NatSim.net – an open teacher's platform for web-based homework on simulation programs

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Abstract

NatSim.net is an Internet service for science teachers to download web pages with simulations from the web, to edit the text on these pages, and to publish the modified versions back on the Internet. This note gives some indication as how to use the system and how to deal with copyright issues. Furthermore, we discuss the organizational and educational benefits for Science Teaching at schools. One concrete example is web-based homework that asks for e-mail feedback from the students. Following the idea of Just-in-Time-Teaching (JiTT) this feedback can be used in subsequent lessons – with remarkable advantages even at high school level.

Introduction

Physics Educational Research has found a broad range of applications where the use of simulation software does enhance Physics learning – especially when it comes to conceptual understanding and (inter-)active acquisition of knowledge. And many teachers are intrigued by computer-calculated animations in which the consequences of theoretical equations can be directly compared with experiments: Methodologically, simulations give hands on theory! So what can a motivated teacher do in order to integrate simulations into every-day teaching, given the widespread restrictions as to technical facilities and skills at school? The NatSim.net concept provides a solution to this under the following conditions:

1. Every student has at least once in a week access to a school computer or to the Internet.
2. The teacher has access to the Internet and an opportunity to edit web pages (e.g. with MS Word)
3. The teacher is flexible enough to build on the work of others that may only match with 80% of his/her initial ideas. (This is the hardest requirement!)

The trick of the NatSim.net is to recycle e-content that already is available on the Internet. Thus, rather than making computer programming their time-consuming hobby, teachers can focus on the pedagogical task of translating or inventing learning activities that fit in with their needs. An interesting pedagogical application of web-based simulations is Just-in-Time-Teaching (JiTT). Although in principle applicable to any independent student activity, the JiTT concept is also historically linked to web based simulations, particularly with the Physlet™ applets from Davidson College [1].

1 Just-in-Time-Teaching (JiTT)

JiTT basically means that a teacher uses feedback from students on individual learning activities to prepare the next in-class session closer to the students' actual needs. In practice, the individual learning activities are published on the web. They serve, for example, as motivation before introducing new concepts ("What is Physics good for?"), or as exercises that apply physical concepts thereafter. In both cases, they can include investigations on computer simulations like: "Determine the focal length of a lens by dragging the light source with the mouse while observing the plotted rays". Other simulations serve as mere visualisations, e.g. "Which one of the given position-time graphs describes the displayed motion of the car?" The students send in their answers, comments or questions via e-mail. A purpose-built hyperlink on the web page prevents the teacher's inbox from being flooded6. The students' feedback can be used in various ways. A promising approach is to start an in-class discussion over selected statements, usually on a base of anonymity.

The idea of JiTT originates from Physics departments at U.S. universities and colleges. But here are good reasons to give this concept a place at European high schools as well:

- Students are motivated by the discussion over their own sent-in wordings. In an atmosphere of trust, they make efforts to publish both intelligent and witty contributions in-class. (It is important that the teacher

6 A tip for the more advanced reader: Here is an example of a e-mail hyperlink „bsmith@school.org" that firstly cannot be scanned by commercial address hunters, and secondly sets a predefined subject („Exercise 1") in the student's reply. An appropriate filter rule in the e-mail client would collect such replies in a separate folder. Use a text editor to place this JavaScript of the html source code of a web page:

```
<script>m="lto:";a="@";document.write('<a
href="mai'+m+'bsmith'+a+'school.org?subject=Exe
rcise 1">bsmith'+a+'school.org</a>');</script>
```

acknowledges the value of false answers and misconceptions for scientific discussions and learning.)

- The teacher's effort of skim-reading the students' contributions is rewarded by the convenience of more predictable lessons: Less improvisation in class means in general less stress for the teacher and less unrest among the students…
- Students are better prepared for the lesson, because they know that the teacher can track their contributions anytime.
- The teacher accumulates a comprehensive archive of individual contributions throughout the whole school year. This is especially valuable when contact time is only one or two hours per week.
- Students who have difficulties to contribute in class get another chance to express themselves.

And finally, there is a substantial practical advantage of web-based homework: The use of private computers complements the often limited school facilities. Even if Physics teachers may at times have difficulties to find a computer room during their regular Physics lessons, it will often be feasible to organise some sort of general access for individual activities in the afternoon for those who have no Internet connection at home.

2 NatSim.net

2.1 Overview

NatSim.net7 is a web site that provides services for teachers who wish to use web-based simulations in their lessons. One of these services, *NatSim-Search*, helps teachers to find and to download web pages with applets or Shockwave/Flash products that deal with Natural Sciences, but mostly Physics. In a next step, they will edit the text of the web pages on their computers. In the special case of Physlets™ – the applets from Davidson College – they can in principle also change the simulation itself and the text that appears therein. But even if one can not control the actual simulation – editing the surrounding web page is by itself a challenging opportunity for teaching: Apart from mere translation, a teacher can formulate new activities and even a flawed simulations can be reused in an exercise that pays attention to its shortcomings.

Technically, the text of a web page (= html file) is best changed by means of so-called web editor software, but is also possible with Microsoft Word, which is familiar to many teachers.

The modified simulation activities can – mostly – be used off-line and they could even be distributed on floppy disks. Nonetheless, Natsim.net enables teachers to publish their simulation pages back on the Internet where pupils can work with them and – in most cases – can download them for off-line use. Especially, the service *NatSim light* only requires a minimum of technical knowledge from the teacher in order to publish an html file that he has edited.

Finally, NatSim.net includes discussion forums where teachers can exchange their ideas and where they find help on technical issues. Specific features shall work against the common tendency of such forums to die out after sporadic use. The following subchapters contain details about the individual NatSim services before we discuss the delicate question about copyright in section 3.

2.2 NatSim-Search

NatSim-Search is a database with Internet addresses (URLs) of about 14000 different web pages that contain simulation programs for Natural Sciences and Mathematics, but mostly Physics. Relevant pages can be found by means of a full text search that includes the invisible parts of the web page as well, e.g. the JavaScript sections of Physlets, see 2.7.

A particular feature of *NatSim-Search* is that it provides download options for all of the pages in the database, but also for any other web page whose URL (http://...) is entered into the search field. There are three different download options:

1. [zip] - attempts to collect all files necessary to display the simulation page correctly in the browser. In addition to the html file these are programme files (.jar, .class, .swf, .dcr), images (.gif, .jpg, .png), and possibly others files (.css, .js, etc.). All these files are compressed into a single file in zip-format, which will be transferred to the user. This procedure can fail though if, for instance, the programme files (.class) are too much scattered across the server. Otherwise, extracting the download will set up a folder structure on the local computer. It contains an html file that displays the simulation off-line when opened in a browser.
2. [exe] - does the same as the zip option, but delivers a self extracting file for Windows computers that have no uncompressing software installed. (This is obsolete for Windows XP.)
3. [html] - downloads a purpose-built "*autonomous*" html file without the additional resource files. With such a page one needs to be on-line to display the simulation, for the browser attempts to load the required resource files from their original location. The advantage for the teacher is that he has got only one file to deal with. And the student will be on-line anyway – at least, if he is supposed to access the teacher's modified version on a web server like

7 http://www.natsim.net
NatSim stands for „*Nat*ural Science *Sim*ulations"

NatSim.net. Additional features: A footer is added to the html page that contains a link to the original site (see 3. Copyright issues) and there are zip/exe download options for students that refer to the modified page but will include all resource files from the original server as well.

2.3 Editing web pages

An html file can either be displayed in a browser or it can be edited in an editor program. A plain text editor like Windows Notepad would display the html formatting tags, e.g. `<b>` and `</b>` for a bold font, which is certainly confusing for beginners. Specialised web editors like Namo, Dreamweaver, Frontpage etc. make it possible to edit the page as comfortably as teachers know it from any text-processing programme. In fact, it is also possible to edit web pages in Microsoft's Word, although it has some downsides to it. The html code, as it would appear in a plain text editor, is significantly inflated and hardly readable. And teachers must be careful not to delete accidentally the tiny icon that represents the simulation itself – where other web editors would feature an empty frame. But for most teachers working with Word is the most natural starting point, for they should focus on web-based teaching rather than on web technology.

About 40% of the web pages in the database of *NatSim-Search* contain Physlets™, the applets from Davidson College. With Physlets, teachers cannot only control the web page but also the simulation itself and the text that appears inside the simulation area. The configuration of Physlets is usually performed in a plain text view where the JavaScript sections of the html code become visible (see 2.7).

2.4 NatSim light

Most teachers would not know how to publish their own web pages on the Internet. In many cases, there is no web server at their school or they feel not competent enough to use it. And they would not know how to take advantage from free or low-cost web space on commercial or educational servers. For many teachers, managing the interlinked html and resource files may seem more difficult than it actually is. Or they simply wouldn't know where to begin.

The service *NatSim light* overcomes this hurdle by offering a simple web form with a browse button to upload any html file from the teacher's computer. The system will automatically store the file on the NatSim server and will return a URL that the teacher can give his students.

Since *NatSim light* only deals with html pages, it is essential that the teacher work with the "autonomous" html files from the html-download option of *NatSim-Search* (see 2.2). This implies that the uploaded page may only contain images and simulations that are located on other web servers – With NatSim light the teacher must build on existing web pages and cannot add his own images as with more comprehensive services like *NatSim plus* (see 2.5)! The virtue of NatSim light is in the simplicity of the whole production cycle: Download a working example as a single file with *NatSim-Search*, edit it with the familiar Word text processor, and upload the modified file with a simple form in the browser.

The Features of *NatSim light*:

- The web space of NatSim light is organised by language. Up to now, there is an English, a German and a Dutch interface – but further suggestions are welcome. All teachers of a given language group could in principle edit and delete each other's pages – but probably not by mistake.
- If no project name is entered all uploaded pages go into a *temporary folder* and will be automatically deleted after a while. Thus, newcomers can test the system right away with no worries about leaving unwanted traces.
- Typing in an arbitrary folder name before uploading will either create a new web folder ("*project*") or will send the file to an existing collection of pages. It is thus possible to add pages to the project of a colleague. But no files can be overwritten this way, for they are automatically renamed in case of a name conflict.
- To delete a NatSim light page, its URL ("http://…") must be inserted into a dedicated field in the upload form.
- Every project has its own index page that lists all pages in the collection by their title. If no title is typed in before uploading a title will be extracted from the html page, or otherwise the file name will be used. A title cannot be modified afterwards, but it is very easy to upload the same page again and then delete the older version. The teacher can also leave a note for the students on the index page, for example, what activity to do next.
- Every index page must contain a valid e-mail address and the name of a person that feels responsible for the project. Otherwise the whole project will be deleted after a couple of days. This is to clear the system from abandoned test folders and to enforce copyright responsibility. The e-mail address will also be used to inform teachers about broken links and activities in the NatSim forums (see 2.6). It is protected against automated e-mail address hunting.
- Every index page should display some information about the school, the project, the students etc.

- (Advanced topic) In the case of Physlets™, which are configured by JavaScript, all necessary resource files are transferred from the original site to the NatSim server. This is because the Mozilla/Netscape browser will not execute JavaScript commands upon applets that are loaded from another server ("Same Origin Policy").

2.5 NatSim plus (advanced topic)

NatSim plus is an extended web hosting service based on the open-source content management system *CWFM*[8]. Teachers use their web browser to upload any file or whole folder structures in a single zip-compressed file to the NatSim web server, where they are deployed. This could also be the zip-downloads with simulation pages from *NatSim-Search* in which case the dependency on third party servers ends (but see 3. for copyright issues).

The web interface for the NatSim plus can easily be translated into other languages9. The teacher, who uses it, should know how to set up web pages. NatSim plus is thus intended for those who reached the limits of the *NatSim light* system and who are motivated to learn more about web site building. This service is comparable to what regular providers offer, but the threshold to try it out should be lower. An e-mail to NatSim.net with some information about the teacher and his/her intention is sufficient to find access to the NatSim plus system. The new web pages shall however contain simulations or other multimedia applications for Natural Science teaching. They must not be used for commercial purposes and their author must respond to copyright claims concerning his/her pages.

2.6 NatSim Forum

The users of NatSim.net are encouraged to exchange their educational ideas and to consult each other about technical issues. According to the language groups of *NatSim light* there is one discussion forum for each language. It is a well-know problem with web based discussion forums that, if they are not frequented for a while, they will die out because no one will check in for new messages anymore. To prevent this problem, *NatSim Forum* is built on the old Internet standard of (local) newsgroups. This way, the messages can be retrieved via common e-mail clients such as Netscape Messenger or Microsoft Outlook. Teachers, who read their e-mail with these programs, will automatically receive new messages from NatSim Forum. These messages appear separated from the regular e-mails and in a structured manner as threads, i.e. answers to previous messages are indented.

Teachers who don't use such e-mail clients can still access the NatSim Forum on the web. In order to reach these persons after a period of silence, a weekly e-mail digest will inform all registered users as soon as new messages appear.

2.7 Physlet scriptors (advanced topic)

Physlets™ from Wolfgang Christian at Davidson College are a collection of about 40 applets that are designed for teachers who want to shape not only the text around the simulation but also the simulation itself. They might, for instance, want to set-up their own combination of optical devices on an optical bench, or they want arbitrary objects to move according to specified force laws.

The trick with Physlets is that even without having access to the Java programming code of the applets, it is possible to determine their behaviour by adding a few lines of JavaScript on the web page. The applet-specific statements ("methods") are often self-explaining like:

```
addObject("lens","x=0,f=1.5")
```

It is sufficient to know the most common features of a given Physlet to set up countless activities with this one particular applet. Hence, a teacher would not need to learn JavaScript as a general programming language.

So far, this has nothing to do with NatSim.net. Physlets are established as a pedagogical tool for years now, and there is a huge collection of Physlet activities for all kinds of Physics teaching10. But up to now, most Physlet activities have been invented by U.S.-American university staff, whereas NatSim.net tries to make European high school teachers aware of this technology. For motivational reasons – in order to give them a rapid first success – NatSim.net features a suite of so-called Physlet scriptors that generate ready-to-use Physlet web pages within a web browser.

Rather than confronting teachers with the confusing html source code and the lengthy documentation of all possible methods of a given Physlet, they'll find a table with some information about the most prominent features of this applet. A mouse click on such a feature, e.g. "Add lens" makes the browser show a running applet that displays a new lens. In addition to this, it will display the correspondent JavaScript code – similar to the example in the text above. It is also possible to edit this generated JavaScript directly and to watch its effect on the applet.

Thus, Physlet scriptors are meant to serve as interactive documentation for the Physlet applets. From a glance into the generated html code one learns how to write a Physlet page manually. Scriptors also help

8 Comet WebFileManager, (http://cwfm.sourceforge.net)
9 The NatSim plus interface is already available in: English, German, Italian, Polish, Dutch, Brazilian Potruguese, Indonesian

10 Physlet homepage of Davidson College: http://webphysics.davidson.edu/applets/applets.html

implementing advanced features like having two Physlets that interact with each other on a single web page, e.g. a moving object in one applet (*Animator*) and its velocity-time graph in the other (*DataGraph*). Furthermore, scriptors can insert input fields for students into the web page, and push buttons to launch different configuration scripts on one applet one after another.

At present, scriptors are available only for some of the most popular Physlets, and only in English. But more Physlet scriptors can be created, or modified, or translated within a few hours by using the free NatSim tool *MetaBuilder*.

3 Copyright issues

Teachers who build their web pages on material that they have found on the Internet must be aware of the intellectual property of the original authors. NatSim is based on the assumption that most authors of scientific web simulations would like to see their products proliferate for the sake of education. But it is clear that NatSim could not afford any legal disputes over copyrighted material. Objections from authors, which cannot be settled by amending the pages in question, will force NatSim to take these pages off-line. By lack of competence, this article contains no legal advice, but rather gives the technical background to foresee the pitfalls.

I can see two different features of a web based simulation where copyright could be violated: Firstly, the simulation program itself that is encapsulated in resource files (jar, class, swf, dcr, …) and secondly, the web page in which the simulation is embedded, containing the text for educational activities, and possibly images and specific lay-out features (html, gif, jpeg, css, js…). As a consequence, we need to distinguish the author of the simulation, e.g. the programmer, and the author of the web page. This is particularly true with NatSim.net where teachers write new web pages around simulations that they found elsewhere on the Internet.

Some authors of web simulations would ask money for calling their programs from other computers than their own web server. Especially NatSim download links for students that are automatically added to the teachers' pages by *NatSim-Search* and *NatSim light* could be problematic. Other authors may not consent to presenting their simulation in a different context without further notice. But in most cases the authors of simulation programmes and/or the respective web pages are teachers themselves and will gladly see their work reused by colleagues. For example, teachers can use the popular Physlet™ simulation programs on their *own*[11] web pages for non-commercial purposes as long as they display a hyperlink to the Physlet homepage at Davidson College[5].

NatSim light does not store any files of simulation programmes or images; they will be recalled from the original server each time the web page is displayed. This technique may resolve some copyright issues – depending on national legal practice – but it takes some bandwidth from the original server, which sometimes is considered problematic from a legal point of view. Practically, the traffic caused by individual *NatSim light* pages should be negligible though.

In any case, NatSim users are strongly advised to observe the following rules:

- Try to find copyright regulations on the original web site[12].
- If no copyright information is available, try to contact the author of the original site.
- Always give credits to the original authors. Provide a hyperlink to the their web page. Such a link is inserted automatically by the html download option from *NatSim-Search.*

Conclusions

The NatSim.net services help teachers to focus on pedagogics rather than on technical issues when they start teaching with web-based simulations. Furthermore, the tools are designed to flatten the learning curve for those who seek advanced control over their web pages and – with Physlets – over the simulations themselves. Teachers are invited to exchange their ideas in the NatSim forums. New language groups can be added on request.

Copyright issues could in principle undermine the whole idea of NatSim.net. But we hope that these concerns can be resolved in a constructive manner with the authors for the sake of Science Education.

References

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[3] W. CHRISTIAN, M.BELLONI. *Physlet Physics: Interactive Illustrations, Explorations and Problems for Introductory Physics.* Prentice Hall, 2003, ISBN 0131019694

11 Caution: The specific JavaScript configuration for a given Physlet activity, see 2.7, belongs to the surrounding web page and has its own copyright on it! But in practice, this is only problematic with web pages that are found in the context of commercial products such as printed books that feature Physlets.

12 From a given URL it is sometimes possible to find other pages from the same site by deleting the URL successively backwards from slash to slash.