CDF DOCUMENTS – A NEW WAY ON HOW TO IMPROVE OUR E-LEARNING MATERIALS TO BE MORE INTERACTIVE?

CDF DOKUEMTNY – NOVÁ TECHNOLÓGIA PRE ZLEPŠENIE INTERAKTIVITY NAŠICH E-LEARNINGOVÝCH MATERIÁLOV

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Abstract: Information and communication technologies act as a catalyst for innovation in learning, providing access to contextualized high-quality content. The authors of e-learning material can use multiple media to present ideas and concepts, combining traditional educational content (text, images, graphs, and diagrams) with interactive computer-based resources (sound, video, animation, image series). We will inform in this paper about new – simple -tools for providing our e-learning materials more interactive. We will compare these new tools Wolfram computable document format - CDF with previous interactive techniques – webMathematica jsp pages. Both techniques allow adapting e-learning course materials to be more interactive, but the question is on how way and on which restrictions.

Key words: CDF documents, JSP pages, webMathematica, Mathematica, e-learning interactivity materials

Interactive Learning Content

Interactive distance learning technology is an umbrella term that describes the many technologies that bring learning experiences into our classroom from outside sources. Distance learning resources can be in the form of a delayed time format (a postcard, an audiotape, a videotape, a Web page, or an email message), a realtime interactive communication activity (a phone call, a twoway video presentation, online chats and instant messengers, or virtual learning areas), or other formats. But for this time all our thoughts deal to the more interactivity content, deal to the improving the availability and interactivity for our e-learning materials.

A common misconception today is that interactive distance learning activities limit you to the Internet and online utilities. Quite the opposite, interactive distance learning technologies are available in many varieties. No one doubts that the distance learning resources are many, and that you are probably interested in several of these resources, but getting started with distance learning resources may sometimes seem to be just another chore that you, a busy educator, have not found time to research and explore.

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Students who are using technology throughout the learning process are already on track for developing cognitive skills that will be required for a lifetime of learning. Regardless of how many times a student will be expected to change jobs during a career, rapid changes (either with the technology or the job itself) will force workers to be responsible for their own training and retraining within each position. Think of the many new skills that you have learned since you entered your teaching career.

Fortunately, or unfortunately, depending upon your viewpoint, there is no reason to expect a decline in the rate of change in our society. Thus, educators must continue to assess not only how to provide students with the best instruction in content areas, but they must also assess how to provide students with lifelong learning skills that go beyond content, skill, and technical areas. **This emphasis on teaching learning skills, or processes, supports an important transfer and construction of learning, one that is probably taking place in our schools/universities today.**

The question of what type of learning model to follow, as it applies to distance learning, is still being considered. By increasing our awareness of the need to provide students with the opportunity to transfer and construct concepts in a technological environment, we can have an impact on our students' futures. Learning how to learn and emphasizing the teaching of strong cognitive skills will provide students with invaluable learning techniques and strategies. Interactive distance learning technologies support the teaching of this transfer and construction of learning by offering opportunities that support learning how to learn. Granted, there are still those students in the pipeline that are not very interested in interactive or selfdirected learning. After all, passive listening only requires sitting back and absorbing content, letting the instructor do the work. Group work? Projects? These are not for the passive learner, but the day of passive learning, both within and outside of industry, are at a philosophical fork in the road of education. Many of us believe **that students also need to develop the abilities to collaborate and problemsolve.** (BenJacob, Levin, and BenJacob 2000).

In a mathematics course, it can be more difficult to engage students in interactive learning as the traditional method of teaching finds students individually working problems from a textbook. Math can be made interactive by utilizing math manipulative, working in groups and assigning student's math strategies to learn and then teach their peers. Games and role playing with real-life examples of problems can also be utilized to make the content interactive and further student engagement.

No one have doubts about importance to make our e-learning materials more interactive, to bring them closer to our students and to utilize the benefits of interactivity for better explanation course materials. The discussion will follow about the possible ways. We, all teachers and all tutors, are looking for efficient, amazing tool, simple usable and distributable over large student's community. We vote for tools, which are available on different formats, different devices include tables and mobile phones. In case our interactive e-learning materials should be displayed via different web browser, it gives us 50% of future success – no special installation, no special request, no payments. Web browsers are available on all devices; all students hold this space as their second home – so why do not use this space also for distribution math e-learning interactive materials?

In this paper we will speak about two possible ways on how to create interactive materials which allow display interactive math (including math fonts) on different devices via web.

1 webMathematica technology

WebM*athematica* is a new web technology, is developing only for few last years, that allows the generation of dynamic web content with *Mathematica*. It integrates *Mathematica* with a web server. Web*Mathematica* harnesses the full range of Mathematica technology to build sophisticated web applications, especially in creating dynamical web art objects, or the graphical objects for teaching. Web*Mathematica* provide immediate access to the technical computing software with very firm abilities especially in *Mathematica* graphics from any web browser. It allows incorporate also dynamical possibilities to creating graphics objects, so the graphics are live, interactive and responsive to user needs.

WebM*athematica* is the clear choice for adding interactive calculations to the web. This unique technology enables the user to create web sites that allow users to compute and visualize results directly from a web browser. This approach can be used in teaching fundamentals of math calculus, of numerical math, applied math but also on geometry and computer graphics. These techniques allow to users to create their works and to better explore how mathematical algorithms work. They do not need to know the algorithms. They do not need to install nor special programs, or special working space, only web browser is need. It is very advantageous for students, due to they need no special tools and techniques.

WebM*athematica* allows a site to deliver HTML pages that are enhanced by the addition of Mathematica commands. When a request is made for one of these pages, the *Mathematica* commands are evaluated and the computed result is inserted into the page. This is done with a standard Java technology, JSP, making use of custom tags.

But there is need to bring back to memory also disadvantages of this technology. To provide interactive materials via web*Mathematica* technology services, you need to keep your own web*Mathematica* server, or to share/to lease the web space on some of available (not free) web*Mathematica* servers. To buy/to lease this technology is not low cost service and moreover you need to provide its fully functionality day by day. Yes, in case you have a perfect computer administration support from your university, this technology allow you to create and to use several hundreds application and learning materials for your students in a simple way. These application will be fully working, interactive and they allow you to develop the student's skills

and to improve their interest for math. You can read more about this technology in refered literature.

2 CDF technology

The Computable Document Format, or CDF, allows its user to program interactive experiences into a document so that data can be explored more easily. You can create widgets that allow the user to fiddle with sliders, input numbers or play animations on-demand. For example, on Wolfram Research's blog, there's an interactive widget that explains the Doppler effect -- the way sounds change in pitch depending on whether they are approaching or moving away from your position.

Wolfram's goal is to make it as easy to produce little interactive widgets as it is to create a graph in Microsoft Office's Excel -- without requiring someone to learn a programming language. **The theory is that data is more easily communicable when it's interactive, than when it's static.**

The Computable Document Format (CDF) is a document format with a published, open specification. Right now the only way to create CDF documents is by using *Mathematica*, and the only way to view CDF documents is by using Wolfram's CDF viewer (free) or to use the newest version of web browsers. These technology is supported by all web browsers.

CDF is a computation-powered knowledge container. Its interactivity isn't just pre-generated, but live. And for the first time, authoring doesn't require professional programmers to create interactive diagrams for reports, presentations, articles, and textbooks. "The idea is to provide a knowledge container that's as easy to author as documents, but with the interactivity of apps," said Wolfram. "For CDFs to make live interactivity as everyday a way to communicate as spreadsheets made charts."

2.1 PDF and CDF documents

The PDF has long reigned as the universal document, one that can be read by almost any machine anywhere and be formatted to hold various kinds of information: text, charts, graphics, images, etc. But the problem with PDFs (or spreadsheets for that matter) is that they're pretty static--with the exception of a few (admittedly handy) features, they are fixed in what they can do and convey. Wolfram Research is trying to change that with the Computable Document Format (CDF), a new kind of interactive document that brings computation to the document itself.

An easy way to think of the CDF is like a PDF with embedded apps. It's a document that essentially computes within itself, adding a layer of interactivity to things like graphics and charts that let the user not only see data but explore it as well. Computable Document Format (CDF) files supply a rich deployment method leveraging the power and flexibility of the *Mathematica* language with the wide distribution provided by a public format. The new standard aims to bring the kind of computation Wolfram is known for to portable documents that can be used within a browser, on a desktop and on hand-held devices.

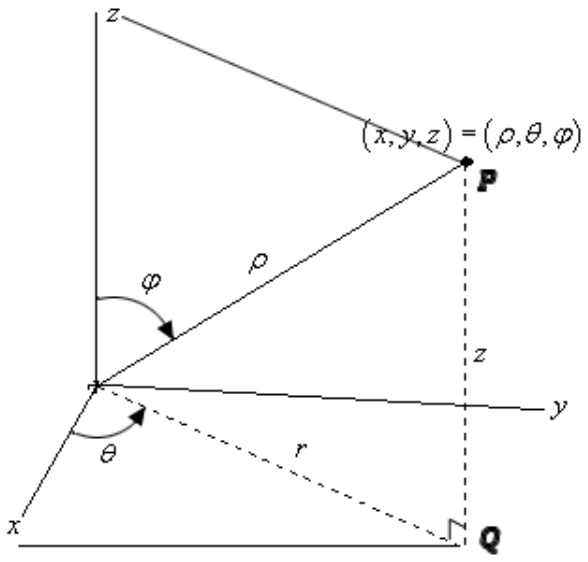
The rub is that Wolfram needs adoption and there's already a dominant document format in Adobe's PDF. One big challenge would be figuring out the interplay between CDF and PDF. The Computational Document Format (CDF) allows authors to embed interactive charts, diagrams and graphics into their documents, allowing readers to adjust variables to see how the graph changing after parameter modification, to display different math animation for better explanation of math principles. Using Wolfram's Computable Document Format (CDF), users can create visual depictions of their data sets, which then can be manipulated by others. "It is a new way to communicate the world's quantitative ideas much more richly than we have in the past," said Conrad Wolfram, the company's managing director, in a webcast press conference. And we can tell, it is really true, but this format need some time and some more development work.

3 CDF technology – how does it work

As a built-in feature of *Mathematica* 8 (also *Mathematica* 9 extend it), it's easy to save .cdf files straight from your working notebooks, custom-formatted papers and articles, or dedicated application development workflows. Anything you compute in *Mathematica* can be made into a user-interactive object offering maximum clarity in the presentation of your concepts, and there are no special considerations when creating documents just for viewing in Wolfram CDF Player; all notebook features can be displayed and printed. Computable Document Format files can be created from existing notebooks or from scratch. They can contain absolutely anything you can put into a *Mathematica* notebook.

The main difference between a *Mathematica* notebook and a .cdf file is the allowance of interaction when viewing your document in CDF Player or your browser. Notebook files (files with the extension .nb are viewable as static documents in CDF Player, but any Manipulate objects present in a .cdf file are fully interactive in CDF Player.

We will demonstrate this technology on classical math calculus application - relationships between spherical and Cartesian coordinates. For our students it is not easy to imagine how does it work? So simple CDF document can help them to better understand these relations and on the other hand it is not take much time for teacher to prepare this demonstration field.



Spherical coordinates can be a little challenging to understand at first. Spherical coordinates determine the position of a point in three-dimensional space based on the distance ρ from the origin and two angles θ and φ. If one is familiar with polar coordinates, then the angle θ isn't too difficult to understand as it is essentially the same as the angle θ from polar coordinates. But some people have trouble grasping what the angle φ is all about.

We will show the simple example and interactive CDF file which may help our atudents understand spherical coordinates

better. We will remind the relationship between spherical and Cartesian coordinates, show an CDF document that allows them to explore the influence of each spherical coordinate, and illustrate simple spherical coordinate surfaces.

Spherical coordinates are defined as indicated in the following figure, which illustrates the spherical coordinates of the point P. The coordinate ρ is the distance from P to the origin. If the point Q is the projection of P to the xy -plane, then θ is the angle between the positive x -axis and the line segment from the origin to Q. Lastly, φ is the angle between the positive z -axis and the line segment from the origin to P.

We can calculate the relationship between the Cartesian coordinates (x, y, z) of the point P and its spherical coordinates (ρ, θ, φ) using trigometry. As the length of the hypotenuse is ρ and φ is the angle the hypothenuse makes with the z -axis leg of the right triangle, the z -coordinate of P (i.e., the height of the triangle) is $z = \rho\cos\varphi$. The length of the other leg of the right triangle is the distance from P to the z -axis, which is $r = \rho\sin\varphi$. The distance of the point Q from the origin is the same quantity.

The distance from Q to the origin, which is the length of hypotenuse of the right triangle, is labeled just as r. As θ is the angle this hypotenuse makes with the x -axis, the x - and y -components of the point Q (which are the same as the x - and y -components of the point P) are given by $x = r\cos\theta$ and $y = r\sin\theta$. Since $r = \rho\sin\varphi$, these components can be rewritten as $x = \rho\sin\varphi\cos\theta$ and $y = \rho\sin\varphi\sin\theta$. In summary, the formulas for Cartesian coordinates in terms of spherical coordinates are

$$x = \rho\sin\varphi\cos\theta$$

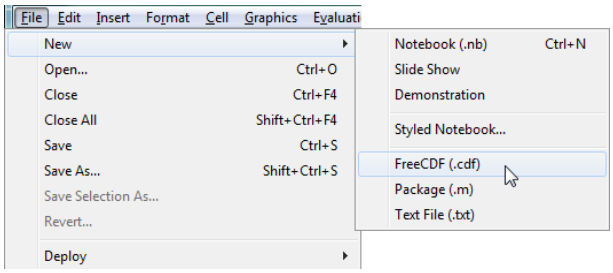
$$y = \rho\sin\varphi\sin\theta$$

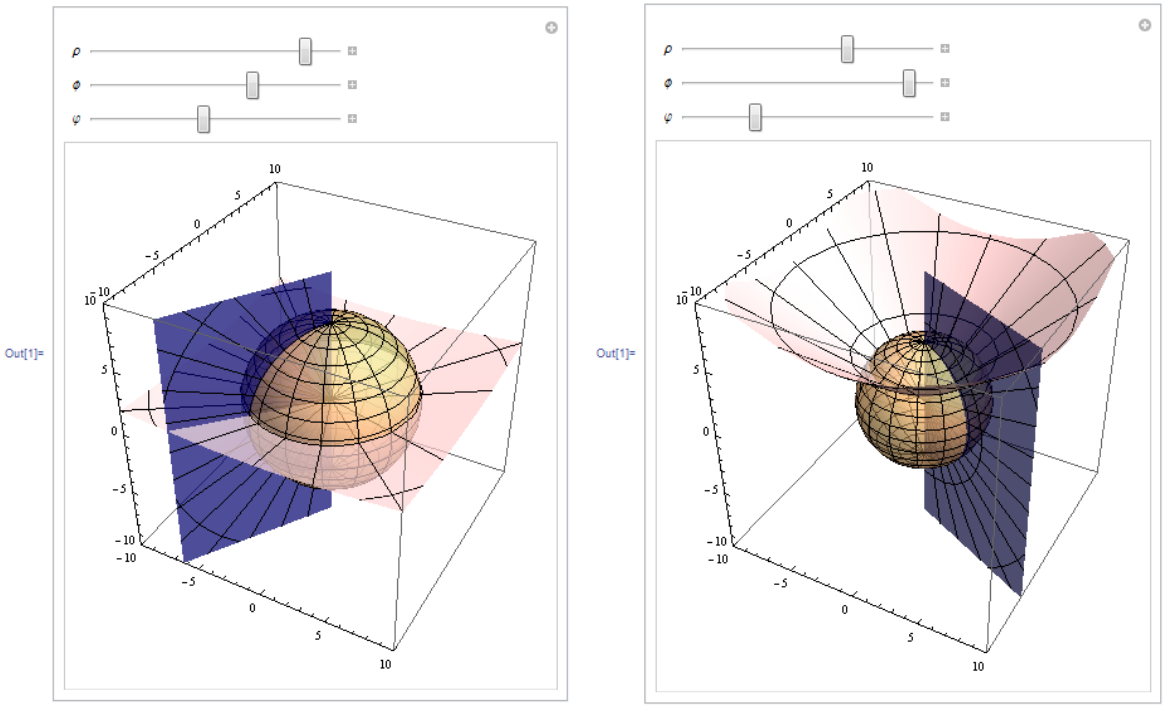
$$z = \rho\cos\varphi$$

It seems that it is very easy, but not for our students. For our students it is not easy to imagine the representation of each angles and each distance. So can simple prepare CDF document which allow them to imagine and to explore how does it work. Only three ParametricPlots command are used, all pictures are stored togather with Show and Manipulating movers are added.

```
In[1]:= Manipulate[Show[
          ParametricPlot3D[{ρ Cos[ϕ] Sin[φ], ρ Sin[ϕ] Sin[φ], ρ Cos[φ]}, {ϕ, 0, 2 Pi},
           {φ, 0, Pi}, PlotPoints → 30, PlotRange → {{-10, 10}, {-10, 10}, {-10, 10}},
           PlotStyle → {Lighter[Orange, 1 / 2], Opacity[0.7]}],
          ParametricPlot3D[{ρ Cos[ϕ] Sin[φ], ρ Sin[ϕ] Sin[φ], ρ Cos[φ]}, {ρ, 0, 100},
           {φ, 0, Pi}, PlotPoints → 30, PlotRange → {{-10, 10}, {-10, 10}, {-10, 10}},
           PlotStyle → {Darker[Blue, 1 / 2], Opacity[0.7]}],
          ParametricPlot3D[{ρ Cos[ϕ] Sin[φ], ρ Sin[ϕ] Sin[φ], ρ Cos[φ]}, {ρ, 0, 100},
           {ϕ, 0, 2 Pi}, PlotRange → {{-10, 10}, {-10, 10}, {-10, 10}},
           PlotStyle → {Lighter[Pink, 1 / 2], Opacity[0.7]}],
          PlotRange → {{-10, 10}, {-10, 10}, {-10, 10}}, Lighting → "Neutral"],
         {ρ, 0, 7}, {ϕ, 0, 2 Pi}, {φ, 0, Pi}]
```

By a very simple way *Mathematica* notebook document which includes simple parameterization was created. The easiest way to create a new .cdf file is to select File ► New ► FreeCDF (.cdf) from the menu:





By the same way as we can model this problem in Mathematica notebook, we are able to model it also in CDF document, which is available under web browsers.

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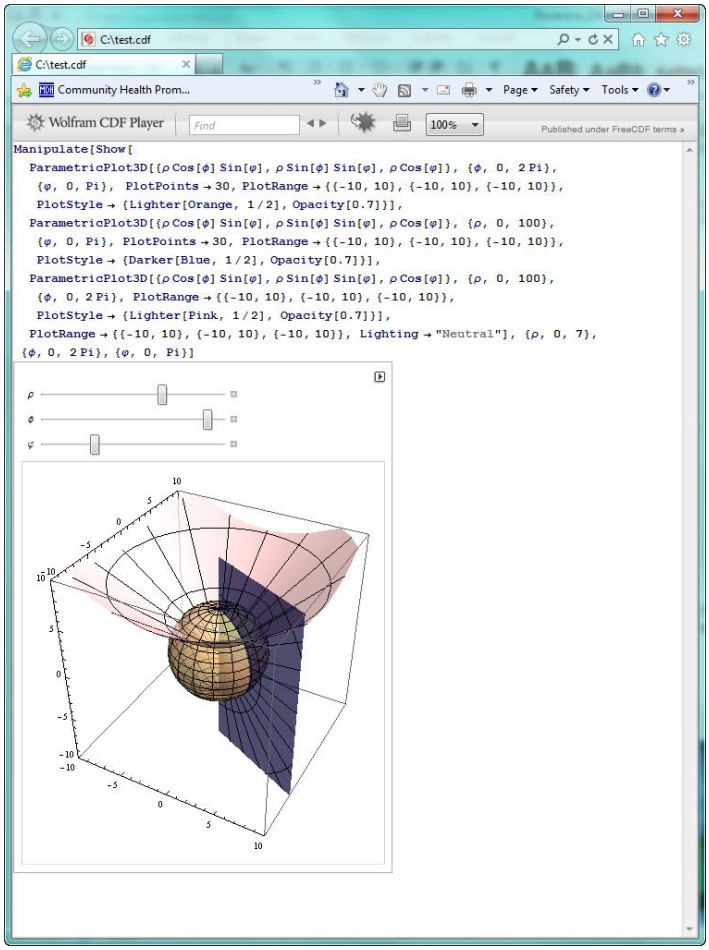
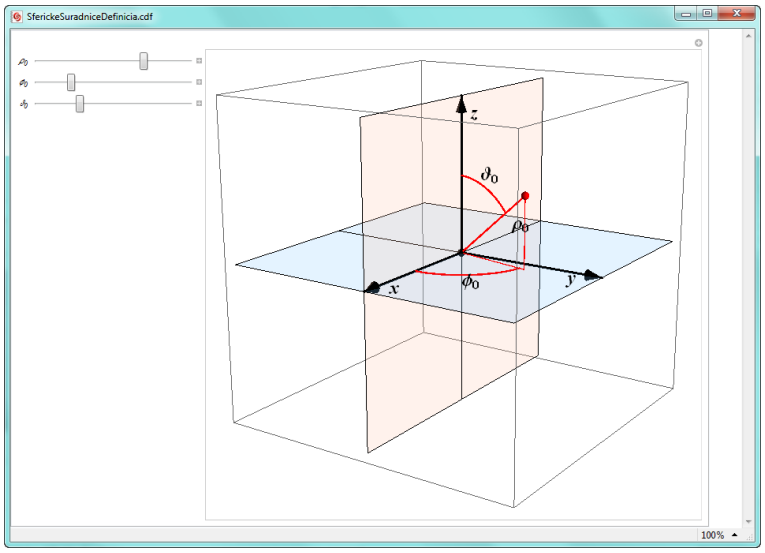
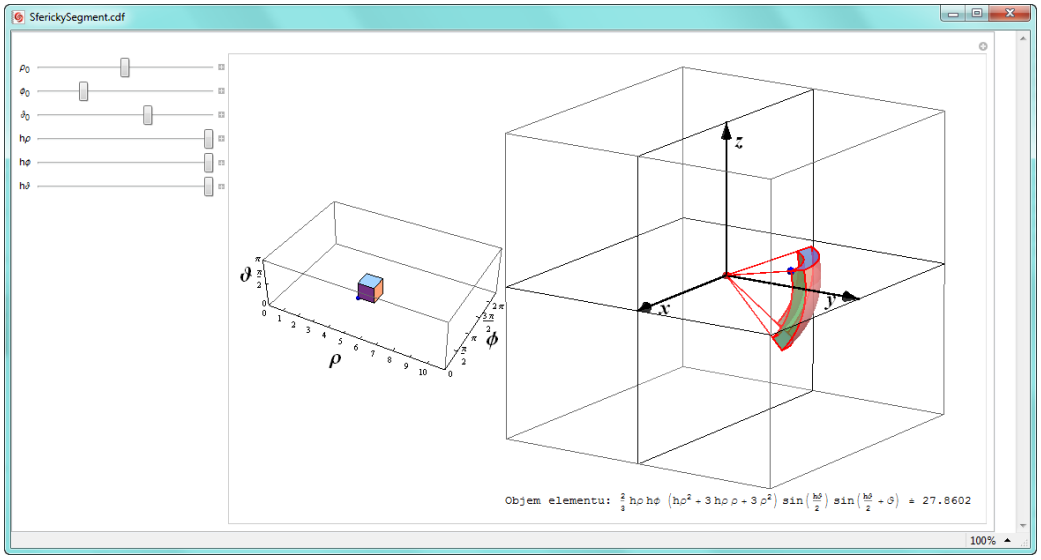


We can present for our students also other application

How to manipulate with coordinates:



What is spherical element:



Conclusion

Computable Document Format (CDF) is an electronic document format designed to allow easy authoring of dynamically generated interactive content. It was created by Wolfram Research. Computable document format supports GUI elements such as sliders, menus and buttons. Content is updated using embedded computation in response to GUI interaction. Contents can include formatted text, tables, images, sounds and animations. CDF supports Mathematica typesetting and technical notation.

CDF files can be read using a proprietary CDF Player with a restrictive license, which can be downloaded free of charge from Wolfram Research. In contrast to static formats such as PDF and pre-generated interactive content provided by formats such as Adobe Flash the CDF Player contains an entire runtime library of Mathematica allowing document content to be generated in response to user interaction using any algorithms or visualizations which can be described in Mathematica. This makes it particularly suited to scientific, engineering and other technical content and digital textbooks.

CDF reader support is available for Microsoft Windows, Macintosh and Linux but not for ebooks. The reader supports a plugin mode for Internet Explorer, Mozilla Firefox, Google Chrome, Opera and Safari, which allows CDF content to be embedded inline in HTML pages.

It seems that this format should be a good tool for creating interactive e-learning materials. We plan to explore other possibilities of this tool and then prepare several interactive materials especially in numerical math area and in basic calculus, all materials will be available on web page www.mathematica.sk for free to all who are interested.

Some materials you can find also on Wolfram documentation centre.

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http://www.wolfram.com/cdf/

http://www.wolfram.com/cdf-player/

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