ABSTRACT

New web technologies have enabled online education to take on a massive scale, prompting many universities to create massively open online courses (MOOCs) that take advantage of these technologies. However, the design of MOOCs is anything but trivial. To design an effective MOOC, instructors need to integrate both pedagogical and information systems theory. In this paper, we identify five principles for designing MOOCs that result from these foundations. We then illustrate how these principles were used for making decisions about technological and pedagogical components in a collaborative grant for a MOOC in economic development.

KEYWORDS: Online education, theory development, instructional design, MOOC

INTRODUCTION

MOOCs (massive open online courses) have been attracting attention worldwide, enrolling thousands of students in hundreds of courses using various technology platforms. While early courses have been primarily designed for baccalaureate level subjects, the massive, open, and online nature of these courses has also attracted the attention of K-12 educators looking to enhance curricular options for younger students as well as post-graduate programs seeking to enhance advanced studies by attracting the top scholars in the field in one centralized location. Because of newer Internet technologies, the cost of creating these courses has plummeted, allowing MOOCs to provide their content for free to any student with Internet access. For cash-strapped schools, such free offerings can help administrators supplement course offerings not normally available to students or those with insufficient enrollment to justify assigning a teacher.

Student attrition in MOOCs has been high, suggesting that the goals of students may not be aligned with MOOC goals. Many innovative techniques and tools to interact with and retain students have been tried, from discussion forums, badges, and interactive tools, to self-assessments, peer assessments, and automated grading. Undoubtedly, innovation will continue at a furious pace as educators seek ways to present materials and inspire learning in ever more effective ways. Given the vast and ever changing technological opportunities available for course integration, course designers may find it difficult to judge what technologies to incorporate into MOOCs and the impact that those technologies will have on student learning.
The many challenges of online learning – for students, instructors and administrators – have been researched and discussed many times (Crawford-Ferre & Wiest, 2012; Shelton & Saltsman, 2005). Online, however, is only one word in the MOOC title. Because of the massive scale and open nature of MOOCs, not only are these challenges often magnified – an entirely different set of considerations must be adopted to set up the course for success. The massive nature of the course, for example, ensures that instructor interaction with students will necessarily be limited due to the limitations of time and energy of the instructor. Yet research clearly demonstrates that interaction with the instructor is a critical success factor in online courses (Soong, Chan, Chua, & Loh, 2001). Because humans are social creatures and social activities can enhance learning, the more interactions students can experience the vaster their learning opportunities. When collaboration mixes people with varying levels of expertise, experience and knowledge, learning is enhanced (Bellamy, 1996). Furthermore, design choices that could easily be adjusted in small classes, cannot be modified at a massive scale without significant disruption that may result in extensive dissatisfaction from the students. Given issues involved with developing MOOCs, a set of guiding principles would help instructors and course designers make better decisions in building and managing course content, technologies, process, organizational structure, and administration.

We propose that five principles are applicable for all MOOC development projects, based on pedagogical and information systems theory. These principles are that the MOOCs should be meaningful, engaging, measurable, accessible, and scalable. Below, we detail how pedagogical theory and information systems theory helped guide the identification of the principles. We then detail what those five principles mean for MOOC development projects. Lastly, we illustrate how these five principles guided decision making in a successful grant proposal for a new MOOC in economic development.

LITERATURE REVIEW

Pedagogical Theory

In his classic Assimilation Learning Theory, David Ausubel developed a cognitive view of education that emphasized conceptual development in learning (Ausubel, 1968). In this theory, learning takes place on a continuum from meaningful, deep understanding of newly presented concepts to shallow, rote memorization of concepts. When concepts are learned in a meaningful manner, they persist in memory for longer periods of time, can be applied to new problems and contexts, enable differentiability of related materials, and improve the capacity to learn unrelated subjects (Novak, 2010). Moreover, concepts learned this way approach the upper levels of learning in Bloom’s Taxonomy as they enable analyzing, evaluating and creating new knowledge (Krathwohl, 2002). When concepts are learned in a rote manner, they persist in memory for shorter periods of time, cannot be applied to new contexts, are not differentiable, and are unhelpful in learning unrelated subjects. This rote learning would correspond more closely to the lower levels of Bloom Taxonomy: remembering, understanding and applying. Meaningful learning of concepts takes place when four things happen, 1) when concepts are clearly defined, 2) when clear exemplars are provided that tie concepts to reality, 3) when concepts are integrated with existing knowledge, and 4) when students are properly motivated to learn the topic (Novak, 2010).

While the first and second criteria for meaningful learning are relatively straight forward for most instructors, integrating concepts with existing knowledge and motivating students are often more challenging and problematic. Ausubel stressed the third criteria when he argued that one of the most important factors for developing meaningful course materials is knowing the knowledge of
students before they start the class. This continues throughout the course, as instructors must continuously assess the learning of new concepts when they build upon prior course concepts. This assessment should allow both the student and the instructor to adjust. Students should be able to re-consume the course content they did not understand and the instructor should adjust the course content that was not well received.

It is important to note that meaningful learning is not synonymous with active learning. Novak argued that the two should be viewed as orthogonal (Novak, 2002). Active learning, while championed as a technique for overcoming boring lectures, can induce rote learning in ways similar to lectures. The temptation to rely on active learning puts the wrong emphasis on the course (Drake, 2012). Active learning excels when it stimulates cognitive engagement with the course topics (Mayer, 2004). While cognitive engagement is critical for learning, many students crave social engagement as well. The interaction with other students helps keep motivation levels high, inducing continuous learning.

**MOOCs and Information Systems Theory**

Higher Education can be viewed as a socio-technical system (STS) (Watson, Boudreau, York, & Greiner, 2008). Every organization can be thought of as having two sub-systems: the social and the technical (See Table 1). The social system comprises people and structure; the technical system comprises technology and task. Attributes of people (such as their attitudes, skills and values), as well as reward and authority structures are among the concerns of the social system while the technology that drives task accomplishment are the concerns of the technical system (O’Hara, Watson, & Kavan, 1999). To optimize the entire system, STS design seeks to maximize the interaction of the two subsystems and their components. In a course environment, we are concerned with faculty and students, the structure of their interaction and the reward system (grades) for students. The tasks are teaching and learning and the technologies run the gamut from a blackboard to a tablet with everything in between.

<table>
<thead>
<tr>
<th>SOCIAL SYSTEM</th>
<th>TECHNICAL SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>Structure (Interaction &amp; Grades)</td>
<td>Technology (All)</td>
</tr>
<tr>
<td>People (Faculty &amp; Students)</td>
<td>Tasks (Teaching &amp; Learning)</td>
</tr>
</tbody>
</table>

When any new technology is introduced into a social system, three levels of change can result - automating or alpha changes, informing or beta changes, and transforming or gamma changes (O’Hara et al., 1999). When the main impact of a new technology is the only or primarily the task, it is considered an automating or alpha level change. These new technologies automate existing processes and tasks, but have limited impact on people and their roles within the organization. Informing or beta change occurs when the people interacting with the technology change their roles and their tasks. These types of technologies inform the people in unique ways, enabling decisions and alternative tasks not available prior to the technology. When new technology impacts the social structure, the interaction between individuals radically transforms the social system.

In higher education, when Learning Management Systems were introduced, they automated many activities performed by students and their instructors. Assignments, for example, could be submitted electronically and syllabi could be delivered and viewed that way as well. Such automation could also be accomplished with other technologies. For example, in large classes, clickers greatly automate checking attendance.
When distance education and its associated technologies came to the fore, the change not only automated the delivery of instruction, but also changed the relationship between the instructor and students. No longer were students and instructors locked into fixed times for class meetings; no longer were they tied to a specific geographic location; and no longer would they necessarily recognize each other on sight. This indicates a beta level change, as both the task and the individuals involved were affected. Flipping the classroom is another example of this type of change. In effect, the roles of the instructor and the students are reversed.

With the advent of MOOCs, a transformative change may be occurring. MOOCs do not just automate instruction; they do not just change the roles and relationships of those involved; they may change the infrastructure and landscape of higher education. First, many MOOCs introduce peer grading, which allows students (usually two) to grade the work of other students. While student team members have been evaluating teammate performance for some time, the instructor is typically involved in issuing a final grade for an assignment. With MOOC, the peer grading is often the final grade.

Second, as the “M” in the name indicates, MOOCs often have massive enrollments. These large enrollments transform the relationship between instructor and student so that personalized – or even small group – interaction with the instructor is not likely. Instead, student interaction within discussion forums or wikis can add value to the course through the construction of new content. This can allow MOOCs to develop new content over time, without direct instructor input. Students police the forums and wikis themselves by reporting misuse, editing other student input, and voting on posts they like.

Finally, indirectly, MOOCs are transforming higher education. Their arrival on the scene of the traditional campus has caused instructors, administrators and students to re-examine the structure and future of the university. While the future of MOOCs may be questionable, there is little doubt that their appearance and potential to disrupt has awakened many in academe (Baggaley, 2014; Waters, 2014).

THEORY DEVELOPMENT

While synthesizing these pedagogical and information systems theories, five principles were discovered that could guide the design and development of MOOCs such that instructors can achieve the better impact with course materials. These five principles – meaningful, engaging, measurable, accessible, and scalable – provide a decision-making framework that is applicable across disciplines. Below we articulate each principle and how it can apply to decisions.

Meaningful

While virtually all instructors strive to create meaningful content, it is easy to make mistakes such as presenting too many ideas without integrating them, introducing irrelevant topics, presenting ideas in a confusing order, providing insufficient examples or examples students cannot relate to, or introducing boring material uninspiring to students. In smaller classes, any of these mistakes can be identified through direct dialog with the students. When working on a massive scale, these same mistakes are much more difficult to catch or avoid.

A variety of tools and techniques exists to facilitate meaningful learning in a MOOC, including cognitive and meta-cognitive prompts, short distilled lectures focusing on single topics, study guides, concept maps, and self-assessment quizzes. Even discussion boards can induce meaningful learning by encouraging more experienced students to share examples with the less
experienced students, thereby helping all the students to integrate the ideas in a more holistic fashion. The primary value in focusing on meaningful learning, however, is that it helps the course designer put the student’s learning first, and keeps MOOCs with their corresponding capabilities as secondary concerns.

**Engaging**

Although it may be tempting to include engaging as a sub-topic of meaningful learning, it deserves special attention when working on a massive scale. Consider that high attrition rates in MOOCs are often considered norm. It is not uncommon for fewer than 5% of the total students signed up for a course to finish that course (Daniel, 2012). Even if thousands of students signup, only hundreds may complete all of the course content. This may not mean that the course was a failure; however as students may take the course for any number of reasons, and a completion certificate may not be one of them (MOOC Forum, 2013). However, the fact remains that MOOCs present a challenge in engaging students because of their massive size. Instructors do not have the energy and time to interact with students in the same way they can in smaller classes.

Engagement can be accomplished with traditional education techniques, including lectures, but careful attention should be paid to best practices in these techniques in order to elicit the best effect. Lecture videos should be kept short (Sugar, Brown, & Luterbach, 2010). Jokes and colloquialisms may be lost on students from different cultures. Immediate feedback should be given on student work through automated grading. Interaction with fellow students can be facilitated through discussion forums or virtual chat rooms. Instructors can also enhance engagement with automated email messages and reminders.

**Measurable**

Measuring student progress and course material effectiveness is a staple for course development of all types. But in MOOCs, the massive size allows for and calls for vastly more precise evaluations and assessment, unavailable in smaller class sizes. The massive size of MOOCs creates a massive amount of data which, coupled with the technology inherent with MOOCs, allows for more precise evaluation of course efficacy. Furthermore, because everything is done online, every action made on the platform can be tracked. With appropriate analysis, two forms of measurement improvements become available – first from the students’ perspective as they track their own progress, and second from the instructor’s perspective when viewing progress of the students.

Many MOOCs provide progress splash screens that display feedback on course accomplishments, from completion of homework assignments to passing quizzes and exams. With massive sample sizes, statistical analysis such as means and standard deviations become useful benchmarks. In discussion forums, up or down voting threads and comments provides quick measurements of student interest, allowing students to focus more quickly on good and interesting ideas. The massive number of samples allows artificial intelligence programs to better evaluate student homework and provides instant feedback.

Given the size of the class, it is easy for instructors to lose touch with the effectiveness of course content. Measurability puts some of that touch back in the hands of instructors so they can adjust content to be more effective. Instructors can see quantifiable evidence regarding which discussion questions gained the most interest. They can view which content items were viewed most often, even being able to see if the same video was viewed more than once.
Statistics software can be used to relate success on the exam with various factors in students and their usage of class materials. Furthermore, instructors can continuously monitor and research learning goal outcomes to provide immediate feedback during the course.

**Accessible**

Because of the open nature of MOOCs, students of all sorts can join the class. The level of knowledge of students varies dramatically. Students may range from high school students to PhDs. Some join the course to learn a brand new subject, while others join to brush up on an area with which they are already familiar. Some students join to learn skills for a job; others join for the pure joy of learning something new. While some students may have high bandwidth Internet connections, many still work with low bandwidth connections. Students may prefer various methods of presenting content or suffer from a variety of disabilities. It is impossible to address all the variations, nor is it recommended, but placing an emphasis on accessibility is necessary for satisfying truly massive numbers of students.

There are a number of things that can be done to enhance accessibility. For example, many MOOCs have no pre-requisites. Given the large variety of skill levels and experience of potential students, this may not be entirely warranted. There may be some assumptions on ability to read or write or some base understanding of science in general. To overcome these limitations, scaffolding of materials may help students of all skill levels maximize their learning (Hogan & Pressley, 1997). Another option might be to supplement video lectures with audio only or transcripts for low bandwidth consumption.

**Scalable**

To achieve massive scale, a course should be designed for thousands of students through the use of automated systems. While this assumption was implicit in much of the discussion above, it warrants its own discussion because of its importance to the concept of MOOCs. Scalable systems have the capability of growing from small to large with only minimal adjustments. This necessarily prohibits certain types of classroom structures and techniques. Classes that depend heavily on classroom discussion may find massive online discussion chaotic and disorderly (McGuire, 2013). Instructors may find it difficult to personally diagnose conceptual misunderstandings and to correct them.

Effective design of MOOCs requires scalability and such scalability is achievable through automated systems enabled by Internet technologies. To enable scalability, instructors should be limited to three points of contact throughout the course – 1) creating content, 2) managing operations, and 3) assessing student progress. Although teaching assistants can be added as attendance grows, there are limits to the number of teaching assistants that can be effectively utilized. Given that MOOCs are free, that also creates a financial incentive to ensure scalability.

**ILLUSTRATIVE CASE STUDY**

**The MOOC grant**

In July of 2013, the University of North Carolina System issued a request for proposals (RFP) to develop a MOOC on the theme of emerging economies. As part of the UNC System’s strategic priority “to leverage technology to enhance student learning and strengthen academic equality,” a key objective of the UNC MOOC RFP was to assess opportunities and limitations of the
MOOC format for delivering high quality education with measurable student learning outcomes (UNC General Administration, 2013).

The RFP included three features that distinguish this MOOC from others that had been developed. The developed course would be offered to students throughout the world as well as to matriculated UNC systems students who would receive course credit. Additionally, grant applicants were encouraged to develop inter-institutional teams from the UNC System institutions and to involve faculty and experts from around the world in delivery of part of the course. The RFP specifically required that there be no prerequisites for the course, that flexible assignments be structured that could be used by both for-credit and non-credit students, and that the course be designed to appeal to a broad range of students. Also required were research and learning objectives, strategies for promotion, and delivery and assessment plans. SAS Institute would partner with the awardees in developing the learning management system (LMS), video classroom, discussion rooms and other necessary elements of the MOOC platform.

Three professors at two UNC institutions were awarded the RFP for their proposal, “The Economics of Emerging Markets: Exploring the Transformation of Developing Economies into Developed Nation Status”. The proposal incorporates the success factors outlined earlier in the paper:

“The following five goals framed our thinking on specific pedagogic and structural components of the MOOC:

1. Meaningful – To enable meaningful learning, we will provide content that stimulates understanding of core concepts and their relationship to the world.
2. Engaging – We will keep the course engaging to limit attrition by providing feedback for completion and/or inactivity, communities of interest, and public recognition for accomplishments.
3. Measurable – Both students and instructors will have access to measurable progress on usage of learning objects and technology, as well as success in understanding course concepts.
4. Accessible – The content and structure of the course is designed to be accessible to matriculated UNC students, non-traditional students, global participants, UNC alumni, and individuals interested in applying to UNC schools.
5. Scalable – To achieve massive scale, the course is designed for thousands of students through the use of automated systems. Instructors will have three points of contact throughout the course – 1) creating content, 2) managing operations, and 3) assessing the results. None of these three hinder scalability.” (Seeman, Drake & Maysami, 2013)

In a brief video highlighting a UNC/SAS partnership for developing the MOOC platform, Dr. Tom Ross, president of the UNC system, detailed these five critical objectives (Ross, Goodnight, & Goodnight, 2014). The proposal specified that course content would be created by the economics professor in the group and organized into modules consisting of reading assignments, brief single topic video lectures, cognitive and meta-cognitive prompts, calendars, study guides, and discussion questions. Further, a self-assessment quiz at the end of each module would verify mastery of the material. Successfully passing a self-assessment quiz will result in a user earning a badge. Badges will display on user profiles, in the Q&A forum, and in the virtual communities.

The course would offer two discussion mediums. An interactive Q&A would algorithmically determine current popular questions and answers and give those questions prominence in the
forums. The algorithm would be based on up/down voting for each discussion post, the number of comments, and the date of the votes and comments. This would keep recent and popular discussions near the top of the discussion boards, while less recent or less popular discussions would receive less prominence. Instructors and guest lectures would vet popular questions for misunderstandings and add their own comments. To encourage interactivity, using the up/down voting system to rate discussions, top vote geters would receive recognition on the Q&A forum and in the virtual communities. The second discussion mode would give participants access to virtual communities with web conferencing capabilities. These virtual communities would be assigned algorithmically to maximize commonalities across student demographics, yet diverse enough to spark deep conversations around course material. Communities would be capped at 25 students to foster discussion, collaboration, idea-sharing and motivation. Study guides would prompt discussion around module content.

Along with the self-assessment quizzes offered to all students, matriculated UNC students would also write short papers throughout the course which would be graded both through grading software (to evaluate writing quality and guard against plagiarism), and through randomly assigned peer assessment. Additionally, for-credit students would take two proctored exams administered on the learning management system and proctored using the UNC Proctoring System.

The proposal laid out plans to conduct ongoing, formative evaluation of the use and usefulness of delivered technologies and learning objects throughout the course. This ongoing evaluation will enable the instructors, in consultation with an instructional designer, to adjust focus and emphasis throughout the semester by conduction ongoing, formative evaluation. The goal of the evaluation is to keep students engaged and promote meaningful learning while sharing those findings with the academic community.

Table 2 below maps components listed in the MOOC proposal against the five principles for MOOC development:

<table>
<thead>
<tr>
<th>Component</th>
<th>Meaningful</th>
<th>Engaging</th>
<th>Measurable</th>
<th>Accessible</th>
<th>Scalable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Content</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td>Badges</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Self-assessment quizzes</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>Short video lectures</td>
<td>X</td>
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<tr>
<td>Discussion forum</td>
<td>X</td>
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<tr>
<td>Up/down voting</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Guest lecturers</td>
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<td></td>
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<tr>
<td>Peer reviewed papers</td>
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</table>

Application of principles to decisions
While developing the MOOC proposal, various pedagogical and technology ideas were considered. Some were adopted while others were rejected. Below we highlight three decisions that required a choice between two alternatives. In each of the decisions, one of the options was rejected because it failed to satisfy one or more of the principles. The alternative option was chosen because of its ability to satisfy each of the principles.

In the first decision, The Economist, a weekly financial and economic publication, was considered as the possible text. While The Economist offers discounted student subscriptions, even that nominal price might discourage students taking the course because of their expectations that the course is free. Accessibility would be limited by requiring students to sign up for the magazine in order to take the course. The team considered paying for the subscription from the grant money, but that would not have been scalable. The team then approached The Economist in order to offer a fixed sum for all enrolled students, paid for by the grant. This would have enabled the accessibility and scalability of course content. However, The Economist preferred not to operate on a fixed sum payment plan.

The alternative text considered was materials in the public domain. After consulting with the university librarians, the team decided to adopt a mix of online articles, YouTube videos, guest lectures, and video lectures. To align with the meaningful and engaging criteria, video lectures were limited to six minutes; similarly, the guest lecturer concept was incorporated into the MOOC to allow country experts to relate core course concepts to their experience within the countries studied.

The second decision consisted of how best to engage students in the course. Originally, the team planned to add a layer of engagement through the use of a Global Classroom concept, wherein synchronous classroom discussions would be held jointly with students at North Carolina universities and students at a university in the emerging economy country being studied. Students not involved in the synchronous discussion would be able to view a video of the session at their convenience. When this concept was reviewed against the five principles, the team decided that while certainly engaging to the participating students, the Global Classroom might actually decrease engagement for those able to view but not participate. Given the limitations of the Global Classroom technology, it was not scalable to hundreds or thousands of students. Furthermore, students in the Global Classroom would have more accessibility than students only participating via the online recordings. The team discarded the concept for these reasons. Instead, the team decided to use virtual chat rooms that could accomplish the same purpose, but accessible to all participants.

The third decision entailed the scope of countries to include in the course. The countries under study initially included more countries than the four nations (Singapore, Malaysia, China and India) in the final proposal. The team had invited a range of guest lecturers, with expertise in multiple Asian nations. However, as the team considered the integration of topics and the comparative analysis that they wanted students to make, they ultimately chose to limit the countries studied to only four to avoid a survey type approach with no strong end product. This decision related to meaningfulness and engagement as the limited number allowed for more focused and in depth consideration of what specifically has helped and hindered the development of these Asian economies.

A number of components were incorporated into the proposal because they strongly supported the success criteria. For example, the use of badges can be measured, is accessible to all, is highly scalable, and can be both meaningful and engaging for students. Along with badges,
components such as up/down voting for Q&A posts and the self-assessment quizzes, also contribute measurability.

The table 3 below maps those components considered but discarded against the five principles for MOOC development. Factors limiting criteria are indicated by an L.

<table>
<thead>
<tr>
<th>Table 3: Components that failed to satisfy principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE ECONOMIST MAGAZINE AS TEXT</td>
</tr>
<tr>
<td>GLOBAL CLASSROOM TECHNOLOGY</td>
</tr>
<tr>
<td>MULTIPLE NATIONS STUDIED</td>
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</table>

CONCLUSION

In this paper, we articulated five principles that can help MOOC developers design and MOOC instructors manage massive classes. These five principles - meaningful, engaging, measurable, accessible, and scalable – stem from pedagogical and information systems theory. We also demonstrate how these five principles were used in the crafting of components and features of a winning grant proposal for a collaborative, multi-institution MOOC through the UNC system. Decisions on what components and features to include had to pass the requirements for each principle before being adopted. We highlight three decisions where alternative components were considered and rejected because they failed to satisfy all five principles. While assuredly additional principles will be identified and added to this list, these five principles provide a foundation for instructors designing and developing new MOOCs.

REFERENCES


