits of DLRs in science, and many do not answer questions about these subjects. In our analysis of experiences with DLRs in the sciences, we have therefore concentrated on the students belonging to NSM (n = 302).

The students in this study are basically successful in the sense that they are about to finish three years of upper secondary school. But there are large differ-

ences within such a group in terms of academic qualifications and motivation. In national education policy it is assumed that the use of DLRs will benefit all students, including those who are academically weak (Kunnskapsdepartementet, 2010). We question whether this is true, and have therefore asked our respondents to characterize their own level in Norwegian and science. This form of self-evaluation has obvious weaknesses, but we argue that since we are talking about senior students they have a relatively clear opinion of where they stand academically.

In this paper we first present the students' experiences with DLRs in science and Norwegian. This is followed by a comparison along some selected variables. Finally, we discuss the need for research-based knowledge about how the use of DLRs affects the students' work with different subjects.

DIGITAL LEARNING RESOURCES IN MATHEMATICS AND NATURAL SCIENCES

Students were asked to focus on one subject (Table 1). The results presented below are mostly related to mathematics, physics and biology since the highest number of respondents relate their answers to these subjects.

Table 1: Number of students that focus on the various subjects when responding to questions about DLRs.

Biology	Physics	Geosciences	Chemistry	Mathematics	Natural science
81	68	21	21	80	25

In which stages of the learning process does the student benefit from the DLRs?

In the questionnaire we listed some situations where it might be appropriate to use a DLR and asked students to consider their benefit. The result is illustrated in Figure 1.

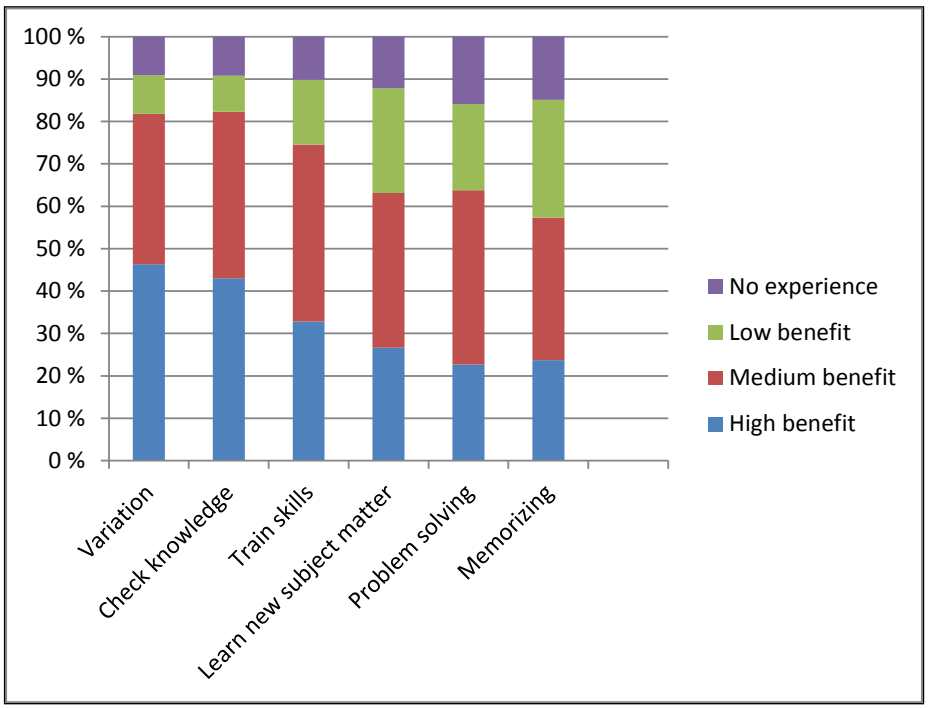

Figure 1: Students in NSM specify the contexts in which they benefit from using DLRs. n = 302.

We see that DLRs are considered useful to some extent by the majority of the respondents in all of the situations that were mentioned. The student experiences the

highest benefit when he or she is checking her knowledge, less benefit when learning new subject matter and in problem solving. This result agrees well with the response to the question about ways of working when learning new subject matter where DLRs are listed quite low (Figure 2). The teacher and the textbook are the most important factors in this situation.

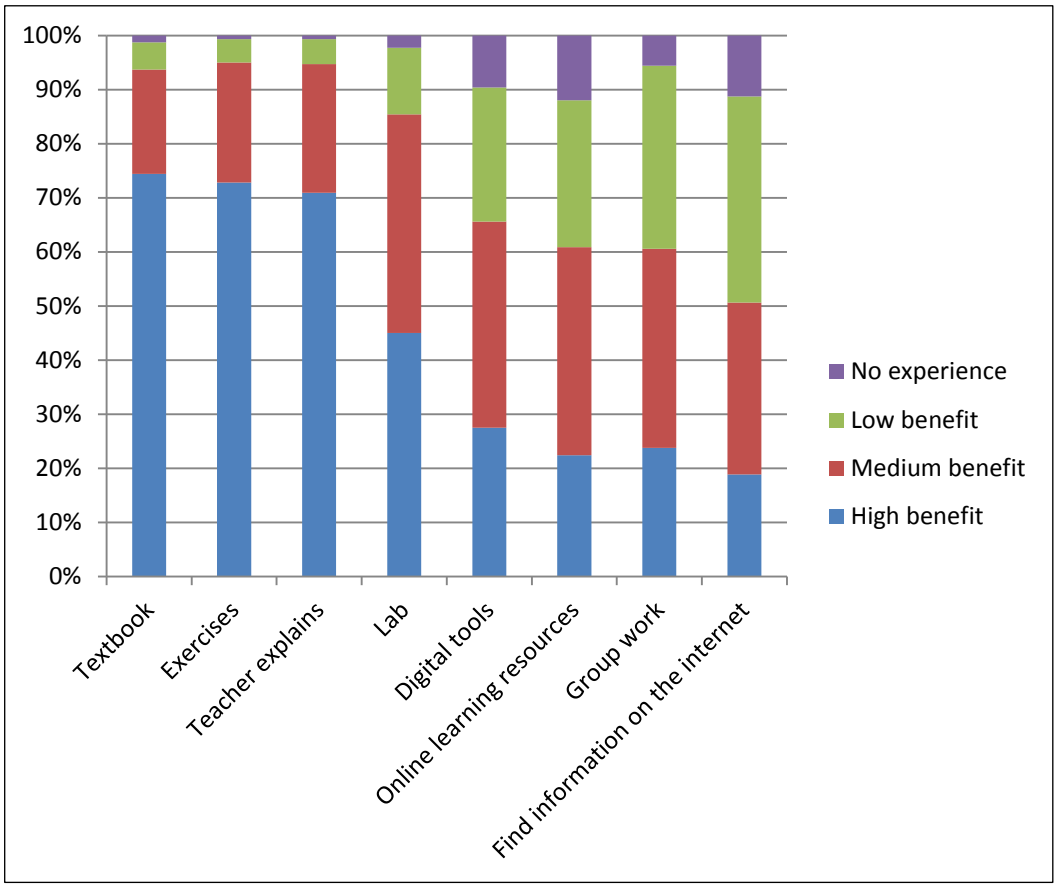

Figure 2: To what degree are DLRs useful when learning new subject matter in science or mathematics? n=302.

We also note from Figure 1 that students appreciate variation. DLRs offer variation from the teacher and the textbook and they also offer many different types of learning materials and activities.

Students' benefits from different content types

The contents of DLRs vary. Figure 3 shows that the students in NSM generally benefit from such content that cannot be presented in a printed textbook, such as animation and simulation. The possibility of watching a video is appreciated, and so are exercises with immediate feedback and help to find the correct answers. Although games are specifically mentioned in the curricula for science and mathematics, few students report high learning outcome from using games. It is possible that there exist few relevant games. Another explanation could be that the existing games are not adapted to the relevant age group.

We have checked whether there are any differences between the subjects regarding what kinds of content contribute most to learning. It is mostly the same types of content that are appreciated. In biology video is valued higher than in the other disciplines and in physics simulation is important. These findings agree well with the subjects' characteristics.

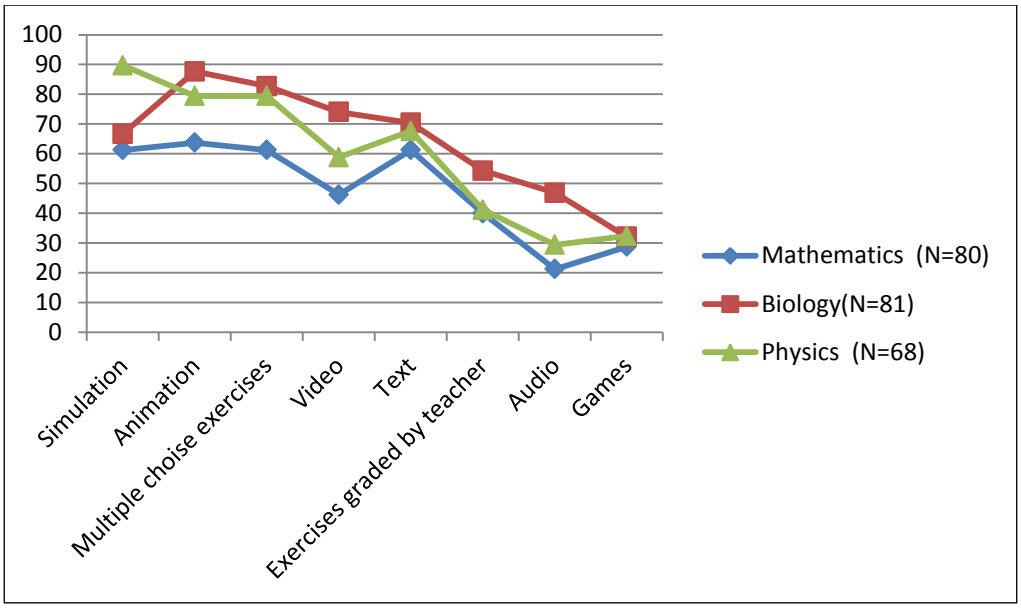

Figure 3: The figure shows the proportion of respondents who report high or medium benefit from different types of content in DLRs.

Students' overall benefit from working with DLRs in science and mathematics is presented in table 2.

Table 2: Science students' overall yield of DLRs. Percentage, n = 302.

High Benefit	Medium benefit	Low benefit	No experience
32	51	14	3

In mathematics and science the DLRs seem to be an important factor in the learning process. More than 80 % of the respondents report good or average benefit from DLRs. The sites are more useful when revising and verifying knowledge than when working with new subject matter. In that case the teacher and the textbook are considered the most important. The value of variation in teaching also appears in the students' answers. Although learning is not primarily digital DLRs are a significant tool in the learning process for the majority of students.

DIGITAL LEARNING RESOURCES IN THE SUBJECT NORWEGIAN

Most textbooks in the subject Norwegian are accompanied by DLRs. A majority of schools seem to use Aschehoug's site lokus.no (Berg, Wallace, & Aarseth, 2012). What kind of content in DLRs do students have the highest benefits from? Multiple choice and text production assessed by the teacher have for more than 60 % of the respondents high or moderate yield (Table 3). Subject related texts are considered somewhat less rewarding, while video, audio and games seem to provide less learning. This may indicate that the impact of DLRs varies between the different learning activities.

Figure 4 shows how students evaluate various ways to learn new subject matters. The DLRs come out lowest. The textbook and the teacher's lecturing are considered as giving highest benefit for the best students. Fewer of the students who consider their own skills in Norwegian as below average, state that reading the textbook provides good outcome. Among these students the teacher's lecture of material is important. There is however no significant difference between strong and weak students regarding benefits from DLRs in learning new subject matters.

Are students seeing the DLRs as useful when working with Norwegian? We conclude that the DLRs do not provide a preferred way of working when learning new subject matters.

Table 3: "Digital learning resources contain various teaching materials. How do you assess your learning outcome when using the different types of content?" Percentage, n = 689-696.

	High learning benefit	Medium learning benefits	Low learning benefits	No experience
Text	25	44	15	16
Multiple choice exercises	21	39	23	18
Exercises assessed by the teacher	28	33	15	25
Video	19	34	21	26
Audio	10	30	31	29
Games	11	20	30	40

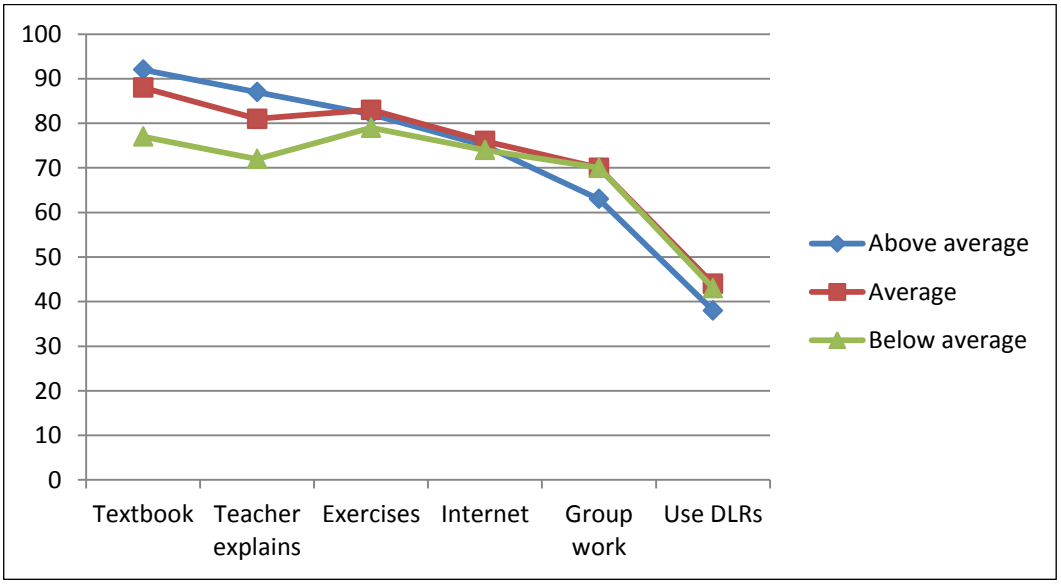

Figure 4: The proportion of the respondents who evaluate an activity to have high or medium benefit when it comes to learning new subject matter. The respondents are grouped with regard to the level they consider themselves to have in the subject Norwegian. Percentage, n = 689-696.

Table 4: How do you assess your learning benefit from using the DLRs in Norwegian?" Percentage, n=699.

High learning benefits	Medium learning benefits	Low learning benefits	No experience
4	38	36	21

Table 4 shows that a relatively large proportion of respondents experience a low yield or a lack of experience in using DLRs in Norwegian. This is a rather remarkable result seen in the light of the strong emphasis on ICT as part of the learning activities in Norwegian (Ministry of Education, 2006).

Table 5: "What benefits do you have from using DLRs in Norwegian in different activities of the learning process?" Percentage, n = 681-692.

	High learning benefits	Medium learning benefits	Low learning benefits	No experience
Approaching new subject matter	15	36	22	27
Variation	27	36	14	24
Revision	27	34	17	23
Entertainment	11	21	29	39
Check if I have understood the subject matter	20	35	18	26
Skill training	16	36	22	26

Table 5 divides the learning process into six different activities. The DLRs seem to work best in the final stages of the learning process, when revising and memorizing. In addition, we get the impression that variation is appreciated. When learning new subject matter, maybe the most important phase in learning, it is still the teacher and the textbook that provide the best learning outcomes, as we found for mathematics and natural sciences.

ARE THERE DIFFERENCES BETWEEN SUBJECTS AND BETWEEN WEAK AND STRONG STUDENTS WITH REGARD TO EXPERIENCES WITH DLR?

Our respondents consider DLRs most useful in the latter stages of the learning process both in science and Norwegian. When they are asked to sum up their experiences with DLRs in each discipline, we get these results:

Table 6: Overall benefit from DLRs in science and Norwegian. Results for weak students in parentheses. Percentage.

	High or medium benefit	Low benefit	No experience	Sum
Science	83 (77)	14 (16)	3 (5)	100 % (n=296)
Norwegian	42 (36)	36 (39)	21 (25)	100 % (n=699)

The answers show that DLRs are far more valued in science than in Norwegian. The differences between the total group and the weak students are modest, but there is a weak tendency that a lower proportion of the latter group experience benefit from DLRs.

We have seen that both in science and Norwegian our respondents benefit most from traditional teaching methods when learning new subject matter. Table 7 compares the results, with the scores for weak students in parentheses.

When it comes to the differences between the whole groups and the weak students, there is a consistent - and not unexpected - tendency for the latter to have less academic benefit from most learning methods. But in our context it is interesting to note that the weak students appreciate the use of DLRs in Norwegian somewhat more than the stronger students. This may indicate that the weak students have

more positive expectations of alternatives to traditional classroom teaching and individual work than their classmates.

Table 7: Students' benefit from different approaches when learning new subject matter. Rated mean values, where low values indicate good results. Mean values for students who are weak in the subjects in parentheses.

Norwegian (n=718)		**Science (n=302)**	
Textbook	1,60 (1,93)	Exercises	1,33 (1,48)
Teacher explains	1,72 (1,93)	Textbook	1,33 (1,50)
Exercises	1,86 (2,16)	Teacher explains	1,35 (1,48)
Find information on the internet	2,03 (2,10)	Lab	1,74 (1,87)
Group work	2,11 (2,07)	Group work	2,23 (2,08)
DLRs	2,74 (2,70)	DLRs	2,29 (2,31)
		Find information on the internet	2,42 (2,30)

A major trend is that DLRs play an important and positive role to complement other more traditional teaching methods. The differences between Norwegian and science are exclusively in favour of the science subjects. DLRs in science come out well, but the results are more negative in Norwegian. Overall our findings confirm that DLRs support the students' learning process. But the role of DLRs as a helper must be considered with regard to the characteristics of the various subjects, the stages in the learning process, and the students' academic qualifications.

CONCLUSION

Education policy seems to be characterized by the assumption that the use of ICT in education is a good in itself (Kirke- utdannings- og forskningsdepartementet, 1993; Kunnskapsdepartementet, 2007, 2010; Ministry of Education, 2006). Beck (2011) is critical to this type of general assumption, and calls for more debate and clarification of what we want to use computers for and how to achieve a good learning outcome. His main point is that the use of ICT is not more value-neutral in education than in other areas. Both general debates and research need to open up and give place to more critical perspectives. In our context we are particularly concerned that these perspectives must be sensitive to differences between subjects. We also believe that there is a need for more research on possible differences between strong and weak students in how they use and benefit from DLRs. Our results suggest that there is a positive interest in adopting DLRs among students who are academically weak, but particularly in Norwegian it seems unclear what these students want and how they want to use these resources.

Erstad and Hauge (2011) argue that we are in a new era of ICT in education. An era dominated by the implementation of national action plans for the upgrading of equipment and expertise is in the process of being closed. In the future there will be more attention given to ICT in school organization and school development. We also believe there is a need for an increased interest in exploring the encounter between subjects and DLRs. Such exploration must be done on an interdisciplinary basis which involves technological, pedagogical and disciplinary perspectives.

Interdisciplinary studies of the use of DLRs in schools also imply methodological pluralism. Our study measures students' experiences with DLRs in Norwegian and science by using a structured questionnaire. This type of quantitative research has obvious weaknesses with respect to capturing nuances (Jacobsen, 2005). We learn something about the prevalence of experiences, but we do not know why students respond as they do, or which specific experiences they have had in given situations. A qualitative study would provide insight into how students describe their use of DLRs in different stages of the learning process.

Our study must be considered in the light of a larger debate about the methodological problem of measuring learning outcome (Eng, 2005). Existing studies are criticized for being too concerned with measuring the differences in outcomes, and that the many variables and sources of error make generalization difficult (Torgersen, 2012). Several critics are calling for studies that look more holistically at student learning. We would specially welcome qualitative studies on students' learning activities in specific subjects to explore why and how they make use of DLRs.

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