“Design & Implementation of AR Classroom: A Paradigm shift from traditional School Setup”

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ABSTRACT:
Many Virtual as well as Augmented Reality Systems have been proposed to support education. From many year Augmented Reality (AR) is being subject of great interest among the scientific community. In education application or system textbook plays the vital role which are the part of this system since many years and even many educators are still there who are interested and very passive about applying these same traditional methods but there are many who are active to apply the new material or changes to education system. This paper review such a system which takes AR technology out from research labs into the field of education. Since there are many Augmented related applications such as The Magic Book, The DehAR Book, The SUN-RA etc.to all such applications, add one more that is “AR Classroom. Firstly proper analysis of requirement is kept as priority and then fitting of these requirement to the technology’s environment is kept while making application. Augmented and Virtual reality systems have the efficiency to improve and make the education system more interactive and develop more interest among students. Further research is required to cope with current limitations of virtual and augmented reality in school level and can further be used at any educational level.

INDEX TERMS (KEYWORDS):
Augmented Reality, Virtual Button, Object Scanning, Image Recognition.
1) INTRODUCTION:

Augmented reality is an interactive experience of physical world in which we are present with the computer-generated perceptual information. The idea behind the AR classroom is to combine Augmented Reality technology with the education. AR classroom offers the student to learn using the device they love so much which can be smart phones, tablets and it will be soon available to use by smart glasses also called as AR glasses. AR classroom is a software that provides a user-friendly user interface so that a student of a primary school won’t have any trouble operating with. AR classroom helps student to interact as well as sees objects that are not presents at that particular time which also leads to cost effective and safe learning providing a stimulation where the student can learn and have fun while learning doesn’t matter whether a student is in a class or at home or any other place.

According to research by Shapley et al. in year 2011, it is shown that the lessons that are supported by technology will lead to more innovative ways of teaching and learning the students and also ensures that education is not bounded within schools and colleges. AR classroom offers education in more compact way that is required in today’s era. Switching learning from books to digital platform benefits both the human and the nature as it will leads to less deforestation which will benefits the wildlife and influence the global warming in positive way and for human learning through this medium make sure that education will never be thought as a burden on children. In addition, learning using modern methods and technology is proved to be a boon in complement to the traditional forms of teaching and learning in terms of education system. This project is ideal for the children of primary schools which helps them to visualize the concepts or subjects which are taught in classroom with the help of AR making subjects more interactive and explorative. It was being researched by Geer and Sweeney in year 2012 which shows that the use of a variety of media applications to explain the concepts has been increased resulting in better understanding and supports greater collaboration between students. Including the AR technology had also improved the employment of our country as to develop more feature full and subjects in AR more and more engineers are required to build such software. This technology also eases the job of a teacher to teach a topic in class which was earlier difficult to do because of the absence of any model to demonstrate the concept but now because of this technology embedded in educations system those models can be presented though augmented reality.

AR classroom provides the subjects like biology, social studies and science in a single software. This software uses the photos or images as an image target or platform on which a augmented reality object can be presented in the view of the camera of smart devices like smart phone, tablets and AR glasses. The AR classroom uses the devices camera to detect the objects in front of it and present the objects on which the student can interact with and learn from it.

2) BACKGROUND OF PROBLEM:

From many years, government, has being promoting the start-ups which can lead to changes in education system with the objective to enhance the success and standard of the teaching process and studying process in education system. As stated by philosophy named as ‘Falsafah Pendidikan Kebangsaan’ he has created for the realization of this initiative. Since many governments are taking initiative, Malaysia is aiming at the title of a develop country and develop country require community which is well informed, continuing innovative and willing to play a part for the development of science and technology. These initiatives are promoted by the recognition of existing methods that the traditional chalk and blackboards along with talk teaching method and the use of fixed or either unchanged textbooks are becoming short come to catch attention of students and resulting in poor learning outputs. According to the research conducted by Teoh and Neo (2007), for example, the listener or learner informed that it was boring to just listen the lecturer which are going in front of
them. The students think that the active participation of technologies will support them in their learning process by making it more interactive. Therefore, educators have begun to innovate technologies that have the abilities to be get combined with education system in order to help students learn actively and to improve their understanding and develop knowledge especially in Science subjects. The following sub-sections discuss the issues that have arisen in integration of the teaching and learning of Science and the medium in which technology such as AR can be used in addressing all issues.

2.1) Reduction in Number of Students Interested in Science Subjects and technologies

Process of acquiring knowledge in Science subject is a complimented way that includes knowing a problem, evaluating the problem, making static condition, knowledge of the storing the data by particular ways, evaluating the static conditions and investigating the outputs as per of reports in March, 1998. Performing such activities helps the student to think logically and to generate the results. Due to the popular myth which is widely flowing among the students that Science subjects are hard subjects still many learners are interested in pursuing their careers with Science stream and hope to build their future in such stream.

As per the research made by Phang et al. in year 2012, the percentage of students doing their studies in the Science stream has never reached 60% and the reduction in the percentage of enrolment done by students in Science stream is the major issue of concern. Many govt. among which Government of Malaysia has developed many systems in order to know the reason of the problem but the target still not reached to its destination. In the United Kingdom, ratio in the number of students taking Mathematics, Physics and Chemistry subjects are not chosen by students and a similar trend are seen in one of the countries that is Europe where young people or today’s generation are not choosing Science, Engineering and Technology subjects beyond compulsory subjects (Bevins, 2005).

Many studies had been done with the aim to learn from students about how to develop interest among students to bend there focus on Science. Among the advice made by students includes presence of educators in the area where the knowledge is provided with the relevant notes for the subject and make the classroom activities more exciting and interactive (Bevins, 2005).

Students are interested in learning by using interactive and interesting ways rather than using chalks and blackboards which are the part of previous learning methods. Research done by Osman et al. in year 2007 found that students are not interested in studying Science because of their myths that it is a not an interesting subject as it involves too many hidden (abstract) topic which they can only visualize in their thoughts but can’t see all of them happening in the real world.

2.2) Difficulties faced by students in Visualizing Abstract Concepts along with clumsy structures

It is commonly being seen among students that they find Science subjects to be abstract that is hidden with many more necessary details, that requires a depth of understanding and visualization skills and knowledge. When students face difficulties in understanding the concepts of the subjects, it just leads to misconceptions. According to Palmer in year 2001, the misconceptions among students has to be taken into account because it can interfere with the student’s learning of scientific terms and concepts. Thus, the selection of specific teaching ways plays an important factor in avoiding or minimizing the student’s misconception in respective subjects.

Visualization technologies like AR thus have good potential or abilities for facilitating understanding and preventing misconceptions in the scientific domain or department as been researched by Hay et al. in year 2000. Also, Kozhevnikov and Thornton in year 2007 found that is possible to improve student’s visualization skills in various difficult subjects by presenting a variety of abstract visual images, models which allows the students to manipulate and explore the images. There is probably a wide range of available technologies that can be used for the visualization of abstract concepts that can be easily learnt by the students.
Examples of visualization techniques that have been invented in earlier or previous researches includes animations, virtual environments and simulations. Dede et al. in year 1996 suggests that students can improve their knowledge of abstract concepts or thoughts through the use of virtual environments that have been designed for learning and understanding. These visualizations technologies hence can be used to address the problem of misconception and help students understand better and improve the learning abilities of students.

2.3) Capable Technologies for Visualization of Abstract and clumsy Concepts

We can categorize scientific concepts as theoretical and descriptive concepts and for some practical concepts too. Examples of descriptive concepts can be found in Biology such as food chains and environmental factors and many more. Theoretical concepts represent the concepts that cannot be seen with the eye such as air pressure (colliding molecules) and photosynthesis (Lawson et al., 2000) and many more. Research has demonstrated and concluded the beneficial use of technology as a means of visualizing abstract concepts.

Visualization technologies provide a means for making visible phenomena or concepts that are too small, large, fast or slow to see with the unaided eye (Cook, 2006). For example, Wu et al. (2001) developed or made an animation to help students understand the abstract concepts in Chemistry. According to them, this type of technology allows students to visualize the interactions among molecules and to understand the related chemical concepts practically. Stith (2004) used software to create an animation of enzyme-substrate binding for teaching cell biology and much more. The use of visualization technologies such as these in education is becoming more advanced and more sophisticated to make education System more developed.

Now-a-days, one of the technologies that is showing great potential in education system especially is AR i.e. Augmented Reality. According to Martin et al. (2011), AR is that new technology which is likely to have a positive impact on education and many more fields. This is being supported by the Horizon Reports from 2004 to 2010 which describe that AR as a technology will bring the computer world and abilities to the human world. AR is different from VR because AR combines the real world with computer world and much more, while VR introduces the user in a computer-generated world.

AR is a new method in order to improve the learning of 3D shapes instead of the traditional ways in which teachers use wooden objects to make students learn the things. According to researchers, there are various advantages of using AR techniques for educational purposes and methods. For example, AR can reduce the misunderstanding that arise due to the inability of students to visualize concepts such as chemical bonds, atomic structures, etc because AR allows detailed knowledge of visualization, motions and object animations in the real world. AR also allows macro or micro visualization of objects and concepts that cannot be seen or visualize with the naked eye. AR shows objects and concepts in different ways and at different angles being viewed by the students which helps them to better understand the subjects and concepts in proper manner.

In addition, most of the researches being conducted on AR proves that students are getting excited and more interested to learn using AR technology. For example, In research conducted by Klopfer and Squire in year 2008 shows that students and learners gave positive feedback about their experience of the integration of the virtual and real world elements using AR technology. Burton et al. in year 2011, also shared a similar result, with the students being participating in their study clearly excited about the potential of AR technology for sharing information and learning about new concepts and contents. This feedback proves to be useful in determining the readiness of students to accept and use this new technology in order to develop and improve their knowledge. AR also allows students in becoming more active in the learning process due to the interactivity of its applications and uses. Thus, it encourages students to think in a wider picture and become active creator which, in turn, improves their
experiences and understanding.

There are much more advantages to integrate AR technology into the teaching and learning process in order to enhance the education system. The advantages of AR in education indicates that there is good potential to integrate AR in teaching and learning, especially for the subjects that require the students to visualize. However, the meta-analysis conducted in the recent studies and the researches indicates that, even though a lot of research has been conducted on AR and yet more is to be conducted in order to improve the education system.

3) PREVIOUS WORK:

- **AR in 1960s.** In year 1968, Ivan Sutherland and Bob Sproull made a first head-mounted display and they called it ‘The Sword of Damocles’. Obviously, it was a rough device displaying primitive computer graphics.

- **AR in 1970s.** In year 1975, Myron Krueger developed a video place which was an artificial reality laboratory. This concept was later on used for certain projectors, video cameras and onscreen silhouettes.

- **AR in 1980s.** In year 1980, Steve Mann developed a first portable computer known as ‘EyeTap’, which was designed to be worn in front of the eye. It records the scene to superimposed effects on it and later on it shows all of it to a user who could also play with it via head movements. In 1987, Douglas George and Robert Morris developed the prototype of a head-up display. It displays astronomical information over the real sky.

- **AR in 1990s.** The year 1990 is known for the birth of the “augmented reality” term. It was first reflected in the work of Thomas Caudell and David Mizell – Boeing company researchers. In 1992, Louis Rosenberg of the US Air Force developed the AR system known as ‘Virtual Fixtures’. In 1999, a group of scientists lead by Frank Delgado and Mike Abernathy tested a new navigation software, which was able to generate the runways and streets data from a helicopter video.

- **AR in 2000s.** In year 2000, a Japanese scientist Hirokazu Kato developed and published the AR ToolKit which is a open-source SDK. Later on, it got adjusted to work with Adobe. In 2004, Trimble Navigation developed an outdoor helmet-mounted AR system. In 2008, Wikitude made an ‘AR Travel Guide’ for Android devices.

- **AR today.** In year 2013, Google beta tested the Google Glass with the help of internet connection via Bluetooth. In 2015, Microsoft presented two brand new technologies i.e. Windows Holographic and HoloLens (which is a AR goggle with lots of sensors to display the HD holograms). In 2016, Niantic developed the ‘Pokemon Go’ game for mobile devices. The app blew the gaming industry completely and earned $2 million in a just first week of release.
4) OBJECTIVE:
AR in education system can be successfully used in various purposes. It allows students to easily acquire, process, and remember the things well. Also, AR makes learning more engaging and fun.

Also, it is not limited to a single age group or a particular level of education and can be used equally well in all levels of schooling, from pre-school up to college or even at work.

❖ **Accessible learning materials: anytime, anywhere.** AR has the ability to remove paper textbooks, physical models, posters, printed manuals, etc. It provides portable and cheaper learning materials. As a result of it, education becomes more accessible and mobile and interactive.

❖ **Higher student engagement and interest.** Interactive gaming AR learning acts as a positive side for the students. It keeps them engaged throughout the lessons and makes learning fun and effortless.

❖ **Improved collaboration capabilities.** AR apps offer various opportunities to diversify and shake up the boring lectures. Interactive lessons, where all the students involve themselves in the learning process, at the same time it helps to improve teamwork skills.

❖ **Practical learning.** Apart from schooling, professional training can also be benefited greatly with the use of AR. For example, accurate reproduction of in-field conditions can help the masters to practical skills required for a certain job.

❖ **Universally applicable to any level of education and training.** In terms of learning games for kindergarten or on the job training sessions, AR is not limited to only one-use case.

❖ **Safe and efficient workplace training.** Imagine being able to practice the heart surgery while learning or operating a space shuttle without putting other people in danger or risking millions of dollars in damage if something goes wrong. All of this is possible with AR.

5) PLANNING & WORKING:

5.1) **AREA COVERED:**

5.1.1) Image Recognition:

According to the image shown the 3D model changes and animate.

5.1.2) Human Interaction:

According to the gesture the AR object will be change and animate.

5.1.3) Real Life Object Tracking:

3D model will be displayed and track the real-life object.

5.2) **WORKING:**

5.2.1) **IMAGE RECOGNITION:**

Augmented reality is the combination of the virtual world and the real world in which the virtual element is present along with the real world. The real world is represented by means of virtual elements.

Augmented reality aims to combine together the elements of virtual and real world.

Hence, Image recognition in AR is a feature being used to identify a particular image target and project a 3D model accordingly in an AR-based application.
Various types of image processing is used in AR for a lot of different inputs. According to the inputs type, various outputs can be generated.

From an algorithmic point of view, it is divided into three types:

1) Marker-based image processing
2) Marker less-based image processing
3) Position-based image processing

(1) Marker-based image processing

Here the digital world is tied up with the real world. The application must first recognize which page you are looking at from the live camera view. This is achieved by placing a distinct picture or shape on the page. That picture will be then recognised and the animation can start immediately, when tracked to the appropriate place on the page. We call the distinctive picture that can be recognized by the device, the marker in terms of AR.

A marker can be anything if it has enough unique visual points, especially images with lots of corners and edges work well.
(2) Marker less-based image processing

The user needs to think where the virtual object is to be placed in this case. This is called “Marker less AR”.

Sometimes, all the user want is to place a virtual character right in front of the user which can be a video-game character for suppose. The interaction here is meant by the game-play being experienced by the user and the user does not need to worry about the location of the virtual objects.

Typically, it means that virtual objects will appear to “float” in mid-air.

(Fig 3: Marker-less based AR)

(3) Position-based image processing

As we know, the virtual world is in a physical space. Position-based AR anchors augmented reality element to a specific location in this physical space. Imagine you are walking on a street you’re not familiar with and through your phone’s camera, a virtual road sign displays the street name. This is position-based AR

(Fig 4: Position Based Image Processing)
**Working In AR Classroom:**

1) At first, user will show the image target to the phone’s camera.

2) The application must first recognise which page you are looking at from the live camera view. This is achieved by placing a distinct picture or shape on the page.

3) Then that picture will be recognised and the animation can start immediately, when tracked to the appropriate place on the page.

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**Steps Involved in Working Of Image Recognition:**

1) First step is to setup the license key for the AR Classroom project. Each project has its unique license key.

2) Now the customization of the layout of the application is to be done. The database must contain all the image targets that are to be involved in the scene.

3) Now we just have to save the scene and set up the build for the project.

4) Then simply install the app on the phone and use it.
Note: AR itself is already pretty awesome, but this time we’ll add some more interaction between the real world and the AR world. We’ll achieve this by adding Virtual Buttons to the scene, which simply means that we add buttons to the AR world, which can be touched in the real world. How cool is that! Also, it brings more reality and fun in the education system for the students.

5.2.2.a) VIRTUAL BUTTON:

Virtual button buttons are the mechanism provided by the Vuforia augmented reality software development kit (SDK) which enables the user to interact with image also referred as Image target in unity game engine. This virtual button triggers the developer specified functions or events when touched on the given image. These virtual buttons are visible to the developer of the AR (Augmented Reality) software but not to the user of the same.

FACTORS RESPONSIBLE FOR THE EFFECTIVENESS OF THE VIRTUAL BUTTONS:

The developer of the AR (Augmented Reality) software have to make sure of some factor to ensure effective and accurate usability of virtual buttons.

1) DIMENSIONS OF VIRTUAL BUTTON
The length and width of the virtual buttons are responsible to specified the area a virtual button covers so that when the area is interacted by a user, the developer defined functions must be trigger which is assign to that virtual button when activates.
2) PLACEMENTS OF VIRTUAL BUTTON ON IMAGE TARGET
Placement of a virtual button is an essential part of making a virtual button as a part of the software as an Image when uploaded the Vuforia database, Vuforia Image Target procedure assigns features to the image (the yellow stars on the image).

• When this procedure successfully completed then the image can be use as Image Target by the developer of the AR software to place virtual buttons.
• The developer tries to place the virtual button on the Image Target where the features are sufficiently available.

The placements of the virtual buttons also involve preventing of placing multiply virtual buttons in a column like orientation until it is required to do so, as it may lead to triggering those virtual buttons which were not intended to get trigger and ultimately leads to decrease the effectiveness of the software.

• Vuforia Image Target procedure do not assign any features on the borders of the image as it shown in Figure1 so placing any virtual buttons there is not recommended as the virtual button may not get activates when the user interact.

3) SENSITIVITY OF VIRTUAL BUTTONS
The sensitivity of the virtual buttons determines the responsiveness of the virtual buttons such that how much closer a user must interact with an Image Target where the virtual button has been placed to trigger the functions assign to it.
The Unity software which is used to develop the AR based software and games provides all the required settings to configure a virtual button when Vuforia package is imported in it which also involves adjusting the virtual button sensitivity in the AR software.

![Unity software virtual button configuration]

(Fig 7: Unity software virtual button configuration)

**WORKING OF VIRTUAL BUTTON IN AR CLASSROOM**

When the user interacts with an area on the image where the virtual button is placed than a significant proportion of the features underlying the area of the buttons are concealed from the camera which triggers the buttons events in the software.

![3D augmented model](image)

**5.2.2.b) HUMAN BODY AR IN AR CLASSROOM:**

Human body AR in AR classroom is the biological lesson part of this application in which the user can learn about organs get a compact information about the specific organ which the user chooses just using a single page which is stored in Vuforia database as Image Target. In human body AR user views the human body diagram through the AR classroom camera and just tap on the organ drawn on the Image Target and an AR 3d model will pop out on the device screen in which the user is using the AR Classroom.
application whether it a smartphone, tablet or AR glasses where the user can learn about the organ, sees how it looks like all by using a single image.

**Note:** Object Recognition and Tracking extend the capabilities of the app to recognize and track arbitrary objects for much better AR experiences. Object Recognition and Tracking let you detect objects and entire scenes, that were pre-defined by you and hence act as a boon for the education purpose in our app.

5.2.3) **OBJECT TRACKING:**

There are various ways for people to be educated and trained with regard to specific information and skills they needed such as classroom lectures along textbooks, computers, various devices, and other electronic devices mostly used is mobile phones. The choice of learning innovation is dependent on an individual’s reach to various technologies and the infrastructural environment of a person’s surrounding.

In a rapidly changing society, where there is an access to available information and knowledge, adopting and applying information at the right time and place is required for efficiency in both school and business settings. To enhance such settings, one of the best technology is Augmented Reality, it has many applications such as image recognizing, Virtual button, Object Tracking etc.

For object tracking, also known as Superimposition based AR, we use Vuforia Object Scanner which is an Android application that is used to scan a physical 3D object.

**Tracking of Objects in Object Scanning include various levels:**

1) Looking at the object to scan.
2) Process of scanning a 3D model using Object Scanner application.
3) Finally, superimposition Digital 3D model on top of scanned 3D object.
4) Building and running the application.

(1) LOOKING AT THE SCANNED OBJECT

There are many criteria which must be satisfied by any 3D object for superimposition AR. Criteria are:

a) The object must be **opaque** (it must not be transparent or semi-transparent).

b) The object must be **rigid/hard** (it must not easily bend).

c) Object must have **minimum moving parts/points** such as action figures and toy cars.

d) Pliable and deformed objects are not supported such as bag, cap etc.

e) The 3D object must be placed indoor and moderate bright light that is equally spread all over the place where the object is placed.

(Fig 9: Superimposition digital 3D model over 3D object)

(Fig 10: Object scanning target)

(2) PROCESS OF SCANNING 3D OBJECT USING VUFORIA’S OBJECT SCANNER APPLICATION

The Vuforia Object Scanner is an Android application used to scan a physical 3D object.

The Object Scanner produces an Object Data (*.OD) file that includes information about the source data required to define an Object Target in the Target Manager. The Scanner hence allows you to generate, test and edit OD files. It provides a visualization of the object’s features as well as their coverage across the object. For using this object scanning application we need to:

1. Sign in to Vuforia account which is being followed by going to development and tools tabs.
   After clicking on tool’s tab, we have to download its object scanning apk for further processing and working.

2. Now we will scan the object by placing it over the object scanning target. It allows the scanner to accurately identify the role of the physical target in the grid region and it also defines the culling region of the scanning space.
3. Placing the object over this object scanning target rectangle space and using mobile phone that had installed scanner application. Scanning first need detection which is known to us if the object is covered with the dome structure while we see it in our mobile phone. When complete dome gets green color than the object is being scanned completely.

4. Saving the scanning file we will use it and the extension of the file is od file where od is object data. After adding license key and database is added with object data file than we will use unity for further processing we can see image we scanned as soon as we put object file in unity.

5. After this we had downloaded the digital image of object from asset store as we have done for the toy car similar work we had done for plants, flowers etc. in order to distinguish different flowers and plants and will get superimposed images over them.

(3) FINALLY, SUPERIMPOSITION 3D OBJECT BY DIGITAL IMAGE

This is done by putting the digital image in the axis of real 3d model. We can see overlapping of the image over the model.

We can see the image without object scanner target as shown below in the figure.

(4) BUILDING AND RUNNING THE APPLICATION

- We simply need to change setting in unity to android or either to IOS depending on for what we are making application or building application for. As soon as app is made, we simply need to copy that file in either android or an IOS.
- Installing that application in our mobile phones we can use this application.
(Fig 13: Showing digital image without scanner target)

(Flow Chart for Scanning)
6) CONCLUSION AND FUTURE PERSPECTIVE:

**CONCLUSION:** Now a days, teachers are searching for different ways to help their students learn things faster and retain that things better. They also want to get students to participate better in the class. AR has proved to be a boon for this purpose in today’s time. AR is new to the field of education that has proved its potential for new teaching methods and for benefits to the teaching strategy is incredible. Innovations in teaching and learning are right around as teachers are just starting to get access to the AR tools. The classrooms are going to change but the progress towards more engaging lessons and improved learning is likely to be a gradual process. Thankfully, the potential benefits is tremendous with VR and even parents will be able to use this technology in order to make education a funny thing for their children. If you wish to have innovation in field of education, then you should think about opting for AR education app development. It comes with great potential which is still to be discovered and used. The continuous rise in development of hardware and innovations in mobile technologies is playing a big role in making AR more accessible for the field of education and easy to use. The use of education mobile app development is on the peak too. So, if you expect to make significant change in global education sector, then building AR based education app can be a wise decision.

**FUTURE PERSPECTIVE:** AR is changing todays education system through mobile platform. But AR headsets are still not ready in order to get used. Research & Development department will have the main focus on AR innovation. Also, there would be improvement in AR for the user experience. The AR and VR technology market is expected to raise up to a market size of $215 billion within 3 years. The number of AR and VR technology users is expected to cross 1 Billion mark by 2020.

**The Future of AR in Education and Training:**

Several cutting-edge AR applications to date have been mostly developed for location-based Information, social network services, and entertainment. New AR tools for other purposes such as education and training, however, will continue to be developed as the technology becomes more highly evolved and advanced than ever before. A considerable number of professionals and researchers from the field of education and training science predict that simple AR applications in education will be realized within a few years.
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