

Projector and
Interactive Whiteboard usage
in primary and secondary schools in
China

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Prepared by Futuresource Consulting
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White Paper: Projector and Interactive Whiteboard usage in primary and secondary schools in China

An end-user market survey to explore the energy saving opportunities in the classroom for projectors that use ImageCare® brightness regulation for enhanced picture performance and energy efficiency



This white paper lays out the results of a study into projector usage in schools in China, conducted by Futuresource Consulting. The purpose of this study was to explore the energy saving opportunities in Chinese classrooms for projectors with ImageCare® lamp systems, which can adjust image brightness based upon end-user requirements. ImageCare® is an innovation of Philips Lighting that enables new ways of using projectors for capturing attention in the classroom, delivers enhanced picture performance and saves energy whenever possible.

Most projectors in this study were used in combination with a computer only. In two classes the projector was used in combination with an Interactive Whiteboard (IWB). All classes were also equipped with blackboards next to the projector screen. The results show that projector usage is quite similar across all schools and all classes visited. On average, the projector is on for 1.3 hours per day in blocks of roughly 30 minutes. Average projector usage in the visited schools in China is 267 hours per year. The study showed that the projectors were all used in full power mode, eco mode was not used.

Teachers observed in this study showed a great commitment not to waste energy and a clear preference for bright lighting conditions in the class. Even though screen brightness was hardly mentioned as a drawback of projector usage, every teacher took deliberate action to reduce daylight in their classroom when they used the projector. After using the projector, the teacher turned the projector off, opened the sunscreens again and often switched the ceiling lights on again as well.

Teachers mentioned that the biggest advantage of a projector or IWB is that it is efficient, saves time and keeps the children's attention. The most common mentioned disadvantage was a concern for whether children could learn and memorize a subject properly when taught via a projector (related to seeing the teacher explain things on the blackboard). This implies an opportunity for interactive systems, as such systems could counter the pedagogical reservations against projector usage.

Using the user profile found in this research, Philips Lighting calculated the potential energy saving of an ImageCare® lamp system as compared to a conventional lamp system. The results show that 26% of the power consumed by a projector lamp can be saved during a typical school day in China, whereas in a similar study in the UK close to 50% energy saving was found because the projector was used for a longer time. If teachers could use the projector system in a similar way to a blackboard (i.e. interactive systems) usage might change and perhaps approach a similar pattern as was observed in the UK with similar energy saving opportunities.

1. Introduction

Philips Digital Projection Lighting commissioned Futuresource Consulting to perform research into projector usage in primary and secondary schools in China. Philips Digital Projection Lighting is a projection lamp provider and the inventor of UHP technology. Futuresource Consulting is an independent specialist market research and consulting company, providing its clients with expertise in consumer electronics, digital imaging, entertainment media, broadcast, education markets, optical manufacturing, storage media and IT.

ImageCare® technology is a Philips Lighting lamp operation innovation which offers new ways of using projectors. By offering a very broad dynamic dim range, projectors can now operate the lamp between 100% and 30% of its maximum power. This means that the projector screen can be dimmed either to actively manage attention or to save energy by going into the Saver mode, at which the lamp operates at 30% of its maximum power level. In addition, ImageCare allows the projector to optimize lamp light output for optimal picture performance and maximum energy saving by using only the amount of light that is needed. This means that both projector usage and the image content on screen determine how much lamp power is used. The ImageCare® lamp operation algorithm also has a positive effect on lifetime of the lamp, which results in lower total cost of ownership and less maintenance. To explore the energy-saving and lifetime opportunities of lamp systems with ImageCare® it is necessary to have insight into the actual projector usage and displayed screen content in the fast growing education market.

During previous research, Philips and Futuresource studied projector usage in the UK, where projector usage is widely adopted in schools (Futuresource Whitepaper, May 2010: Projector and Interactive Whiteboard usage in primary and secondary schools). All schools visited in that research worked with interactive whiteboard systems. The results showed that projector usage is quite similar across all schools and all classes visited. A cycle of two hours usage followed by a break of at least 20 minutes is the typical norm in education. Projector usage was slightly higher in primary than in secondary education (64% of a school day versus 51% of a school day). Average total projector usage in education in the UK is 784 hours per year.

However, for emerging markets, the usage pattern may be different. Governments across the world are encouraging schools to purchase projectors by using enormous incentive programs. In environments where projectors are new, the usage may be different and will depend on the willingness of individual teachers to adopt the technology. The interactive whiteboard functionality is most often not included in the sales to education in emerging markets. In the previous UK research, all classes were equipped with interactive whiteboards, projector usage in educational establishments without interactive functions can be expected to be different. In addition, cultural differences may influence the adoption of new technology in classrooms and lead to a different usage pattern than has been found previously in the UK. Therefore, Philips Digital Projection Lighting commissioned Futuresource Consulting to perform research towards actual projector usage in primary and secondary schools in China. China was selected as it is one of the fastest growing markets for projectors in education. In the UK research there were several remarks about screen brightness. In this next phase of research it was decided to also have a look at general lighting conditions, in order to better understand the circumstances under which projectors are being used and how this relates to the teachers use-experiences. The data gives an impression of the screen brightness requirements of teachers when they use their projector in the classroom.

Projector usage was mapped in both primary and secondary schools. In other research, Futuresource found that almost equal quantities of IWBs are sold in primary and secondary education. Only small quantities were sold to other segments.

2. Research Methodology

2.1 Method and Sample

In China there are dedicated subject teachers, both in primary and in secondary school. All the students remain in the class and the teacher goes from class to class, whereas in secondary schools in the UK, the students go from class to class. Three primary schools and three secondary schools were visited. For each of the schools three different classes were visited. In total projector usage was observed during 18 school days.

The researcher sat at the back of the class with a laptop and every five minutes registered the type of screen content displayed on the projector and what ambient light conditions were applied by the teacher. At the beginning of the day or when students moved to another classroom, the researcher logged the following information regarding the projector setup:

- Which type of projector is used, brand/model nr.
- Mounting of projector: upside down (e.g. from ceiling) or normal (desktop mode)
- Projector used in connection with IWB or projector used on its own.
- Projector/IWB fixed installation or moveable from class to class.

At the end of the lesson the researcher had briefly interviewed the teacher to find out if this was a typical day.

2.2 Projector usage modes

The following projector usage modes were defined which are relevant for exploring the energy saving opportunities for ImageCare®:

- OFF
- ON- searching for input/standard output screen of projector
- ON-other content -actively used
- ON-other content continuously same image for most of 5 minutes
- ON-full-screen film
- ON-full-screen photo
- ON-full-screen photo continuously same image for most of 5 minutes
- ON- content off

A further explanation of each of these modes is given below, together with the corresponding energy-saving opportunity for ImageCare® as indicated by Philips Lighting.

Mode *OFF*: Projector is off, not used.

Mode *ON- searching for input/standard output screen of projector*:



Figure 2.1 - Example of standard output screen of projector

Energy saving opportunity up to 70% depending on the implementation of ImageCare® by a projector manufacturer.

Mode *ON-other content -actively used*:

Definition of other content: This is everything, covering all kinds of content except for full screen photo and full screen video.

Definition actively used: display content is being actively referred to by the teacher and changes in the five minute timeframe.



Figure 2.2 - Examples of on - other content - actively used

Energy saving opportunity: very limited energy saving opportunity, most cases will require full system brightness.

Mode *ON-other content continuously same image for five minutes:*

The same image is shown for the full five minute timeframe. The image type covers all types of content except for full screen video and full screen photo.

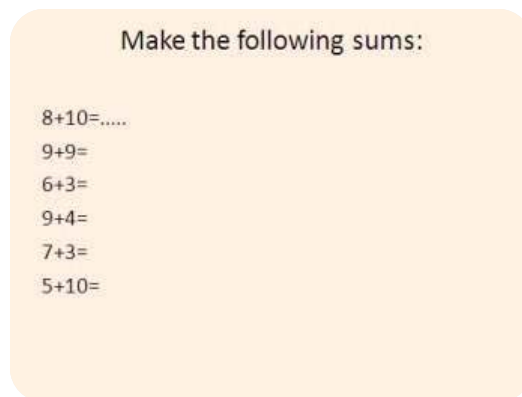


Figure 2.3 - Example of ON-other content continuously same image for 5 minutes.

Energy saving opportunity up to 70% depending on the implementation of ImageCare® by the projector manufacturer.

Mode *ON - full screen film:*

A movie is shown in full screen mode. This could be a movie from DVD but also from the internet. Key is that it is shown in full screen mode.

Energy saving opportunity: 35% energy saving, using ImageCare® for vivid contrast performance. This energy saving indication is based upon extensive power monitoring of ImageCare® systems while displaying movie and/or photo content.

Mode ON - full screen photo:

A photo is shown in full screen mode. The photo is not used as background for text. The photo is used on its own.

Energy saving opportunity: 35% energy saving, using ImageCare® for vivid contrast performance. This energy saving indication is based upon extensive power monitoring of ImageCare® systems while displaying movie and/or photo content.

Mode ON - full screen photo same image for five minutes:

A photo is shown in full screen mode. The photo is not used as background for text. The photo is used on its own. The photo is left on for the full five minutes

Energy saving opportunity: 35% energy saving, using ImageCare® for vivid contrast performance. This energy saving indication is based upon extensive power monitoring of ImageCare® systems while displaying movie and/or photo content.

Mode ON- content off

The content is off, the projector shows:

- Screensaver
- Computer locked log in screen
- black screen/white screen



Figure 2.4 - Example of ON- content off

Energy saving opportunity up to 70% depending on the implementation of ImageCare® by a projector manufacturer.

1.3 Ambient light conditions

- Together with projector usage information, the researcher also recorded whether teachers took action to influence relative screen brightness by using sun-screens, curtains or ceiling lighting. In the research the following definitions with respect to lighting conditions were used: Daylight: is defined as light that comes in through the windows. Daylight can be shielded by darkening the windows with curtains or blinds or by using sunscreens.
- Lights: defined as the ceiling lighting that the teacher can turn on or off in the classroom
- Darkened window: defined as a window with curtains or blinds closed in order to reduce daylight
- Sunscreen down: is defined as using the sunscreen to deliberately block out daylight

Using the above definitions, the following 6 distinctly different classroom lighting options that the teacher can choose from were recorded during the school day:

- daylight + lights on
- daylight + lights off
- darkened window + lights on
- darkened window + lights off
- sunscreen down + lights on
- sunscreen down + lights off

2.3 The five minute interval

Every five minutes the researcher registered the type of screen content displayed on the projector and whether there was a change in ambient light conditions during the last 5 minutes.

As the projector can show different images/content in the five minute period, the researcher wrote down the type of content she observed most during the five minute interval. Only exception is the "same image"-mode that needs to be on for the full five minutes.

Example:

During a five minute interval, the researcher observes that for two minutes the projector is searching for input and for three minutes a presentation is shown. In that case, the five minute interval is classified as: ON -other content actively used.

3. Typical installation

All projectors in the visited classrooms were fixed installations. Most were used with a computer only and mounted to the ceiling. In two classes an interactive whiteboard was

installed. In all classes the projector screen was installed next to the traditional blackboard in front of the class.



Figure 3.1 - Typical installation of a projector

4. Projector usage

All observation results were collected in an excel file and were analyzed across all schools and all classes. (see appendix: table 4.1 shows an example of the used excel file and figure 4.1 shows the individual usage patterns per school and class)

Detailed analysis of the data revealed that projector usage was very similar across all schools (primary and secondary). The projector tends to be on for on average 30 minutes at a time, followed by a period where the projector is off. Table 4.2 shows the average occurrence of the different usage modes.

Usage Mode	Number of occasions	Total time - [mins]	Total time - [hours]	% of total day	% of on time	Average time on when this mode is chosen [mins]
OFF	71	354	5.90	81%		130
ON-searching for input/standard projector screen	0	0	0.00	0%		0
ON-other content actively used	10	49	0.81	11%	58%	15
ON-other content same image for 5 minutes	4	20	0.34	5%	24%	8
ON-full screen film	1	4	0.06	1%	5%	4
ON-full screen photo	0	1	0.02	0%	2%	1
ON-full screen photo same image for 5 minutes	0	2	0.03	0%	2%	2
ON-content off	1	7	0.12	2%	8%	5
-			0.00	0%		
	88	438	7.29	100%		

Table 4.2 - Average results over all schools and all classes

On an average day, the projector is on for 1.3 hrs. Only two classes of a secondary school had a projector that was used in combination with an IWB. These two classes had a lower than average projector use: respectively 40 and 45 minutes per day. Using projectors was not new to the teachers, as most of the schools visited had been working with projectors in the classroom for the past three to five years. The most observed projector ON usage mode was: "on other content - actively used". This mode is used for 15 minutes at a time on average. The second most used mode is "On other content same image for five minutes". The same image is left on for an average of eight minutes and this state was observed during 24% of the on-time. It is especially this type of idle time that presents an energy-saving opportunity for ImageCare® projectors in the classroom: if the projector allows the system to switch towards 30% of its full power energy consumption, the image is still available but not distracting attention from the subject at hand.

In the observed classrooms, full screen film and full screen photo were rarely used by the teachers. For about 8% of the time the projector was on, but content was off, meaning that during 8% of the time, the system could save energy by dimming the lamp.

The projectors in the visited schools are seldom used after school hours. Based upon the interviews this is estimated to be 10 minutes per week outside school hours.

5. Energy saving opportunities

Using Table 4.2, Philips Lighting calculated the energy saving opportunities for a projector lamp with ImageCare® as compared to a non ImageCare® system. The results are given in table 5.1 and show an energy saving opportunity of 26% in the Chinese classrooms.

Usage Profile	Mins on average day	No ImageCare	ImageCare
OFF	354		
ON-searching for input/standard projector screen	0	100%	75%
ON-other content actively used	49	100%	100%
ON-other contents same in age for 5 minutes	20	100%	30%
ON-full-screen film	4	100%	65%
ON-full-screen photo	1	100%	65%
ON-full-screen photo same in age for 5 minutes	2	100%	65%
ON-content off	7	100%	30%
Average energy consumption		100%	74%

Table. 5.1- Energy consumption for a projector lamp system on an average Chinese school day without ImageCare® compared to a system with ImageCare®.

6. Average usage of projector per year in hours

The data was also used to calculate average usage of projectors per year in hours of operation. Most classes used a ceiling mounted projector and two classes had an interactive whiteboard. After every use-session the projectors were always turned off by the teacher. Discipline in doing this was very high.

It was found that projector usage was higher in primary education than in secondary education (24% of schooldays vs. 15% of schooldays). Projectors are rarely used outside school hours, this is estimated to be 10 minutes per week. The average projector usage per week (1.3 hours per day times five schooldays + 10 minutes /week outside school hours) for 40 school weeks resulted in an average yearly use of 267 hours.

Primary Schools		
	Hrs	% of schoolday
Off	5.3	76%
On	1.5	24%
Secondary Schools		
	Hrs	% of schoolday
Off	6.7	85%
On	1.0	15%
Average over all schools		
	Hrs	% of schoolday
Off	6.0	81%
On	1.3	19%

Table 6.1 - Average projector usage per year

7. Dim or Eco-mode versus full power mode

In all observed classes the projector is always used in full power mode. Eco mode (dim mode or low temp mode) is never used. In the interviews all teachers, except for one, said that they never use eco-mode. One teacher, a math teacher in a primary school, indicated that he sometimes uses the eco-mode.

Clearly eco-mode is not actively used by the teacher (dimming when the situation allows it and switching back to full brightness when needed). A solution for this problem is ImageCare®.

8. Day-light versus sun-screen down

The results of the recorded lighting conditions during the school day are presented in figure 8.1 as a function of whether the projector is on or off. The results show whether teachers took action to influence relative screen brightness by using sun-screens, curtains or ceiling lighting. If a teacher darkens the room when he/she uses the projector, that is an indication that he/she feels that the screen is not sufficiently visible.

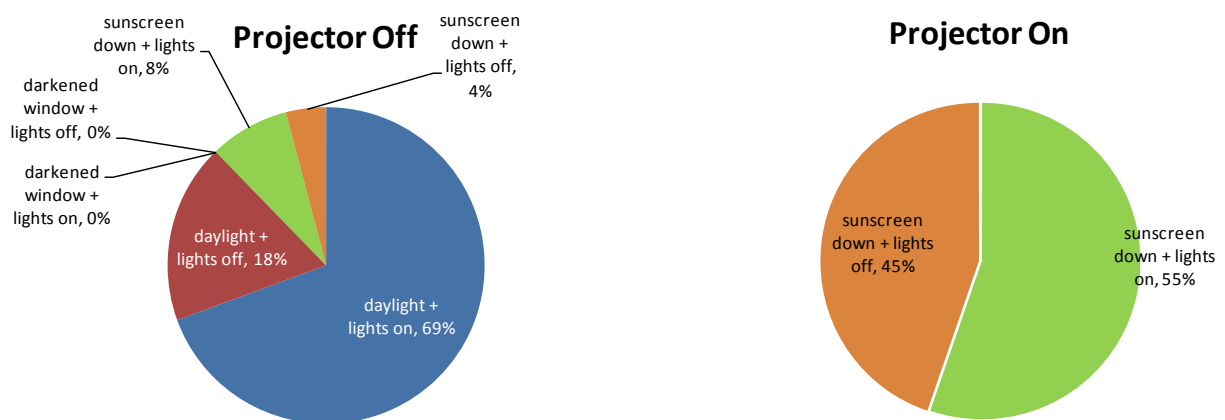


Figure 8.1 - Lighting conditions in the classroom.

With respect to darkening the windows, it is interesting to note that none of the classrooms visited had darkened windows, either by the use of curtains or blinds. Teachers used sun-screens and ceiling lights to regulate ambient light in the classroom. In almost all cases, the sunscreens were open before projector usage. As soon as the projector was going to be used, the teachers took action to lower the sun-screens. There were only two cases where the teacher did not have to change light conditions, because the sunscreens were already

lowered. Since the sunscreens were always down during projector use, teachers link projector use to having to lower sunscreens. In roughly half of the cases the lights were kept on during presentations, for the other half of the time they were turned off. Every teacher took action to reduce daylight in their classroom when they used the projector. The ceiling lighting however, is sometimes left on and sometimes turned off.

In 86% of the cases teachers deliberately removed the sunscreens again after projector use. In 26% of the cases the teachers also turned the lights back on if they had been off during projector use. These numbers indicate that teachers are motivated to recreate a bright environment again after projector usage.

The data also gave insights into ambient lighting preferences and requirements during the off-time of the projectors. During 69% of the time, when projectors were turned off, teachers worked both with daylight and ceiling lights, and for 18% of the time, only daylight was good enough (i.e. ceiling lights off). The data hint at a preference of teachers to have bright light conditions in the classroom, since most of the time they use maximum light capacity: daylight + ceiling light. The only times that the sunscreens were down *and* the projector off, were after previous projector use and nobody took action to put the screens back up again, but this happened for only 8% of the time.

The projectors observed in the study all had specified ANSI lumens between 2500 and 3500 lumen, a relative high brightness but still the choice was made to always lower the sun screens when the projector was on.

9. Interview results: Advantages and disadvantages of using projectors / IWBs

After the lessons, the researcher carried out a short interview with the teacher and/or ICT manager of the school. In total 25 people were interviewed.

“Compared to the teachers of the other subjects, the English teacher is more in favour of using the projector, because it is the most efficient and direct way to make the students understand another language and the culture of the other countries.”

English Teacher Secondary School China

The statement of the English teacher above is verified by the analysis results. A cross-analysis of the subjects with projector usage shows that the projector is mostly used in English language lessons, followed by Chinese language and thirdly maths lessons. See appendix B

Many teachers indicated that the biggest advantages of the IWB/projector are that it attracts the student's attention. Other frequent comments were that usage of the projector makes it easier for students to understand and that the images are vivid and clear. Most teachers also mention as biggest advantage the efficiency and time saving effect of projector usage.

“Expand contents with lower cost, shorter time, and higher efficiency.”

Chinese teacher Secondary School China

When asked what are the disadvantages of using a projector/IWB 50% of the interviewees answered that there are NONE. The other half indicated a variety of disadvantages which can be grouped in the following categories:

- Large concern voiced by several teachers on the ability of students to properly learn the subject when being taught via a projector when compared with traditional teaching. See appendix C for detailed comments.
- The projector is not bright enough - need to keep classroom dark
- Display quality is not good enough
- Others: one teacher mentioned function of remote control too complex, another teacher mentioned: have to rely on machine.

The detailed remarks that teachers made about not being able to learn the subject properly are interesting. Several teachers worry about the negative impact of projector usage on cognitive skills (memorization of projected content). Other teachers worry that the students don't practice their writing skills, structure information and solve problems, because they don't see the teacher do it anymore. They believe that the blackboard is instrumental to conveying such skills, whereas a projector simply puts things on screen. Also the fact that the most fervent users are English and Chinese teachers is interesting. It indicates that the teachers of the other subjects have a projector available but see hardly any use for it in their lessons.

10. Discussion of results and comparison with UK study

When comparing the China data to the UK data of our previous study, the first noticeable difference is that in China the projector is used a lot less frequently than in the UK. On an average day the projector is on for 1.3 hrs versus 3.8 hrs in the UK. In the UK all projectors were used in combination with an IWB, in China only in two classes of a secondary school the projector was used in combination with an IWB. And these two classes had a lower than average projector use: respectively 40 and 45 minutes. Therefore, the combination with or without IWB in itself does not explain the much lower usage in China compared to the UK.

The projectors were also not new to the teachers, as most of the schools visited were used to working with projectors in the class room for the past three to five years. A detailed look at the day-to-day data reveals a very different usage behavior of the Chinese teachers vs the UK teachers. In the UK, teachers prefer to keep their interactive whiteboard systems on standby for use during their lessons. Only during bigger lunch breaks and at the end of the day, the UK teachers turn off their projectors. In Chinese classes however, the projectors are only turned on for immediate use and always turned off after use.

This difference in usage is also reflected in the recorded usage modes. During the study in China, the most observed projector ON usage mode was: “on other content - actively used”. And on average this mode is used for 15 minutes at a time. This means that the teachers give a lecture or instruction that usually takes 15 minutes. The second most used mode is “On other content same image for 5 minutes”. The same image is left on for an average of eight minutes and this state was observed during 24% of the on-time. In the UK the projector was not turned off during the lesson: for 23% of the time the projector was actively used for a period of 12 minutes on average and for 55% of the time it was showing content but not used for periods of 25 minutes. Comparing overall active projector usage during the entire day, the results show that Chinese teachers spend around 11% of the day using the projector actively and UK teachers 13,6%. So overall active content sharing with projectors is comparable in both China and the UK. Similar to the UK, full screen movies are seldom shown.

Another interesting difference between the UK and China is how projector usage is perceived. Whereas UK teachers were mostly very positive about using interactive projector systems in their lessons, many of their Chinese counterparts had reservations. About 50% of the teachers in China were positive about having and using a projector (could not think of negative aspects) whereas the other 50% had doubts or concerns regarding projector usage. The remarks that some teachers made on not being able to properly learn the subject is interesting and was not heard in the UK. Despite the fact that projectors have mostly been available for three to five years, some teachers are still negatively inclined towards their use. Teachers mentioned concerns that projected information will not be memorized properly and clearly teachers find it important that children see how they solve problems or write text on blackboards. This finding implies an opportunity for interactive systems to further stimulate adoption of projector usage by Chinese teachers.

Whereas in the UK we found close to 50% energy saving, the saving potential in China is 26%. This is related to the different usage pattern: in China the projector is turned on, to give a lecture/instruction, and then it is turned off. In the UK, the projector is turned on at the start of the lesson and only turned off before a break. In the UK the projector and IWB have replaced the blackboard whereas in China the projector is used in addition to the blackboard. If in future projectors and IWB are being used in China as replacement of the blackboard then the usage pattern will probably approach the UK pattern resulting in similar energy savings.

11. Conclusions

Most projectors in this study were used in combination with a computer. In only two classes was the projector used in combination with an Interactive Whiteboard. All classes were also equipped with a blackboard next to the projector system. The results show that projector usage is quite similar across all schools and all classes visited. On average the projector is on for 1.3 hrs per day in blocks of roughly 30 minutes. Projector usage was slightly higher in primary than in secondary education (24% of school-day versus 15% of school-day). Average

projector usage in the visited schools in China is 267 hours per year. The study showed that the projectors were all used constantly in full power mode, eco mode was not used.

Teachers observed in this study showed a great commitment to conserving energy and a clear preference for bright lighting conditions in the class. Even though screen brightness was hardly mentioned as a drawback of projector usage, every teacher took deliberate action to reduce daylight in their classroom when they used the projector. The data shows that whenever it is possible maximum light capacity is used: daylight and ceiling light. The only reason to reduce light is the projector, which was always used in combination with lowered sun-screens.

Teachers mentioned that the biggest advantages of a projector/IWB are that it is efficient, saves time and keeps the children's attention. The most common mentioned disadvantage was a concern on whether children could learn or memorize a subject properly when taught using a projector (related to seeing the teacher explain things on the blackboard). This implies an opportunity for interactive systems to further stimulate adoption of projector usage as such systems could counter the pedagogical reservations of projector usage in lessons.

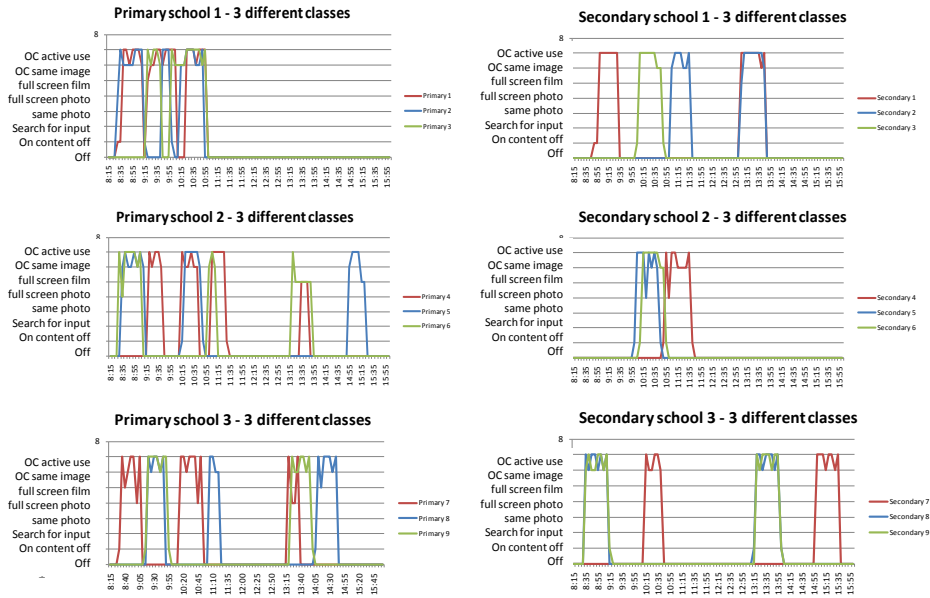
The average daily usage pattern also reveals that there is a great opportunity to improve energy consumption in the education environment in China. Using the user profile of this research, Philips Lighting calculated the potential energy saving of an ImageCare® lamp system as compared to a conventional lamp system. The results show that 26% of the power consumed by a projector lamp can be saved during a typical school day in China, whereas in the UK close to 50% energy saving was found. This is related to the different usage pattern. If teachers could use the projector system in similar way to a blackboard (interactive systems) usage might change and perhaps approach a similar pattern as was observed in the UK, with similar energy saving opportunities.

12. Appendix A

Table 4.1 - Part of Excel file logging showing results of a typical school-day for a year 1 class in a Primary School in the UK:

time of day	screen content	Subject being	Ambient Lighting
8:00	-		-
8:05	-		-
8:10	-		-
8:15	-		-
8:20	-		-
8:25	-		-
8:30	OFF		-
8:35	ON - other content same in age for 5 minutes	Chinese	sunscreen down + lights off
8:40	ON - other content actively used		-
8:45	ON - other content same in age for 5 minutes		-
8:50	ON - other content same in age for 5 minutes		-
8:55	ON - other content actively used		-
9:00	ON - other content same in age for 5 minutes		-
9:05	ON - other content actively used		-
9:10	ON - other content same in age for 5 minutes		-
9:15	OFF	Break	day light + lights off
9:20	OFF		-
9:25	OFF	Maths	-
9:30	OFF		-
9:35	OFF		-
9:40	OFF		-
9:45	OFF		-
9:50	OFF		-
9:55	OFF		-
10:00	OFF		-
10:05	OFF	Break	-
10:10	OFF		-
10:15	ON - content off	English	sunscreen down + lights off
10:20	ON - other content actively used		-
10:25	ON - other content actively used		-
10:30	ON - other content actively used		-
10:35	ON - other content actively used		-
10:40	ON - other content actively used		-
10:45	ON - other content same in age for 5 minutes		-
10:50	ON - other content actively used		-
10:55	ON - content off	Break	day light + lights off
11:00	OFF		-
11:05	OFF	Physical Education	-
11:10	OFF		-
11:15	OFF		-
11:20	OFF		-
11:25	OFF		-
11:30	OFF		-
11:35	OFF		-
11:40	OFF	Lunch	-

Figure 4.1 - Analysis of results



Appendix B

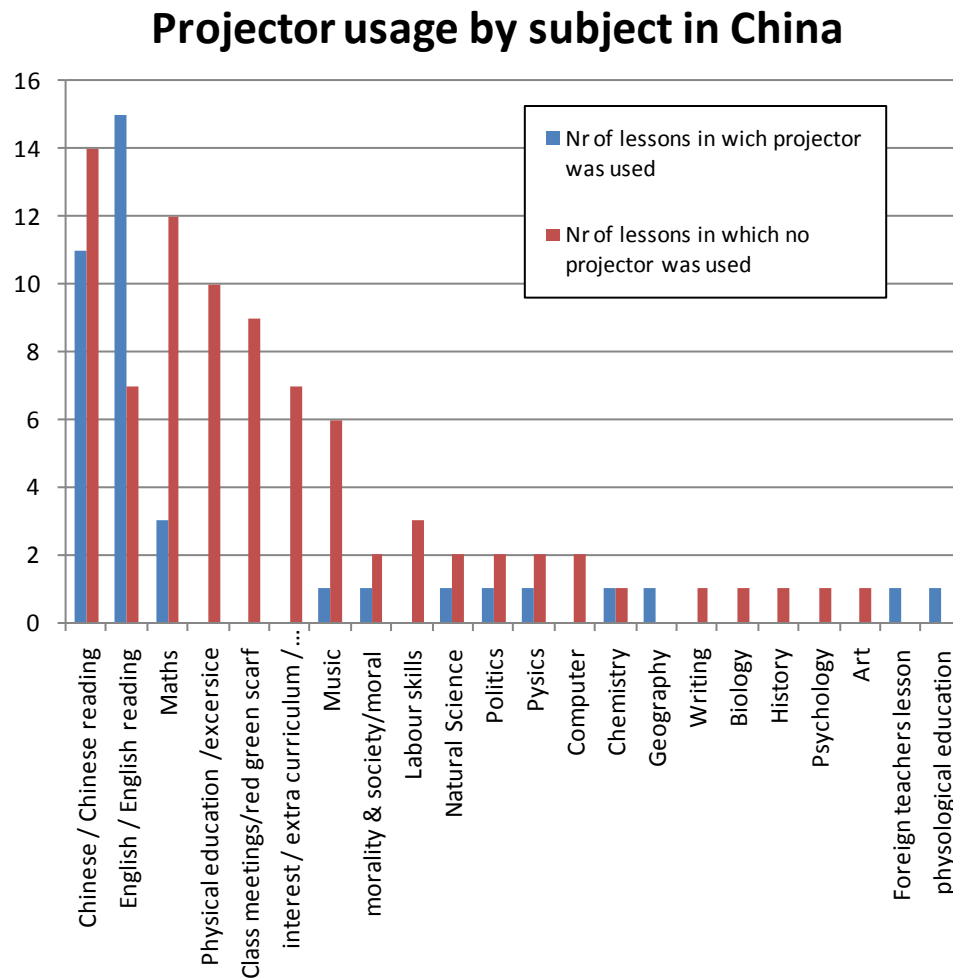


Figure B-1 – Projector usage by subject

Appendix C

The following comments were made by teachers who doubt the ability of students to properly learn the subject when being taught via a projector:

- Cannot make a deep impression on students' memory.
- Neglect the contents on the blackboard.
- Students lack thinking by themselves.
- The overuse of the projector could weaken the teacher's ability to teach in a more traditional way: writing on the blackboard, by which the teacher better strength the memories of the students and at the same time serves as a model for the students how to take notes. In a word, the use of the projector cannot substitute the blackboard, and it is just a supplement.
- Students cannot catch main point because of the huge amount of information.
- It is earlier for the teacher to present mathematical figures by the projector, however, in which way the students cannot learn how to draw mathematical figures, which is a skill that will be tested.

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