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CREATING SMART EDUCATIONAL CONTENTS FOR SCIENCE AND ENGINEERING LECTURES IN HIGHER EDUCATION INSTITUTIONS, AND SOLUTION PROPOSALS

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Abstract

The use of intelligent technologies in education increases every day. There are a lot of new technologies implemented lately. Intelligent White Boards (IWBs) are the most popular devices among them and preferred to use in education nowadays. But the use of these technologies requires compatible and supportable smart educational contents (SECs). It does not seem possible at this stage to find such SECs ready to use for university lectures. Undoubtedly one of the reason behind this issue is that contents of some lectures or their syllabuses show huge differences between universities, even from lecturer to lecturer. In addition, some of the universities could open some courses only for their specific needs. In this paper, our aim is to figure out the necessary characteristics of SECs and the lecturers who need SECs in their lessons, should take care of while preparing their own SECs.

Yüksek Öğretim Kurumlarındaki Bilim ve Mühendislik Dersleri İçin Akıllı Eğitim İçeriklerinin Oluşturulması ve Çözüm Önerileri

ÖZ

Akıllı teknolojilerin eğitim alanında kullanımı her geçen gün artmaktadır. Son zamanlarda birçok yeni teknolojinin geliştirildiği görülmektedir. Akıllı tahtalar bunlar arasında en popüler olanı olup günümüzde eğitim alanında kullanımı tercih edilmektedir. Ancak bu teknolojilerin kullanımı, bu teknolojilerle uyumlu ve desteklenebilir akıllı eğitim içeriklerini (AEİ) gerektirir. Şu aşamada üniversitelerde okutulan derslerin birçoğu için bu tür AEİ'lerinin hazır olarak temini mümkün gözükmemektedir. Bunun bir nedeni bazı derslerin içeriklerinin ya da ders müfredatlarının üniversiteler arasında köklü farklılıklar içermesi, hatta dersi veren öğretim üyeleri arasında bile uygulamada karşılaşılan farklılıkların olmasıdır. Bunun yanı sıra bazı üniversitelerin kendilerine özgü gereklilikleri karşılayacak dersler açabilmeleridir. Bu makalede bizim amacımız bahse konu AEİ'lerinin gerekli karakteristik özelliklerinin neler olması gerektiğinin ortaya konulması ve bu tür AEİ'lere ihtiyaç duyan öğretim üyelerinin kendilerine ait AEİ hazırlarken nelere dikkat etmesi gerektiğini ortaya koymaktır.

***Keywords**: Interactive White Boards, Smart Educational Contents, intelligent lectures, technological teaching tools.*

***Anahtar Kelimeler:** Akıllı tahtalar, Akıllı Eğitim İçerikleri, akıllı içerikler, teknolojik öğretme araçları.*

1. Introduction

Smart technologies find a broad usage area in our daily life and its usage is increasing every day. One of the most important inventions in this area is touchable screens. There are a number of application area for touchable screens such as smart phones, tablets and etc. Instruments supported with touchable devices give more flexibility to users to interact with their available software. These kinds of instruments are more valuable for teaching purposes, because teaching requires students' interaction during the lessons. The technological improvements accelerate one after another however their usage at specific areas need much more time than expected to become widespread. Changes in educational system should be distributed in a time period to make it work perfectly and to avoid its side effects. Otherwise, their results and contribution to education system would be more dramatic and worse than its expected benefit. In the literature there are a lot of study about the use of IWBs and their results. As summarized in the following.

Campbell et.al. stressed that while IWBs provide a means of introducing new learning opportunities, the technology must be supported from a pedagogical perspective in [1]. The effective use of IWBs must go beyond the manipulation of colorful, dynamic images to involve students acting in ways that might not readily have seen elsewhere [2]. Turel recommends researchers both to design interactive training packages for teachers and to find out the effectiveness regarding learning and interaction for students in [3].The written responses of the teachers were analyzed using descriptive analysis in [4]. According to the results teachers think that smart board increases the motivation, helps students to focus the course better, makes students attend the courses actively and also provides more enjoyable courses. There are a lot of works done in Turkey to make IWB technology to be widely used. The studies carried on the attitudes of teacher and student show that, without giving the required in-service training to teachers, there is no use to set up this kind of technology to the classrooms. Because the studies show that their use is not adequate and relevant without teachers training [5].

These literature shows that there are still problems about the aim of how to use new technologies in educational area. When a quick literature search is

done, it can be concluded that smart technologies applications are widely seen in kindergarten, primary school and high school educations. Because syllabuses are similar between these educational levels and there are lots of these kind of schools among the country. This situation take attention of business organizations and make them to invest on the smart educational tools in these schools in general. In addition, national educational system forces these schools around similar contents which helps the business organizations to apply smart technologies easily on these schools. In this aspect, even the private educational institutions have been producing their own smart contents according to their own needs and perspective. Lately these private schools started to create their educational tools such as video recorded lectures for distance learning, interactive teaching programs, educational platforms such as school specific lecture and question databases etc. But the government schools mostly supply their interactive educational software from business organizations.

The situation for universities are different. They have to find their own solutions by themselves. There are not so many alternatives to provide universities with solutions that make presentations ready for lecturers in Turkey. In this paper, the lack of such special purpose materials in universities are focused and suggestions for lecturers are figured out. Firstly the historical evolution of the intelligent devices used in education is presented. Secondly the characteristic requirements for intelligent educational contents in universities are analyzed. Thirdly the drawbacks and precautions for the usage of the intelligent systems are addressed. At the end, an example presentation and its results are shared.

2. Historical Evolution of Classroom Technology

Tremendous innovations are brought into life in classroom technology at the end of 17^{th} century. Some of the important historical improvements for the classroom technology are presented in Figure 1.

1870 Magic Lantern 	**1925 Film Projector** 	**1950 Headphones** 	**1958 Educational Television** 	**1972 Scantron** 	**2005 iClicker** 
1890 School Slate 	**1925 Radio** 	**1950 Slide Ruler** 	**1959 Photocopier** 	**1980-Plato Computer** 	**2006 XO Laptop** 
1890 Chalkboard 	**1930 Overhead Projector** 	**1951 Videotapes** 	**1960 Liquid Paper** 	**1985 CD-ROM Drive** 	**2010 Apple iPad** 
1900-Pencil 	**1940 Ballpoint Pen**	**1957- Reading Accelerator** 	**1965 Filmstrip Viewer** 	**1985 Graphing Calculator** 	**2013 Virtual Reality** 
1905 Stereoscope 	**1940 Mimeograph** 	**1957- Skinner Machine** 	**1970-The Hand-Held Calculator** 	**1999 Interactive Whiteboard** 	

Figure 1: The Evolution of Classroom Technology [9]

Invention of the first computer started a new era in all areas of life. It can be seen that after 1980, computers are started to use in the classrooms and computer based educational technologies are continuously developing. In Table 1, average starting ages to use computers, internet and mobile phone by age groups are presented based on the data of year 2013 [6].

Table 1: Use of Information and Communication Technology by Children Aged 6-15, [6]

Average Starting Ages to Use Computers, Internet and Mobile Phone by Age Groups, 2013

	Avarage Starting Age	**Age group 6-10**	**Age group 11-15**
Computer	**8**	6	10
Internet	**9**	6	10
Mobile phone	**10**	7	11

This information gives us the clues of why computer technology is being frequently used inside the classrooms. According to another statistics presented in Table 2, the ratio of the children who have their own private computer is 19.6% for 6-10 age group and this ratio increased to 29.4% for age 11-15 in Turkey [7].

Table 2: Proportion of children who have their private devices by age group [8]

	%	**%**	**%**
	Total	**Age group 6-10**	**Age group 11-15**
Computer (Desktop, Laptop, Tablet, etc.)	**24,4**	19,6	29,4
Mobile phone (including smart phone)	**13,1**	2,5	24
Game console	**2,9**	2,6	3,2
None of the above	**68,3**	78,5	58

Note: Respondents are allowed to choose more than one option. Therefore, the total is not equal to 100.

This statistics shows that student's interaction with smart technologies based on their early ages. If 29.4% of the students at age 11-15 have their own private computers, this shows that most of them can access and use computers at these ages even they don't have their own. According to another statistic given in [8], computer usage by higher education students (for last 3 months) in 2015 is 91.7%. These data shows that, computer and smart technologies are often used at higher education ages among the students. So the smart technologies should take a big role in higher education as it deserves. Opinions of the students should be investigated about the smart technologies. Are these smart technologies used properly while teaching in the classrooms and satisfies students needs? The answers are expected to provide lots of results about how the smart technologies are used in education. In this paper, our aim is to make clear how to use smart technologies while preparing lectures and to make benefit from their advantages. Interactive boards offer five different abilities, given in Table 3, to its users which are also very important properties for education. The properties of educational technologies can be listed as in the following areas; visual, sound, motion, interaction and touch. These properties are the reasons behind why Interactive White Boards (IWBs) are become so popular.

Table 3: Educational Technologies and their properties [10]

Device	Visual	Sound	Motion	Interaction	Touch
Real goods and models	*				
Written materials	*				*
Visuals (photo, picture, drawing, graphs, etc.)	*				
Show boards (chalk, bulletin, multi purpose)	*				
Overhead projector	*				
Slide and film tapes	*	*			
Sound tools (cassette, CD)	*	*			
Video and film	*	*	*		
Television	*	*	*		
Computer Software	*	*	*	*	
Multimedia	*	*	*	*	
Intelligent Board	*	*	*	*	*

3. Higher Education Needs For Interactive Education

Higher educational institutions are distinguished from primary and high schools from the perspective of the aim of the education. Universities are free to apply their own programs and they create their own teaching syllabus according to their aims. Meanwhile, course credits shows differences between universities. Bologna process is established to bring out these differences. It is managed along 50 countries around the world. The overarching aim of the Bologna Process is to create a European Higher Education Area (EHEA) based on international cooperation and academic exchange that is attractive to European students and staff as well as to students and staff from other parts of the world. This process is brought to clear the complexity to understand what other universities provide to their students around the Europe. With this complex structure of the higher educational institutions, it is difficult to find standardized smart educational tools ready to use with IWBs. Recently, business organizations provided some solutions to supply educational contents for universities. However, these are not sufficient and adequate to be used directly by lecturers. As a result lecturers in higher education still prefer to use classical teaching tools such as pens over boards in most of the essential universities.

In fact the use of smart educational technologies present lots of benefits to Science and Engineering Departments in universities. These departments mostly use high technology for research purposes. "While giving undergraduate education, how can lecturers benefit from those IWBs?" Before giving some clues about it, some of the benefits, contributions and problems to be encountered and proposals about using IWBs in higher education is presented below.

Benefits of IWBs:

- Decreasing lecture time by;
    - Recording lectures,
    - Chance to reach previous lectures to review,

  - Capability to print out the contents of the boards to give students,
- Unlimited work area and storage capability,
- Working with Learning Management Systems.

These benefits are valuable to students if it is used properly. Next, the question is "What are the contributions of IWBs to learning-teaching atmosphere?"

Contributions of IWBs:

- Positive contribution to motivation,
- Potential to support teaching and learning,
- Increasing students' participation,
- Capability to use multipurpose systems,
- Make lessons more interesting,
- Positive contribution to interaction,
- Allows usage and modification of readymade learning materials,
- Capability to store, print out and reuse lectures, using LMS systems.

In addition, some problems may be encountered during the usage of such intelligent educational tools. Possible problems that may occur are presented below:

- Technical issues while using IWBs,
- Problems in learning-teaching and motivation,
- Lack of adequate and suitable materials for using with IWBs,

- Physical problems about classroom environments, (such as lights, position of IWBs, visual clarity)
- Initial excitement to use IWBs may be lost after a while,
- Technical support requirements for teachers,
- Teachers' needs for in service training during education period.

Before using the IWBs actively in educational system, some of the precautions should be taken. These necessary precautions and proposals for using IWBs are presented below:

Proposals for using IWBs efficiently:

- Teachers and students should be trained to use IWBs,
- Proper materials should be prepared for teaching,
- Hardware and software problems should be solved quickly,
- Both hardware and software should be renewed periodically,
- There should be a user manual for efficient use of IWBs, and should be updated continuously,
- Physical properties of the classrooms should be considered,
- Technical personnel should be ready to help teachers when necessary.

The addressed subjects above are the benefits of the IWBs in education. In the next section, the requirements arose in classical education and solution proposals are investigated.

4. Requirements in Classical Lectures in Science and Engineering Classrooms

The question are “What are the difficulties while presenting science and engineering lectures?” and “How can the instructors teach and make clear some of the techniques and subjects in science and engineering students’ mind?”. These questions come from the difficulty to express some of the science and engineering subjects, which becomes cumbersome to express in classical black boards. In addition, required visuality to present some of the subjects on black board is not so easy for most of the lecturers. In this paper an example form the math lecture is given. Definition of the theory of integral in calculus is selected as an example topic. Instructor have to define partial sums and display how Riemann Sums are converging to a limit which is addressed as integral in this topic. Computing the area under a complex curve or computing the volume of a complex body can be selected as other examples which can be better presented using smart technologies. These examples can be extended to graphic drawing, 3-D coordinate systems, surface integrals, etc. "What are the significant reasons to use IWBs in science and engineering lectures?". These reasons can be listed as follows:

- Complex graphical presentations necessary to describe the subjects,
- Difficulties encountered to draw 3-D graphics and making changes to describe subjects on black boards,
- Requirements to use animations to describe difficult physical subjects which could not be understood by imagination,
- Difficulties to repeat similar problems with different scenarios,
- Needs for presenting tables during the lectures,
- Sound and motion requirements and user interaction within the presentation,

- Describing scientific problems by using moving sketches and graphs during lectures,
- Students' unwillingness to take notes while trying to understand the lectures,
- Spending time while describing and writing by lecturers and students.

This list can be extended, but at first glance, these are commonly encountered requirements.

Another requirement in classical teaching system is perfectly described with the following words written by a famous poet. *"It is the disease of not listening, the malady of not marking, that I am troubled withal."* says William Shakespeare in his history play IV. Henry. These words still preserves their value. There are two big benefits of taking notes during lectures;

- First of all, it provides active participation to the education. In this way, it is easy to keep awake, concentrate on the subject learned,
- Secondly, marking and editing notes later prevent disremembering.

Other benefits of taking note are,

- Makes students active along the lectures,
- Ensures that the learned things become permanent by repeating,
- Enables economy from time and energy,
- Reduces anxiety before exams,
- Allows easy preparation of reports and assignments,
- Develop the ability to evaluate and criticize.

What should be considered while preparing such an IWB material to make audiences to take their own notes?

- Note-taking habits should be considered,
- Prepared lecture contents should avoid giving everything ready at first sight. Lecturer should add his own statements to the subject interactively during the lecture to make students active,
- Courses should be prepared to give feeling that, it is given in a normal black board and interaction during show should be added to the screen by writing and lecturer should give time to students to take their own-notes wherever necessary,
- Lecturers should use blackboards simultaneously while using IWBs and should allow students to write their own notes during example solutions,
- Smart boards should not take the place of teachers,
- Smart boards should not be used just to transfer copy of book papers to the screen. This may be harmful to the learning process.

If lecturers misuse IWBs in their lessons, students may fail to listen after a while as illustrated in Figure 2.

Figure 2: Students are passive and not following the lecture.

Considering the subjects presented above, lecturers can prepare their own teaching materials using smart technologies better than the classical manner. In this way, students can be active during the lectures and learn the subjects with better understanding. By using IWBs' benefits such as touch screen, lecturers can add their marking simultaneously on the board while explaining the importance of the subject. During the lecture, adding useful graphics and animations may attract students attention and also save the time to describe a lot of subjects whenever necessary. List of tables can be presented easily and time consuming writing issues can be prevented. It is clear that, the lecturer can save a lot of time during presentation of their lectures, but it depends on how the subject is prepared before. It is the key issue. If the lecturer does not spend enough time to prepare the sketch of the lecture for IWBs, it may be just a simple projection of lots of uninteresting knowledge for the students. So, the lecturer should think that, "What should be presented?" and "How they should be positioned?" in each screen. In this way, lecturer can leave enough space for editing purposes to use during the presentation of the lecture on IWBs. Therefore, lecturer should study and plan each screen of the lecture step by step. After that, lecturer should consider preparing the Interactive Content for White Boards (ICWBs). In preparation step, lecturer should consider that they are going to present this material in the class and fill the necessary empty spaces of the screen with their explanations to keep students active during the lecture.

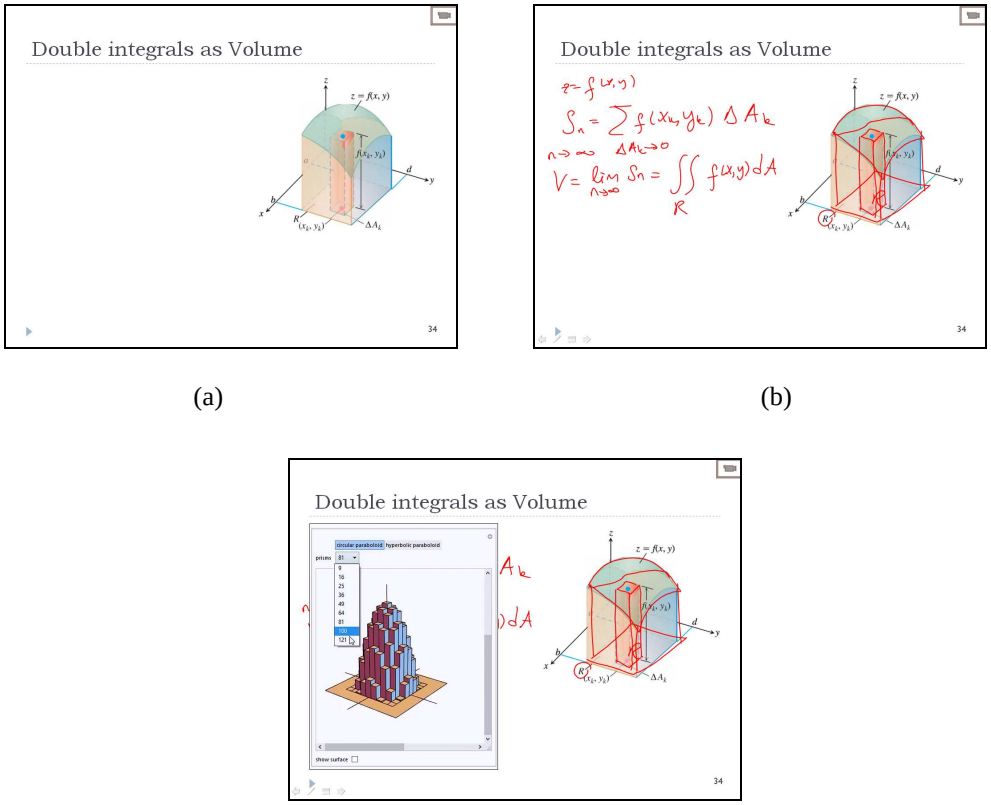
Some of the parts of an example lecture are prepared for illustrative purposes here considering the above topics using IWBs. The title of the lecture is “double integrals as volume” from the calculus lesson. The presentation screen is planned in three stages.

- At first stage, just the figure describing the volume in 3-D is presented in Figure 3-(a) and talks about the area on x-y plane and the volume above this area up to the surface represented by z=f(x,y) is described to the students by marking on the 3-D image using IWB.

- In the second stage, the volume is written as a finite Riemann sum S_n and its limit is taken while n goes to infinity, which is presented as double integral. Later on, it is shown as volume under the surface z=f(x,y) as pictured in Figure 3-(b).

- At the end, lecturer wants to demonstrate this limit by increasing n using an animation, which is proposed to help students to realize how the limit covers the whole volume under the given surface. To do this, lecturer plans to just press 'video icon' at the upper right corner of the screen and the animation gets start as presented in Figure 3-(c).

Three steps of the topic are described above. This presentation is totally depends on what lecturer wants to give to their students and how lecturer wants to present the topic. The lecturer prepares all of the empty spaces and their position at the preparation step and edits the figures by himself during presentation. Also, an animation is located on the same screen to make the topic interesting and more understandable for students.



(a) (b)

(c)

Figure 3: Example screen captures about the double integral as volume in three steps.

By giving this example here, it is addressed that, lecturer's imagination and ability to describe the lecture plays the key role. This depends not only to the lecturer, but also to the group of students and the topic. When all of these factors are considered together, a good presentation which can be used interactively can be built and used. Taking into account the feedbacks, instructors can improve their presentations by editing. If lecturer record and send these notes to the students, even including sound, then students can replay and strengthen their understand of the lectures. These are the benefits of presentations prepared using smart educational tools.

This example lecture is applied to a group of 25 first year engineering students. After this lecture is presented, a questionnaire is applied to this group of students. Selected questions and students replies are presented in Table 4.

Table 4: Questionnaire applied to engineering students to learn their opinion about the use of IWBs.

Questions	**Percentage of favorable answers**
When IWBs used in lessons, the things I have learned are getting more permanent.	%72
Through interactive whiteboards I can access information quickly and easily.	%72
When interactive whiteboards are used in lessons my focus is scattering.	%20
I like to use the board and the interactive whiteboards together.	%88
There is sufficient course content prepared for the use of the IWBs.	%60
I think the course contents should be prepared in a professional manner.	%96
I give importance to the presentation style of the lecturer rather than the course content.	%76

The results of the questionnaire show %96 of the students think that the lectures for IWBs should be prepared by professional manner. In addition, %88 of them think that IWBs should be used together with the classical boards. Just %20 of them say that the use of IWBs make them lose their focus on the lesson. Also %60 percent of them think that there is sufficient course content available for IWBs. When the questionnaire analyzed, the result shows that the students in engineering departments are eager to use IWBs during the lectures. They already understood the benefits of this technology and their opinions point out the importance of the preparation of the contents used with IWBs. At

the end of this questionnaire, a place in the sheet is left empty for students to write their own ideas and offers. Most of them request that the scope and the rate of the presented knowledge on IWBs should be carefully arranged. Otherwise, students do not follow the lecture after a while. In addition to the students ideas and offers, lecturer's opinion are asked after the presentation. The lecturer who gives this lecture in different classes in classical way says that, the questions from this group and the other groups are different. The students which took the lecture using IWBs ask more difficult and deep questions while the other group which took the lecture in classical way still try to understand the topic. This shows us the importance of using animation and visual tools while presenting science and engineering topics.

5. Conclusion

The aim of this paper is to describe "How the smart educational technology should be used in today's classrooms?" in higher education. Smart educational technology should be used considering both its benefits and drawbacks. If it is used just to project a sheet of paper on the screen in the classroom with classical manner, the mentioned problems in section 4 may be encountered and as a result student attendance to the class decreases. If the instructor plans their lectures to use IWBs interactively, then its benefits can be felt by students and positive feedbacks returns to the instructors. Otherwise, these technologies could be just a waste of money and time for both sides in higher education.

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