# UWE AND OOWS: A COMPARATIVE APPROACH OF NAVIGATION MODELS FOR WEB ENGINEERING

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**Abstract:** With the increasing emergence of technologies that make use of the Internet, the need for methodologies that would help the development of applications for the web emerged. Researchers and developers in order to meet this lack proposed methodologies based on Software Engineering, creating a subarea of it, called web engineering. This work aims to compare two of these methods, known as UWE (UML Web Engineering) and OOWS (Object Oriented Web Solution). They define their own notation for modeling, which often run the same concepts. The study was conducted under a qualitative approach, seeking information through educational materials analysis, systematic review articles and monographs, which were starting tool for the study of comparative case method. Thus it was found, by building a navigational model, which methods have very similar concepts, being differentiated on how these concepts are represented. It was also found that the UWE method is more concerned with the structure of modeling, while the OOWS method prioritizes the functional system requirements.

**Keywords:** UWE, OOWS, web engineering, navigation model.

## 1. INTRODUCTION

With the increased use and ease of access to the Internet, the use of web applications has raised significantly, contributing to a migration of existing applications to the web platform (Souza, 2008). Due to the high growth of commercial activities on the Internet, these systems are being implemented in short periods of time, without having appropriate support tools.

Given this lack of a better systematization, researchers and developers have proposed methodologies for the development of web applications based on Software Engineering, giving a new impetus to existing processes, leading to a new subarea of software engineering, web engineering (Murugesan et al., 2001), which maintains the goal of applying engineering principles to develop quality web applications. Similar to the conventional software engineering, its focus is on how to develop a correct and complete application, according to user requirements.

Various methods aimed at developing web applications have been proposed and are in constant process of improvement, such as HDM (Hypertext Design Model) (Garzotto et al, 1993), RMM (Relationship Management Methodology) (Isakowitz et al, 1995), HDM-Lite (Hypertext Design Model) (Fraternali et al., 2000), OOHDM (Object Oriented Hypermedia Design Method) (Schwabe et al., 1996), WSDM (Web Site Design Method) (De Troyer et al., 2007), WAE (Web Application Extension) (Conallen, 2002), webml (Web Modeling Language) (Ceri et al., 2000), W2000 (Baresi et al., 2000), UWE (Koch et al., 2002) , WAE2 (Web Application Extension) (Conallen, 2003), OOWS (Fons et al., 2003a), OO-H (Object-Oriented Hypermedia Method)

(Gomez et al., 2001), among others. Some of these methods, in general, have similar steps, such as conceptual modeling, navigational modeling and performance modeling (Souza, 2008).

Most of these engineering methods defines its own notation for the creation of models, and in many cases, is just a notation to the same concepts. For web engineering methodologies, the major point to be considered is the navigation model, which is essential for representation of a conceptual model of an application. Thus, this work presents a comparison of the UWE and OOWS navigational models. A case study is presented, exposing their features and limitations.

## 2. BACKGROUND

### 2.1 UML Web Engineering - UWE

The UWE came up in 1998 by a web engineering group of the Ludwig-Maximilians University of Munich (Koch, 2001; Koch et al., 2002). It is an expression that uses UML itself to demonstrate new concepts not covered by this originally language. The UWE is based on stereotypes, tagged values, and constraints. It is also considered an extension (or profile) of UML 2.0, this means that, the original elements of the UML remain the same at UWE so, there is no change and all elements are referred to as extensions (mechanisms like inheritance between classes) (Atkinson et al., 2001; Koch et al, 2003).

Second (Koch, 2001), the main features of UWE modeling are:

- Supports visual and systematic modeling;
- Hypermedia questions such as content, navigation and presentation are treated separately from user modeling problems and adjustment;
- It provides a UML profile based on UML extension mechanisms.

In software engineering, there are several methods for development, each one with its annotation, but all represent the same concept and based on the same principle: conceptual and navigational modeling, and presentation. This metamodel is part listed for UWE as (Souza, 2008):

- Use Case Model to capture system requirements;
- Conceptual model to content (domain model);
- Navigation model that includes a hyperspace model navigation and a navigation structure model;
- Presentation Template that includes static and dynamic models (presentation design template, presentation flow model, user interface abstract model and object life cycle model);

The UWE navigational model can be seen as a structured view of the conceptual model and is defined in two steps (Koch, 2001):

- Navigational space model: the class diagram is used to represent which classes can be visited by web browsing.

• Navigational Structure Model: defines the application navigation. It demonstrates how the navigational objects are visited. It is necessary to use modeling elements such as guided tours, queries and index.

An item can represent an index from a menu or just a link to another class. Figure 1 shows the representation of the index and a link to a navigation class. The stereotype used for this element is <<*index*>>.

The query is a compound object from a string that performs a query. In Figure 1, the class with the stereotype <<*query*>> there is a search form, which is processed in a database, being the result passed on the class <<*index*>> to be shown later in <<*navigation class*>>.

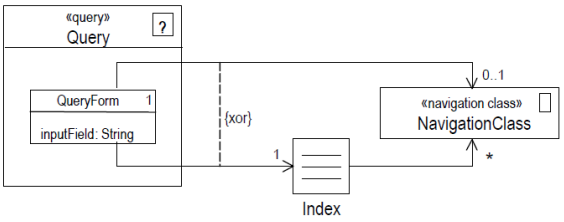


**Figure 1 - Example of index and query notation (Koch, 2001)**

A guided tour allows sequential access, which is typically used in conjunction with the <<*query*>> class. Property {ordered} which is shown in Figure 2, allows to display the data in an orderly fashion.

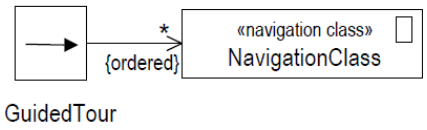


**Figure 2 - Example notation of guided tour (Koch, 2001)**

A menu is a set of items which may represent an index, a nagivation class or other navigation components.

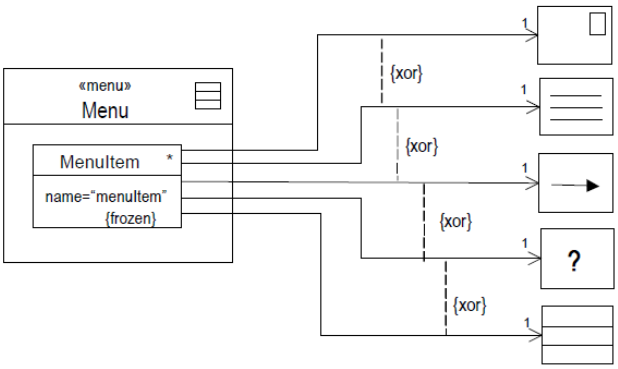


**Figure 3 – Example of menu (Koch, 2001)**

## 2.2 Object Oriented Web Solution – OOWS

Object Oriented Web Solution (OOWS is an extension of OO-Method methodology (Fons et al, 2003b; Shepherd et al., 2001). OOWS uses UML notation and was developed with the intention of allowing the specifying of a web application through an integrated framework.

Following the methodology defined by OO-Method, there are two main steps for the construction of an object-oriented system: system specification and development of the solution (Souza, 2007). The system specification involves the following steps: survey of functional requirements and conceptual modeling. The solution development phase, we seek to generate software elements that represent a technological solution for the system. At this stage, there is the system architecture definition and implementation (Souza, 2008).

In the navigation model described by OOWS, types of system users are defined. The navigation model captures the application's navigation requirements, setting a navigation map for each type of user. Its construction is divided into two stages: identification and user categorization and navigation map specification.

The map is represented by a directed graph whose vertices represent the basic unit of interaction (the navigation contexts) and the arches denote the navigation paths predefined valid. The navigation contexts (stereotyped by the reserved word <<*context*>>) allow to define a view of a set of class attributes and operations from the class diagram. Regarding accessibility, there are two types of contexts (Fons et al, 2003b.):

- Always accessible vertex (represented by the label "E") are the vertices (nodes) that are accessible from any other vertex. This context defines navigation links implied from any vertex and explicitly map the root of which is represented by the user; it is also represented by the dashed arrow. A context of exploitation can be defined as default vertex or home (represented by the label "H"). These permissions allow the user to automatically accomplish this context when connecting to the system. Such representation of stereotypes can be seen in Figure 4.

- Sequence navigation contexts (represented by the label "S") can be accessed only following a preset navigation path also being represented by the solid arrow, as can be seen in Figure 5.

When defining a complex web application, there is a need to organize and structure the navigation contexts. It has been set for the OOWS navigation model as a new primitive: the navigation subsystem. Navigation subsystems (stereotyped by the reserved word <<*subsystem*>>) allow represent a logical group of contexts and other navigation subsystems that share the same navigational properties (Figure 4). It is also represented as a navigation map, which is active when the user navigates to the subsystem (Figure 5) (Fons et al., 2003b).

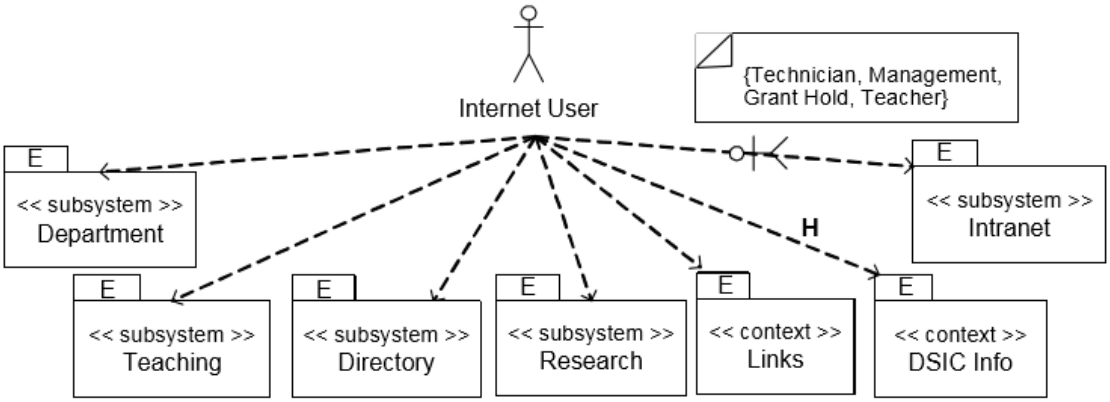


**Figure 4 – Exemple of a navegacional map (Fons et al., 2003b)**

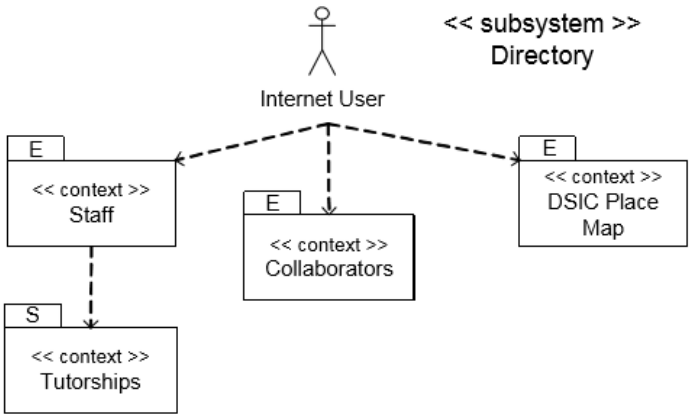


**Figure 5 – Navigational Map for de Directory Subsystem (Fons et al., 2003b)**

## 3. MATERIALS AND METHODS

A qualitative approach was used to develop the case study. Data collected are descriptive in its entirety, in order to discover and understand the functioning of UWE and OOWS methods.

The teaching materials analysis, systematic review articles and monographs were data collection instruments for the research. For the data, analysis was carried out the study of comparative case, which seeks to show the advantages and disadvantages of using each method.

To build the navigation model has been chosen the Ponta Grossa State University (UEPG) website, and the same is extremely important as it provides access to other pages of the institution. In preparing the navigation diagram for OOWS method, first there is the need to define the types of system users, which were: Internet user (which was used to be a generic user and allow a better comparison with the model

navigational the UWE, for which you do not need categorization of users), academic server (teacher or college Agent).

They were not explored all page information because it contains a very high level of detail, which would make the very extensive navigation map and difficult to understand. OOWS method for navigation contexts were selected representing best way the Internet user (given that the UWE method has no characterization users in navigational modeling), and also it was possible to show all components of navigational modeling

## 4. RESULTS AND DISCUSSION

Figure 6 represents the subdivision adopted in the UEPG page to make the case studies and their comparison.

Figure 7 shows the navigational structure model. The web page is represented using the stereotype <<*menu*>> and from there you can navigate between menus.

Analyzing each subdivision in Table 1 with Figure 7, it can be observed:

- Header: access is possible only by navigation classes, such as UEPG sites, addresses, among others;
- Left menu: You can expand the menus Systems, Institutional Education and the other menus; this subdivision is used to represent a class query search, which will be processed and presented in a navigation class;
- Center: there is the stereotypes index and query; to represent the slide image, links were used. Another way of representing the slides would be to use a class query to see which images should be shown that day. After this check in the database, you should use the guidedtour class to view the navigation class. To check the latest news to be shown, we used the query class, but as for the slides you can use the guidedtour to display in an orderly fashion or not these latest news;

Right 1: has our news and notices, which are links redirecting to pages containing news or notices that are open. Events are represented by the class query, which conducts research in the database and returns the open events.

- Right 2: are links that will display content according to each page.
- Footer: it can be seen that Twitter UEPG and the state of Paraná website is not part of the UEPG system are external elements being represented by the class externalLink.


**Figure 6: Main page for UEPG website (http://uepg.br)**

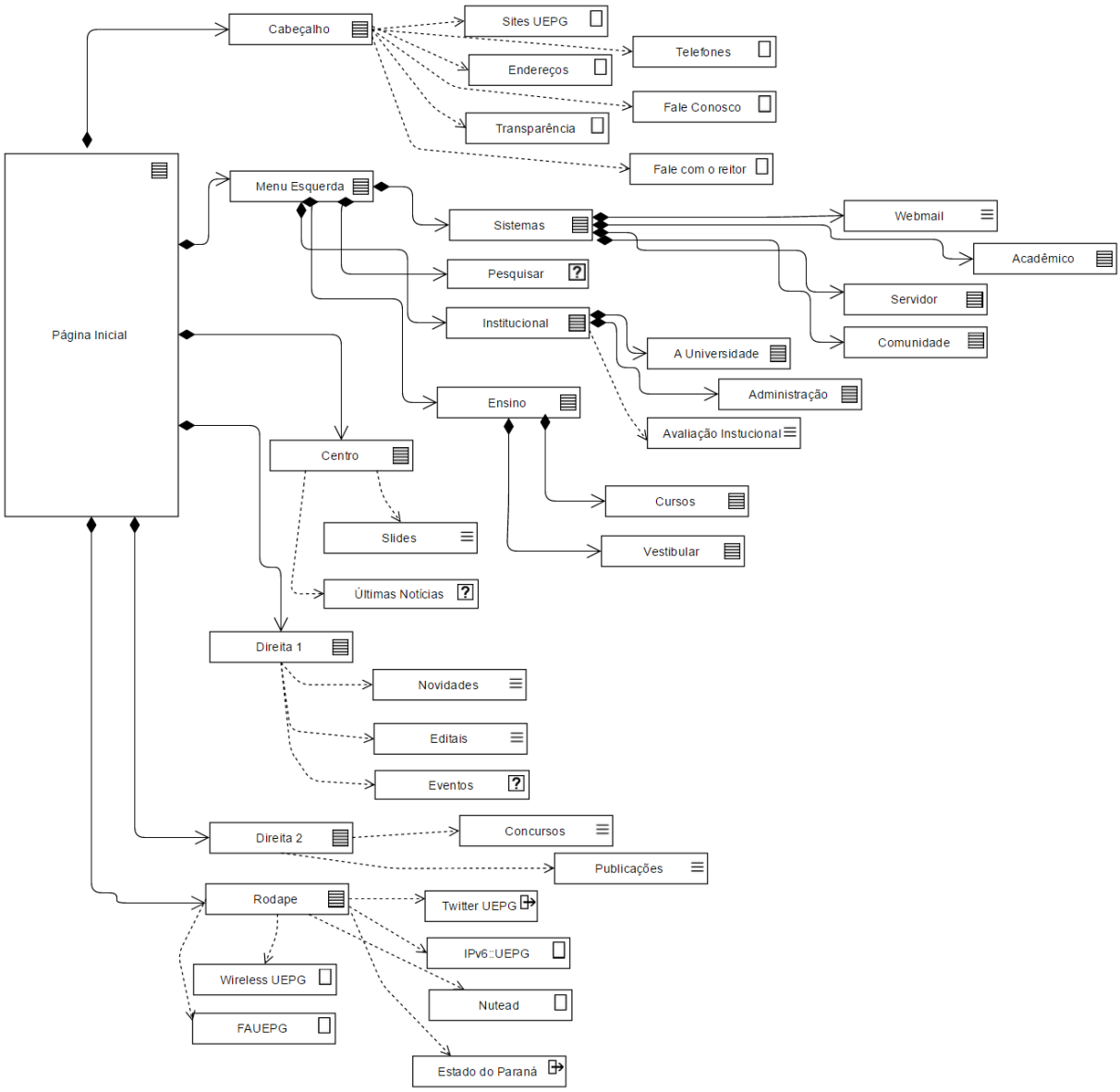


**Figure 7: Structural Model for UWE method**

Table 1 - Representation of the UWE navigation model

| Subdivision | Allow Access |
|---|---|
| **Header** <<***menu***>> | • Sites UEPG <<*navigationclass*>><br>• Endereços <<*navigationclass*>><br>• Transparência <<*navigationclass*>><br>• Telefones <<*navigationclass*>><br>• Fale conosco <<*navigationclass*>><br>• Fale com reitor <<*navigationclass*>> |
| **Left menu** <<***menu***>> | • Sistemas <<*menu*>><br>• Pesquisar <<*query*>><br>• Institucional <<*menu*>><br>• Ensino <<*menu*>> |

| | |
|---|---|
| **Center <<*menu*>>** | • Slides <<*index*>><br>• Últimas notícias <<*query*>> |
| **Right 1 <<*menu*>>** | • Novidades <<*index*>><br>• Editais <<*index*>><br>• Eventos <<*query*>> |
| **Right 2 <<*menu*>>** | • Concursos <<*index*>><br>• Publicações <<*index*>> |
| **Footer <<*menu*>>** | • Twitter UEPG <<*externalLink*>><br>• IPv6: UEPG <<*navigationclass*>><br>• Nutead <<*navigationclass*>><br>• Wireless UEPG <<*navigationclass*>><br>• FAUEPG <<*navigationclass*>><br>• Estado do Paraná <<*externalLink*>> |

Figure 8 presents the modeling of the OOWS model navigation map. It is possible to check through the navigation map vertices that can be accessed by the Internet user, which would be different if they used other types of user, as each may have restrictions and / or different permissions.

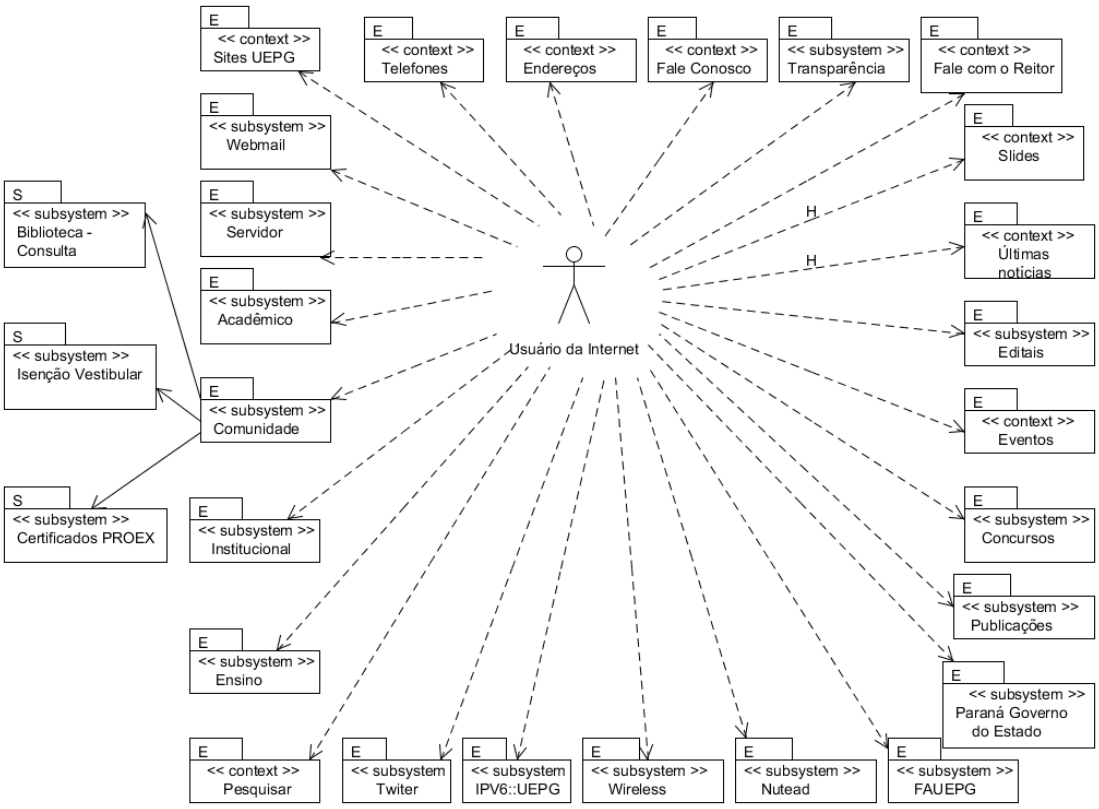


**Figura 8: Navigational Map for the Internet User**

The dashed arrow present between the internet user and contexts (<<*context*>>) and subsystems (subsystem <<*subsystem*>>) navigation in Figure 8 indicates that when the user accesses the system page, the vertices are always accessible . It can be verified that the label "E" also indicates that property navigation model, as both are present in

navigation links as navigation subsystems as the Academic navigation subsystems and Twiter, navigation contexts UEPG and Events Sites, etc.

The navigation subsystems Inquiry Library, Vestibular exemption, PROEX Certificate (Figure 8), the solid arrow with the label "S" indicates that these subsystems can only be accessed from a navigation sequence. This result is explained by the fact that the user having to press the Community option in the left menu in order to access the options present in the submenu.

As can be seen in the navigation contexts Slides and Latest News (Figure 8), in addition to the aforementioned elements, the label "H" is present on the dashed arrow. This indicates that these contexts are considered as the home page; they represent information and news about the institution and can always be viewed in the system homepage.

Analyzing the previous statements, both methods have a particularly like structure and represent, clearly, what the sequence of which can be accessed on the page. Based on the construction of navigation models of each method, it was possible to see which classes stereotypes that are supported on both. In Table 2, it is observed that to represent an image in the image UWE method uses the class. For OOWS method is represented with the reserved word view. For comparison stereotype of each method exposed in Table 2, the subdivision performed in Figure 6 was used.

Table 2 - Comparison of the stereotype of each method based on the subdivision adopted in Figure 6.

| Number | Page Content | UWE Stereotype | OOWS Stereotype |
|---|---|---|---|
| **1** | Cabeçalho | *menu* | Não suportado |
| **2** | Logo UEPG1 | *image* | *view* |
| **3** | Logo UEPG2 | *image* | *view* |
| **4** | Cabeçalho Sites UEPG | *Navigation Class* | *context* |
| **5** | Cabeçalho Telefones | *Navigation Class* | *context* |
| **6** | Cabeçalho Endereços | *Navigation Class* | *context* |
| **7** | Cabeçalho Fale Conosco | *Navigation Class* | *context* |
| **8** | Cabeçalho Transparência | *Navigation Class* | *context* |
| **9** | Cabeçalho Fale com o Reitor | *Navigation Class* | *context* |
| **10** | Menu Sistemas | *menu* | *subsystem* |
| **11** | Menu Institucional | *menu* | *subsystem* |
| **12** | Menu Ensino | *menu* | *subsystem* |
| **13** | Pesquisar | *query* | *filter* |
| **14** | Ultimas notícias | *query* | *filter* |
| **15** | Slides | *index* | *view* |
| **16** | Novidades | *index* | *context* |
| **17** | Editais | *index* | *context* |

| | | | |
|---|---|---|---|
| **18** | Eventos | *query* | *filter* |
| **19** | Concursos | *index* | *context* |
| **20** | Publicações | *index* | *context* |
| **21** | Rodape | *menu* | Não suportado |
| **22** | Rodape Twitter UEPG | *externalLink* | *subsystem* |
| **23** | Rodape IPv6 | *Navigation Class* | *context* |
| **24** | Rodape Wireless UEPG | *Navigation Class* | *context* |
| **25** | Nutead | *Navigation Class* | *context* |
| **26** | Rodape FAUEPG | *Navigation Class* | *context* |
| **27** | Estado do Paraná | *externalLink* | *subsystem* |

In Table 2, Figure 7 and Figure 8, we found that the UWE navigation model is initially concerned about the page structure: the way the elements are arranged and how they can be represented. In contrast, the OOWS navigation model is concerned with the functionality of the system, emphasizing the determination of what type of users are possible, who can access it, and also which parts of the system can be accessed for each type of user.

Based on bibliographic research, we found that the method proposed OOWS non-standard extensions to UML, hindering their use by organizations that do not have tools CASE (Computer Aided Software Engineering) specific to the method. The UWE stands out for already own a CASE tool that supports UML (ArgoUWE). On the other hand, both have some characteristics that are very important for web applications, such as a strategy for code generation from the models and their elements.

## 5. CONCLUSION

Analyzing the UWE and OOWS navigational model, was observed that UWE method is concerned with the structure of system pages, having a well-defined representation of each component. On the other hand, the OOWS method is concerned with the types of system users, and also what each user can access; the OOWS method prioritizes the functionalities.

It can be said that both models are efficient, as they become aid tools in the development of web applications. Also, it can be seen that using any one of them can reach a final systematic application in order to follow a sequence of clear and objective modeling.

The use of these methods, in combination, can bring many benefits in the development of a web application. This is due to the unique characteristics of each, which can result in an application containing structure and well-defined features and a high level of detail.

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