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A didactic unit for the evaluation of the use of assistive technology for access to computers in occupational therapy

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Abstract

Assistive technology (AT) is an umbrella term that refers to different devices that facilitate the performance of activity for people. Future occupational therapists (OT) must acquire specific competencies to undertake the correct selection of such devices, specifically for those that facilitate access and use the computer.

To create a didactic unit to improve the competencies of OT students about assessment of AT to access computers.

The didactic unit was implemented with 95 students in OT Bachelor's degree, involving teachers from 2 Spanish universities. The procedure included: definition of competencies and learning results; determination of evidence; didactic unit design, and implementation.

The main result was the didactic unit, which included 4 content blocks, each one with several activities defined. The evaluation of the students was continuous, where 48.6% of them achieved a score of between 1.9 and 2.00 (the maximum).

The application of the didactic unit allowed to check that students have improved their competencies and knowledge about assessment and prescription of AT for access to a computer.

The selection of competencies and learning results helped in determining and embedding expertise and professional skills concerning AT for computer access.

Abbreviations: AT = assistive technology, eTAO = assessment of technologies to access to the computer (Evaluación para el uso de Tecnologías de Ayuda de Acceso al Ordenador), KPSI = Knowledge and Prior Study Inventory, OT = occupational therapy.

Keywords: assistive technology, computer access, universal design, university education

1. Introduction

Assistive technology (AT) is a tool to increase, maintain or improve the functional abilities of people with disabilities.[1,2] A specialist category of AT is technologies for information and communication, defined as "devices to help any person to receive, send, produce and process information in different formats,

including information technology, like computer inputs and outputs."[3] Devices have great importance, because the use of a computer as an adaptive and rehabilitation medium can be an important tool to normalize the life conditions of people with disabilities, allowing active participation. In concrete, the Assistive Technology for access computers are devices that can improve the communication, participation and access of information for people with disabilities.[4] Those devices include both hardware (adapted mouses and keyboards, or eye gaze technology) both software (applications to build communication boards, e.g.,).

One profession that works with users to select the best AT to access is Occupational Therapy (OT). These professionals assess, recommend, justify, and counsel about funding, manufacturing, training, integration, and follow-up of AT. They collaborate with the end-user and other professionals in the assessment, adaptation, and application of technologies and interventions.[5] In fact, according to the position statement from the World Federation of Occupational Therapists, "Occupational Therapists have an integrated perspective of AT, in relation to a person's abilities, the occupation, and the environment, which supports understanding the barriers and enablers to access and adoption. Professionals can promote social acceptance and safe, sustainable uptake of AT by educating others."[6]

Taking into account this important role, students of OT have to acquire minimum competencies to be able to apply and integrate AT in interventions, considering the changes in perspectives, needs, interests, and priorities of the users.[7] The Council of Occupational Therapists for European Countries has elaborated this in its "Reference Points for the Design and Delivery of Degree Programmes in Occupational Therapy,"

according to Tuning Educational Structures in Europe. In this document, the general and specific competencies of OT university programs are specified, highlighting skills to, "Select, modify and apply appropriate theories, models of practice and methods to meet the occupational and health needs of individuals/populations."[8] Based on this, students of OT have to acquire an understanding of issues of design, as applied in OT, for example, custom design of assistive devices based on the principles of Design for All, to adapt environments and spaces to the identified needs.[9]

In the field of intervention with AT, the abandonment of devices by people with disabilities is a common problem, as identified in previous studies.[10,11] One way to decrease abandonment indices is to apply validated and completed assessment tools, which help in the process of decision-making. In fact, the problem of abandonment has contributed to the design and creation of specific models and scales to assess AT to access a computer.[12,13]

One of the important aspects of teaching OT at university, therefore, is to empower students so they can acquire the competencies to carry on complete evaluation and prescription of AT, specifically those for computer access.

The goals of this teaching innovation project were:

1. to create a didactic unit, with theoretical and practice perspective, to improve the acquisition of competencies in OT students about assessment of the use of AT to access computers of 2 universities of Spain, and
2. to implement the principles of universal design in learning material and communication tools with the students.

2. Methods

2.1. Participants

The didactic unit was implemented with 95 students in a Bachelor's degree program in OT across 2 Spanish universities. They were enrolled in 2 mandatory subjects: functional adaptation, assistive technologies and ergonomics (University of Salamanca; n=53), and OT for personal autonomy of adults with a physical disability (University of A Coruña, n=42). The age range of participants was from 19 to 45, and the group primarily consisted of women with a 5:1 female to male ratio. The didactic experience was approved by the board of vice-rector for teaching from University of Salamanca.

2.2. Procedure

The experience was developed during the academic year 2015/2016.

The general procedure consisted of 4 consecutive stages:

1. definition of competencies and learning results;
2. determination of state of the art;
3. design, and
4. implementation of the didactic unit.

2.3. Definition of competencies and learning results

First, and to make the contributions to student learning real, the teachers defined the specific competencies and the learning results the students would have to achieve after passing the didactic unit.

For this, the specific law that regulates Bachelor's degrees for OT in Spain was revised.[14] Among all the objectives proposed in that law, the authors selected those that were more related to AT for access to computers. The learning results were determined from this previous selection. In Table 1, selected competencies and learning results are synthesized.

2.4. Determination of the state of the art

This step was carried out in order to obtain the most up-to-date evidence about the assessment and use of AT to access computers by people with disabilities. Several resources were researched to look for information about this topic. First, a bibliographic search was carried out in the main scientific databases that have publications in the areas of knowledge of the subjects involved. The websites of Academic Search Complete and ERIC were consulted, using the keywords "assistive technology" AND "occupational therapy" AND "computer." Forty two results were found.

An analysis of the frequency of papers per journal was carried out to identify the most active journals in relation to the subject. The Scandinavian Journal of Occupational Therapy (n=7) and Technology & Disability (n=4) were the journals with more published papers on that topic. The authors also reviewed different sources of gray literature, including books, and no indexed journals.

The review of the documents found allowed the selection of contents and teaching strategies to promote the acquisition of OT competencies in AT for access to computers.

2.5. Didactic unit design

After completing the analysis and description of the state of the art regarding the topic, the teachers defined the contents and teaching methodology to address the subjects.

The purpose was not to describe a detailed or specific didactic unit but to build a general resource base, organized around the basic competencies related to the role of the occupational therapist focused on AT for computer access, and that could serve different subjects both in Bachelor's and Master's degrees.

Therefore, the didactic unit includes a list of main contents of information and, for each one, several learning activities were defined. All of them were linked with the specific competencies and learning results specified above.

The pedagogical design of defined activities in the didactic unit was based on the application of principles of universal design for learning.[15,16]

For this, the teachers took into account the following criteria:

ˆ Accessibility of learning resources and documents.
ˆ Alternatives given in the types of answers demanded the resolution of the activities.
ˆ Several challenge levels for certain activities.

In general, the design of the activities was based on the use of multimedia design tools, both open-source, and proprietary, that allows export to Scorm 1.2 and html5. The iSpring Suite 7 software was used, which facilitates the generation of interactive html5 content from Microsoft PowerPoint. Also, h5p (h5p.org) was used to generate several html5 interactions to be integrated into the Learning Management System. Finally, the authors used the usual tools available in the Moodle online learning platform

Table 1

Specific competences and learning results related to the didactic unit.

Main competences	Specific competences	Learning results
Professional autonomy and responsibility	To know the national and international organizations of Health	- To know the specific international norm for assistive technology from ISO - To know relevant professional organizations of OT related to AT
	To know, critically assess and know how to use information sources to analyze and construe it.	- To know at least 5 catalogs of AT and their classification systems - To be able to look for AT to access the computer
Knowledge about occupational therapy	To understand the conceptual foundations of the occupational nature or each person and their occupational performance	- To know the general conceptual models about AT - To establish the correspondences between the real situations and the dimensions of the general models of AT
Occupational Therapy Process and professional reasoning	To assess the occupational performance	- To know the general assessment tools for the use of AT - To know the specific assessment tools for AT to computer access - To perform analysis of activities related to computer access
	To know, select and apply the appropriate theories to choose or restore significant occupation, according to the health needs of individuals and populations.	- To know the importance of AT in the discipline of OT
	To understand the fundamentals of action, indications, and effectiveness of OT interventions, based on the available evidence	- To know the outcome results tools in the field of AT - To know to apply an outcome measure assessment in AT's interventions - To know to analyze the usability of any AT for access to the computer
Professional, clinical and community relationships	To acquire basic management knowledge and improve the quality of Occupational Therapy services	- To know models of service organization aimed at advising, evaluating and measuring results in interventions with AT

AT = assistive technology, ISO = international organization for standardization, OT = occupational therapy.
The main and specific competences have been established by the norm of Spanish Ministry of Science and Innovation (2009): Ministry of Science and Innovation. Order CIN / 729/2009, of March 18, establishing the requirements for the verification of official university degrees that enable the exercise of the profession of Occupational Therapist (2009). Spain: BOE. Available from https://www.BOE.es/diario_boe/txt.php?id=BOE-A-2009-5036.

(specifically, discussion forums and tasks), as well as other external resources (mainly webpages).

The activities were configured to send a score between 0 and 100 towards the Learning Management System so that its use would be flexible in terms of integration into different teaching contexts.

2.6. Implementation of the didactic unit

Once defined, all activities included in each content block of the didactic unit were applied during the second semester of the academic year 2015/2016. Students from OT degrees at the University of Salamanca and at the University of A Coruña actively participated in the development of the proposed learning activities at the same time.

At the end of the implementation period, an online forum was planned to obtain feedback from students, as guided by teachers.

3. Results

The main result of this study is the final didactic unit, which was implemented for students on the OT degree at the University of Salamanca and the University of A Coruña. The project was designed through a coordinated process, involving all teachers. It includes 4 content blocks, each one with several defined activities. Table 2 describes the structure. All of them were supplemented with a specific bibliography and learning resources through the Learning Content Management Moodle.

During the implementation of the first content block, a diagnostic evaluation was carried out to assess the level of initial acquisition of competencies perceived by the students, including some of the competencies related to evidence-based practice. To carry out this assessment, an initial evaluation questionnaire was designed, including some questions related to AT, in the Knowledge and Prior Study Inventory (KPSI) format.[17]

Through the administration of the KPSI questionnaire, it was possible to assess the existing level of student knowledge of AT. Each KPSI item allowed 5 answer options, according to determined categories:

1. I do not know/I do not understand;
2. I know it a little/I understand it a little;
3. I know it quite well/I partially understand it;
4. I understand it very well, although I could not explain it to another person, and
5. I have mastered it so I could explain it to someone else.

The averages of assessment of previous knowledge about AT were relatively low: the classification systems of AT was $M=1.4$; examples of assistive technologies used to improve the performance of activities of daily living was $M=1.7$; to identify and to evaluate the need for AT based on structured assessment tools was $M=1.5$, and specific examples of AT for cognition was $M=1.4$. Those results show a need to provide learning activities related to this area.

The second task focused on the description of the state of the art about the topic (use of AT to access a computer) and little research with robust evidence in the field was found. The authors found 42 papers, mostly between the years 2010 and 2015. The journals in which they were published had a medium impact factor, and the level of evidence according to the Levels of Evidence from the Centre for Evidence-Based Medicine in Oxford, was no higher than level 2.b.[18]

Table 2

**Content blocks, competences, and activities of the didactic unit.**

Content Block	Competences	Learning activities
Assistive technology and occupational therapy	-To understand the conceptual foundations of the occupational nature or each person and their occupational performance. -To know, select and apply the appropriate theories to choose or restore significant occupation, according to the health needs of individuals and populations.	- General lectures about Assistive technology and devices. - Discussion activity: "position statement" of AOTA and the "fact sheet" of AOTA, regarding the AT in the profession of the TO
Classification of assistive technology	-To know the national and international organizations of Health -To know, critically assess and know how to use information sources to analyze and construe it.	- Reading and self-assessment about ISO 9999:201 classification. - Exercises to look for on ISO website and catalogs of AT (i.e. EASTIN). - Dynamic conceptual maps about AT for access to the computer. - Sample videos about AT for access to the computer.
Assessment to prescribe and use assistive technology	-To assess the occupational performance	- Assessment with the standard tool: Video-tutorial of Assessment of Computer Task Performance. - Exercise of activity analysis: Reading of online news with the standard devices to access to the computer. - Case Study: A person with amyotrophic lateral sclerosis and communication difficulties. - Tutorial: eTAO (Assessment of technologies to access to the computer) - Application of eTAO in study case: scanning speed selection, choice of best pointing device, training in the use of drag action.
Outcome measures in intervention with assistive technology	-To understand the fundamentals of action, indications and effectiveness of OT interventions, based on the available evidence -To acquire basic management knowledge and improve the quality of Occupational Therapy services	- Application of Psychosocial Impact Assistive Devices Scale (PIADS) in a study case. - Advanced readings with self-assessment: Scientific papers about the organization of services for the use of AT.

AOTA = American Occupational Therapist Association, AT = assistive technology, EASTIN = the global assistive technology information network, eTAO = assessment of technologies to access to the computer, ISO = international organization for standardization, PIADS = psychosocial impact assistive devices scale.

For content block 2, a training exercise to manage International Organization for Standardization 9999:2017 and its classification was proposed to both groups of students. Study cases were proposed so that the students could study the classification in-depth[19] and search for different AT, adequate for each user, based on their needs and capabilities. For this task, 85% of students had problems navigating these resources, due to the complex system of codification and the differences with respect to the Framework of Occupational Therapy.[20]

In addition to this task, in this block, the students had to create a dynamic conceptual map specifically about AT for access to a computer (Fig. 1).
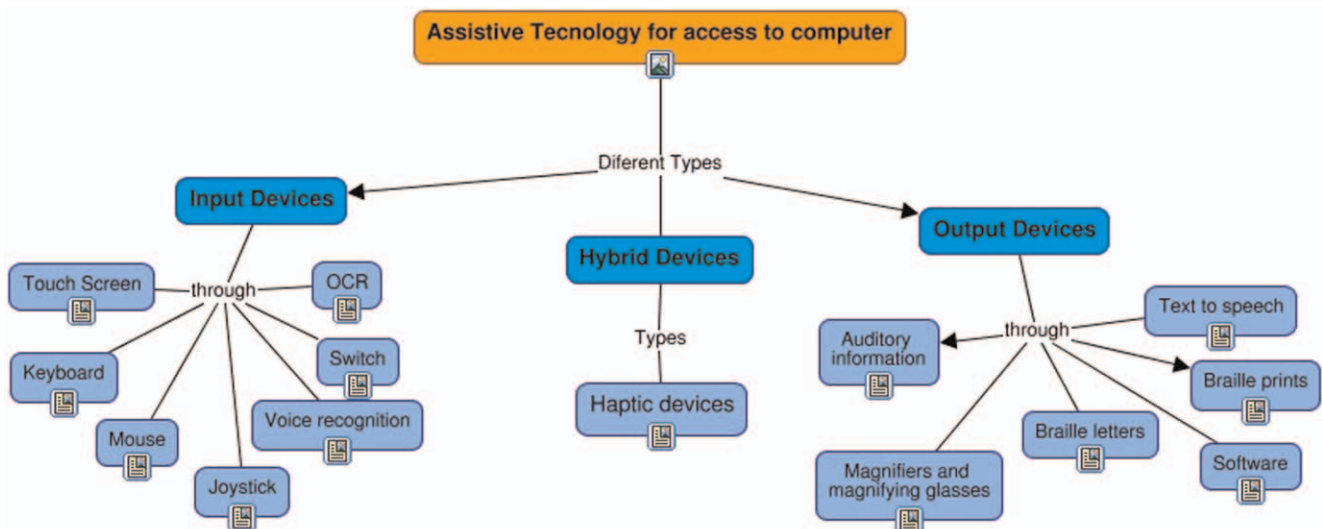
Figure 1. Interactive concept map on products and assistive technologies to access a computer. Each node can be visited and leads to a new concept map.

3.1. Own elaboration

The third block was focused on the relevance of the appropriate assessment of the person-activity context to propose the best AT. This assessment will be very important to get access to, and use of, a computer by any person with a disability. The learning activities proposed in this block were as follows.

3.2. Analysis of activities

The students had to carry out an analysis of an activity that requires the use of a computer. The activity of reading a digital newspaper online, using a common computer mouse and keyboard, was proposed for the analysis. To do the analysis, they had to apply a specially created activity analysis guide (see Table 3).

3.3. Case study

A description of a case of a person with Amyotrophic Lateral Sclerosis (ALS) was presented to the students. They had to analyze functional skills, needs, preferences, and activities concerning the use of a computer. After that, the students proposed a few AT for Information and Communication Technologies more suitable to meet the identified needs.

3.4. Training to manage and apply the eTAO tool

eTAO (Evaluación para el uso de Tecnologías de Ayuda de Acceso al Ordenador: Assesment for the use of computer access technologies) is a software program developed by the Instituto de Integración en la Comunidad (INICO–University of Salamanca) as a tool to evaluate a user's functional capability to use a computer.[21] It was developed and validated in Spain (thus adhering to legal, governmental and cultural guidelines), it is written in the Spanish language and is distributed online free of charge. eTAO is proposed as a more effective tool in the Spanish context. This software was designed to facilitate the assessment and monitoring of the use of assistive devices that support information processing and communications tasks.[22] These tasks are based on 2 existing tools: the assessment of computer task performance[23]; and the Compass software.[24] In particular, eTAO consists of 8 modules that help to evaluate a user's ability to perform mouse-related tasks (pointing and clicking) and keyboard-related tasks. During the application of eTAO, the evaluator can administer all of it or a subset of the task, depending on the evaluation objectives. Previous results obtained using eTAO suggest that it is statistically reliable, valid psychometrically as well as in terms of different environments, offers a high degree of sensitivity, and is easy to use.[22] To address this task, students from both universities received an online lesson through Moodle to learn to manage and configure the eTAO.

3.5. Assessment with eTAO through a case study

Students had to configure the eTAO tool to assess the capabilities and needs of the user with amyotrophic lateral sclerosis. The final parameters of the test from eTAO are shown in Table 4.

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[1]eTAO is a web application created using Java Virtual Machine. Due to external complications in supporting Java in the main web browsers and its planned deactivation on Chrome in December 2019, the authors of this manuscript cannot guarantee the correct functioning of eTAO tool today or in the future.

Table 3

Guide to analysis the activity.

Type of analysis	Criteria	Considerations
Basic	What?	• What is going to do?
		• Is the activity formed by other tasks?
		• Is the activity related to others?
	Who?	• People involved
		• If there are several people, what are their functions?
	When?	• The moment in when it happens
		• Is it part of the daily routine or is it sporadic?
	Where?	• Do you require a specific place?
		• Does the environment influence its realization?
		• Are the necessary materials accessible and available?
	How?	• Necessary sequences and breaks between tasks
		• Approximate duration
		• What skills are most necessary?
	Why?	• The objective of carrying out the activity
		• Is it essential or does it have any specific therapeutic purpose?
Detailed	Motor skills	• Position
		• Movement (Joint balance)
		• Strength
		• Coordination
		• Manual skills
	Sensory and perception skills	• Vision
		• Audition
		• Touch
		• Proprioception
		• Taste / Smell
		• Sensory system and information processing
	Cognitive skills	• Attention, memory, orientation
		• Problem-solving
		• Planning
		• Control of time
		• Reading-writing ability
	Relationship skills	• In solitary or with others
		• Type of formality
		• Ways to communicate
	Emotional skills	• Attitudes and values
		• Feelings management/Emotions
		• Self-control / impulses
		• The symbolic value of the activity
	Cultural Demands	• Specific to a certain social enclave
Applied	Context	• Space
		• Materials
		• Other participants
	Emotions	• Motivation
		• Triggering emotional responses
		• Connection with roles, values and interests
	Adequacy	• Age and stage of development
		• Gender (cultural implications)
	Adaptability	• Adaptable and gradable
		• Individual and/or group
	Level of application	• The occupational value during the intervention
		• Possibility to transfer to other situations
	Cost	• Relationship efficacy - cost
	Security	• Associated risks
	Time	• To complete the activity and its tasks
		• Level of supervision

Finally, block 4 was oriented to learning about the application of outcome measures in the process of prescription of AT to access a computer. Students received brief training in the application of a tool to measures outcomes with AT inter-

Table 4

Configuration of specific characteristics of eTAO tool.

Name of test	Objective	Parameter	Configuration's characteristics
Clicking	Assess the capacity to activate a switch in response to any alert	Alert	Visual: Quadrate
		Time of click	0 sec
		Time of pause	Constant
		Visual alert	Background color: Blue
			Size: Big
			Text: Click
			Size of text: Medium
			Colour of text: black
Objective – Click	Assess the capacity to move the cursor to any stimulate in different places of the screen	Type of objective	Quadrate
		Method of selection	Click on objective
		Image	Clip art 1
		Situation of objective	Per percentages
		Distance	Large, medium and short
		Draw route	Yes
Objective – Double click		Type of objective	Quadrate
		Method of selection	Double click in objective
		Image	Clip art 1
		Situation of objective	Per percentages
		Distance	Large, medium and short
		Draw route	Yes
Drag – Simple Movement	Asses the capacity to drag an object from any localization to destination	Object	Type: Image
			Size: Medium
			Image: Clip art 1
		Destination	Type: Image
			Size: Medium
			Image: Clip art 2
		Method of selection	Click
		Localization	Per percentages
		Background of screen	White
		Draw route	Yes
Drag		Object	Type: Image
			Size: Medium
			Image: Clip art 1
		Destination	Type: Image
			Size: Medium
			Image: Clip art 2
		Method of selection	Click with pointing in first localization
		Localization	Per percentages
		Background of screen	White
		Draw route	Yes

ventions, the Psychosocial Impact of Assistive Devices Scale.[25] Then they had to apply the tool in another case study. To finish the whole learning unit, a proposal of advanced readings with self-assessment was offered to the students.

In the examination of the respective subjects at the University of Salamanca and the University of A Coruña, 1 question about the didactic unit was included. The mean of complete success in that question was 73.2%, being answered by 90% of students.

4. Discussion

The present paper describes a study carried out in university education, by researchers who are professors in 2 different Bachelor's degree programs of OT. The designed didactic unit was innovative because the research group addressed, in a collaborative and online way, the common content of specific competencies of OT that students have to acquire.

In general terms, the didactic unit has meant the students have acquired the main skills to assess AT to access a computer, as well as to select the best device for each user based on their preferences, activities and context.

The use of quantitative assessment tools is a way to highlight the efficacy and are effectively derived from best practice by professionals of OT, increasing the evidence base for their intervention.[26,27] Specifically, the evaluation of the skills of a person with a disability using a computer or tablet, through validated instruments is a consistent practice to facilitate their participation in the digital society. The assessment tools can also benefit from adopting protocols originally developed for Human-Computer Interaction research.[27]

In addition, the implementation of the principles of universal design for learning during the elaboration of learning methods and contents is essential to the training of future occupational therapists, being aware of the guidelines and best practice in force.[9]

The study presented in this paper is not just a learning innovation project but is also special training for students of OT in order to improve their competencies to assess and to suggest appropriate communication and information AT. It is a transversal concern to guarantee the normal use of computers by people with disabilities, promoting real inclusion in Information and Communication Technologies and creating opportunities for those persons to participate in educational, job or leisure environments.

Finally, and in order to concrete some limitations of the study, it can be highlighted that there were not inclusion criteria for the selection of participants, due that all of them were students enrolled in the subjects where the experience was implemented. And for instance, all of that students constituted the sample of the study. It can result in difficulty in the case of wanting to replicate the study or compare the data with other similar research. In relation to the above, it is necessary to take into account that the didactic unit has been specifically designed for 2 subjects of the degree in Occupational Therapy from 2 Spanish universities. Therefore, any reproduction of the study must be carried out with caution, adapting the content of the didactic unit to the institutional and cultural context of the community.

5. Conclusion

This learning innovation project has allowed us to carry out a deep review of the process of teaching in the topic of AT and to update the literature with interesting resources.

The selection of competencies and learning results for OT students helped in determining and embedding expertise and professional skills in relation to AT for computer access. In order to meet these competencies, the didactic unit included several activities specifically designed to get learning results, and they have implemented this unit within the Bachelor's degree program of OT in both the University of Salamanca and the University of A Coruña.

The results derived from the application of the didactic unit allowed the teachers to check that students have improved their competencies and knowledge about assessment and prescription of AT for access to a computer.

The fact that this learning innovation project was carried out by 2 occupational therapists and 1 psychologist with wide expertise in the topic of AT and its outcome measures, from 2 different universities, gives greater relevance to the obtained results.

Author contributions

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