DEVELOPMENT AND VALIDATION OF FLIPPED CLASSROOM INSTRUCTIONAL MODEL FOR SENIOR SECONDARY II (SSII) PHYSICS STUDENTS IN MINNA, NIGERIA

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Abstract
This study developed and validated Flipped Classroom Instructional Model (FCIM) for teaching SSSII Physics students in Minna, Nigeria. The package was validated by three lecturers from Physics Department, Federal University of Technology, Minna, three senior Physics teachers from secondary schools in Minna, and three Physics experts from Educational Development Department, National Examination Council (NECO), Minna. Twenty (20) Physics students from senior secondary school class two (SSII) were randomly selected for the purpose of the study. The study employed the use of three research instruments which include: content expert validation report, computer programmer validation report, Educational Technology specialist validation report, and field trial validation questionnaire. The instrument was pilot tested on 20 students which were randomly selected from Senior Secondary two (SSII) students. The data obtained were subjected to data analysis using Pearson Product Moment Correlation (PPMC) to determine the reliability coefficient. 0.97 reliability value was obtained, which shows that the instrument is reliable. The package was subjected to field trial and the response from the respondents especially on the contents in the package, 94% of the respondent positively agreed to the items while 70% responded positively to the items on feedback from the package. 96% responded positively on the screen design of the package, and 73.14% positively responded on the preference of the package to conventional methods of teaching. The result from the study shows that the FCIM is a very attractive tool for student learning physics and that it enhanced their performance in Physics. It is recommended that FCIM should be employed in the teaching Physics at senior secondary school level.

Keywords: *Flipped classroom, Validation, Field Trial, Physics*

Introduction
Students of this dispensation have been referred to as digital natives or millennial students. They grow up using technology at an early age than other students in other generations. These students learn differently than those before them because the technology that they use has become a way of life for them (Roehl, Reddy & Shannon, 2013). These digital natives learn differently than those before them. They have different desires and not the same kind of patience (as other generations) with learning (Prensky, 2010). They have information at hand and are familiar with participating in environments calling for involvement and reaching out to peers. Through the Internet, they can ultimately connect with others around the world. The application of technology for teaching and learning cut across various disciplines include science.

Science teaching in Nigerian secondary schools started when the grammar schools were established in 1859. Physics is one of the science subjects taught at the secondary school level in Nigeria at that time. Physics is the study of matter, energy and their interaction play a key role in the progress of mankind (Omebe, 2009). The Nigerian education scheme designed for Secondary School Physics in 1985 has it that the objective of studying physics include, among others, to provide basic literary in physics for functional living in the society, and to acquire essential scientific skills and attitudes as a preparation for the technological application of Physics (Jegede & Adebayo, 2013).

The traditional methods of teaching have primarily revolved around a teacher-centered approach where instructors focus on conveying information, assigning work, and leaving it to the students to master the material. This type of instruction forces students to be merely receptors of information rather than participants in their own learning processes through active learning. To overcome these problems, there is need for paradigm shift from traditional methods of teaching to innovative teaching strategies using modern technological devices. Fortunately, technology has increasingly grown and infiltrated our classrooms, especially in developed countries, new learning models has emerged that move away the teacher-centered approach to a more collaborative, student-centered learning environment.

Flipped classroom is an instructional strategy and a type of blended learning that reverses or inverses the traditional learning environment by delivering instructional content outside the classroom. It moves activities, including those that may have traditionally been considered homework into the classroom. In a flipped classroom, students watch online or offline lectures, collaborate in online discussions, or carry out research at home and engage in concepts in the classroom with the guidance of a mentor. Also, content delivery in a flipped classroom may take a variety of forms. Often, video lessons prepared by the teacher or third parties are used to deliver content (Abeysekera & Dawson, 2015).

The main goal of a flipped classroom is to enhance student learning and achievement by reversing the traditional model of a classroom, focusing class time on student understanding rather than on lecture. To accomplish this, teachers post short video lectures online for students to view at home prior to the next class session. This allows class time to be devoted to expanding on and mastering the material through collaborative learning exercises, projects, and discussions. Essentially, the homework that is typically done at home is done in the classroom, while the lectures that are usually done in the classroom are viewed at home (Wilson, 2013). The students worked through exercises with the support of the lecturer (Campbell, 2014). The benefits of this approach include: an increase in interaction between students and teachers; a shift in the responsibility for learning on to students; the ability for students to prepare at a time that suits them, and as many times as meets their needs; an archive of teaching resources; collaborative working between students; an increase in student engagement and a shift from passive listening to active learning (Bergman, 2012).

Previous studies on the development and validation of software for improving students' performance in science subjects were over 90% positive. For instance, Nwokocha, Gambari, and Tukur (2020) developed and validated Edutainment Instructional Package on Biology for teaching senior secondary school students in Abuja, Nigeria. They found that the package enhanced students' academic achievement in Biology. In another study, Anunobi, Gambari, Alabi, and Abdullahi (2017) developed and validated web-based courseware for junior secondary school basic technology students in Nigeria and found that web-based learning enhanced students performance than conventional method of teaching. Similarly, Laleye (2016) reported that reaction from the validating team and students' field trial validation revealed that the development of computer-assisted instructional package is valuable for learning physics concept in Basic science. Similarly, Lakonpol, Ruangsuwan, and Terdtoon (2015) reported that the developed web-based learning package enhanced cognitive skills for undergraduate students in the field of electrical engineering. In 2014, Salve-Opina developed and validated online learning modules for college English and found that students exposed to the online modules in online portals performed better than those receiving traditional instruction in a classroom. In another study, Liu, Yang, Xiong, Yu, Ji, and Wang (2015) developed and validated a portable hearing self-testing system based on a notebook personal computer. The outcome of their study revealed that portable hearing self-testing system based on a notebook personal computer is a reliable and sensitive method for hearing threshold assessment and monitoring.

Statement of the Problem

This era of technology has also distracted students' attention from their notes to the screen. It has been observed that many students prefer to read information on any screen display than to read their note/text books which also affect their attitude to learning and achievement in school. They spend much of their time watching, reading or looking for what to watch. Introducing innovative and blended learning will go a long way to help these students utilize these distractions to profit their learning. Studies on the use of 21st century teaching strategies such as such as flipped classroom are uncommon at secondary schools in Nigeria. Therefore, this study developed and validated the flipped classroom instructional model for secondary school physics students.

Research Questions

The following research questions were raised to guide the study:

(i) What are the steps involved in the development of Flipped Classroom Instructional Model (FCIM) package?

(ii) How was the developed Flipped Classroom Instructional Model (FCIM) Package validated?

Research design

Flipped Classroom Instructional Model (FCIM) was developed by the researcher and media specialist (video producer). The local production of flipped classroom using video instructional package for Physics concepts stem from the facts that the commercially produced ones may not really fit for Nigeria curriculum and may be culturally biased. The researcher developed the Flip Instructional Model package with the assistance of a professional computer programmer. The package was validated by subject specialists, computer and educational technology experts while field trial validation was conducted on SSII Physics students. The design framework is shown in figure 1.

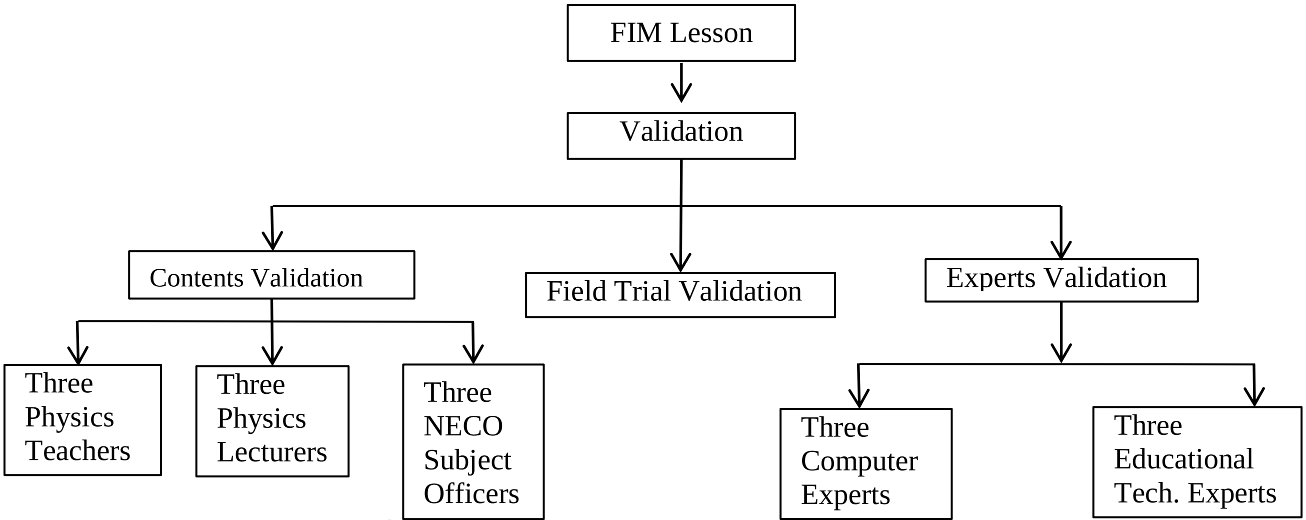

Fig 1: Design Framework for the Study

Sample and Sampling Technique

For the purpose of the study, the FCIM was validated with the help of experts which were purposively selected and these include: three secondary Physics teachers, three Physics lecturers from tertiary institutions, three computer programmer experts, and three Educational Technology experts from Federal University of Technology, Minna, Niger State, Nigeria. Twenty Physics students from senior secondary school class two (SSII) were selected using simple random sampling technique for field trial validation.

Research Instruments

Five instruments were used to validate the FIM, these include: (i) Content Expert Validation Report (CEVR); (ii) Computer Programmer Validation Report (CPVR); (iii) Educational Technology Specialist Validation Report (ETSVR) and (iv) Field Trial Validation Report (FTVR).

(i) Content Expert Validation Report (CEVR): This contains eight statements to which respondents were required to state whether they strongly agreed, agreed, strongly disagreed or disagreed. Respondents responded to the statements regarding the adequacy and appropriate sequencing of the contents, appropriate language use among others.

(ii) Computer Programmer Validation Report (CPVR): The instrument contains issues on navigation, interface, simulation, interactivity, audio output, portability among others. The computer programmers access the software and write a comprehensive report on each of the items.

(iii) Educational Technology Specialist Validation Report (ETSVR): This instrument was designed for Educational Technology experts for the purpose of finding out whether the FCIM conform with acceptable standards in Educational Technology. The respondents are to write report on the simplicity of the package, unity among the illustrations, appropriate use of colours, font type and size, audio output among others.

(iv) Field Trial Validation Report (FTVR): This instrument was designed to test the quality of FCIM as a medium for Physics instruction. The instrument contained some statements to which respondents state whether they are strongly agreed, agreed, strongly disagreed or disagreed. The statements include: content of the package, feedback mechanism, screen design of the package, preference of the package to traditional method of teaching.

(v) **Physics Achievement Test (PAT):** This is an achievement test to determine the performance of students in Physics after using Flipped Classroom Instructional Model package. It consists of 50 items multiple choice objective questions developed by the researcher from Physics text books covering the concept of Propagation of Waves in Physics. It contains five option answers (A – E) with one correct answer and four distracters. This instrument was used to collect data on students' achievement after the treatment has been applied.

The Validity of the Instruments

Flip Classroom Instructional Model package was face and content validated by experts in Physics from secondary schools, Federal University of Technology, Minna and National Examinations Council (NECO), Minna. Observations, corrections and suggestions were noted and effected before given to the programmers for development of the package. The same group of experts assessed the package after the production. The FCIM package was trial tested on some selected students. Three sets of validation forms and a questionnaire were designed to validate Flipped classroom instructional model after production, these include: (i) Content Expert Validation Report (CEVR); (ii) Computer Programmer Validation Report (CPVR); (iii) Educational Technology Specialist Validation Report (ETSVR) and (iv) Field Trial Validation Report (FTVR), (v) Physics Achievement Test (PAT). Observations and recommendations from the experts and students were recorded and corrections were effected to produce the final copy of the package.

Reliability of the Research Instruments

Physics Achievement Test (PAT), and other instruments were pilot tested on 20 students which was randomly selected from Senior Secondary two (SSII) students of Bosso Secondary School, Minna which is not part of the sampled schools but part of the research population, thus they will not be used for the real study. The data obtained from the pilot test were subjected to data analysis using Pearson Product Moment Correlation Correlation (PPMC) and the reliability coefficient value of 0.97 was obtained. This implies that the instrument is reliable.

Results

The data obtained from the study were analysed and reported based on the research questions raised to guide the study.

Research Question One: What are the steps involved in the development stages of FIM package?

In answering research question one, the steps in developing the FCIM are discussed. Flipped Classroom Instructional Model (FIM) was developed for teaching senior secondary school class two (SSSII) students. It was developed by the researcher, programmers and media specialists (video producer). The local production of flipped classroom using video instructional package for Physics concepts stem from the facts that the commercially produced ones may not really fit for Nigeria curriculum and may be culturally biased. Hence, there is need to develop a Flipped Instructional Model using video application for this study.

The concept of Physics (light waves) was selected for this study is from senior secondary school class two (SSII) curriculum. Lesson plans was prepared by the researcher, this covered the scheme of work and used for the video lesson which is termed the FCIM. Flipped Classroom Instructional Model package is a treatment instrument used for the teaching and learning of light waves in Physics. It was developed by the researcher with the assistance of a media expert.

This package contains a video of the lesson explaining the concept of Light Waves in Physics. It contained four topics prepared into four number of lesson plans. Each topic was prepared for each video lesson. The FCIM package finally packaged, installed on systems in computer laboratory of each school for easy access to students. The students visit the laboratory at their convenient time and use the package on their own before the class period. Similarly, the FCIM package was given to each student to use at their various homes.

Research Question Two: How was the developed Flipped Classroom Instructional Model (FCIM) package validated?

The procedures for validating the Flipped classroom instructional model are discussed in the following three stages: Expert validation, Content validation, and Field trial validation.

(i) Expert Validation: This was done by media specialist, computer programmers, and educational technology experts. The developed FCIM package was given to three media specialists, computer programmers and Educational Technology lecturers to determine the appropriateness of the package in terms of legibility, clarity and simplicity of the package, voice clarity, font size, functionality, navigation, portability and durability of the package among other. Their suggestion, correction or commendations were used for modification of the package.

(ii) Content and Face Validation: The Physics content of the package, Physics Achievement Test (PAT) and marking scheme were given to six Physics Experts. These include: three senior lecturers from Physics Department, Federal University of Technology, Minna, three senior Physics teachers from secondary schools in Minna, three experts from Education Development Department of National Examination Council (NECO), Minna. All the experts examined and assessed the contents and test items to determine the face and content validity before it was developed and packaged by the programmers. The face validity of FCIM package was validated focusing on the arrangement and logical sequence of the package, while the content validity focused on the contents in the package. Comments, corrections, suggestions and recommendations of these experts were used to make the final copy of the package.

(iii) Field Trial Validation: The FCIM package was trial tested on twenty selected Physics students from a school which was part of the populations but not part of the schools for the real experiment. The sampled students were taught the Physics concept of Light Waves using the FCIM package for a single period of 45 minutes' duration. The students were allowed to watch the video after school hour and come the following day to work through some tasks and interact with their colleagues and teachers to determine the level of understanding the concept watched before the class period. After they were exposed to the package and participated in the class interaction, FCIM validation questionnaire was administered on them. The data obtained were analysed using simple percentage as shown in Table 1.

Table 1: Frequency and percentage results of the respondents on the content in the Package

S/No	STATEMENT	RESPONSE (%)			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	The messages in the package are easy to understand	12(43.3%)	20 (57.1%)	3 (8.6%)	0 (0%)
2	The content of the package has been well organized (arranged in order)	9 (25.7%)	26 (74.3%)	0 (0%)	0 (0%)
3	The diagrams/illustrations in the package are very clear to me.	10 (28.6%)	23 (65.7%)	2 (5.7%)	0 (0%)
4	The examples used in the various sections of the lessons in the package are relevant.	10 (28.6%)	23 (65.7%)	2 (5.7%)	0 (0%)
5	It was easy to understand the lesson because information was presented from simple to more difficult one.	21 (60.0%)	9 (25.7%)	5 (14.3%)	0 (0%)
Total		**37%**	**57%**	**6%**	**0 (0%)**
Summary of Agree and Disagree		**94 (0%)**		**6%**	

From Table 1, it can be deduced that most of the students used for this study responded that the Physics contents in the package are easy to understand for them with 43.3% Strongly Agreed and 57.1% Agreed to the statements. Only 8.6% of the respondents Disagreed to the statement item that the contents in the package were not easy for them to understand. The statement item on the organization/arrangement of the contents in the package was positively agreed and negatively disagreed by the respondents. They either strongly agreed or agreed to the statement that says the content of the package has been well organized (arranged in order) with 25.7% Strongly Agreed and 74.3% Agreed to the statement item. The respondents view on the clarity of the diagrams/illustrations in the package showed that the diagrams and illustrations presented in the package are very clear. 28.6% of the respondents Strongly Agreed and 65.7% Agreed to the statement item, with only a small fraction on the other side (5.7%) Disagree with the statement items. The responses of the respondents showed that the examples used in the various lessons of the package are relevant with Strongly Agreed and Agreed with 28.6% and 65.7% respectively, and a small fraction of disagreement (5.7%). The lessons in the package are easy to understand and the respondents also believed that the information were presented from the simplest to the more difficult one, with 60% and 25.7% from Strongly Agreed and Agreed respectively. Summarily based on the overall responses of the students on the FCIM package, it can be deduced that contents selection, arrangement, illustration and presentation, the package are good for learning Physics concepts. The statements in the table were further divided into two groups (Agree and disagree), which shows that 94% of the respondents Agreed to the statement items in the table while just 4% Disagreed to the statement item.

Table 2: Feedback from the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	This package provides immediate feedback after selecting the option.	7 (20%)	28 (80%)	0 (0%)	0 (0%)
2	This package displays the correct or wrong answer chosen.	8 (22.9%)	6 (17.1%)	20 (57.1%)	1 (2.9%)
Total		**21.45%**	**48.55%**	**28.55%**	**(1.45%)**
Summary of Agree and Disagree		**70.0%**		**30.0%**	

Table 2 shows the responses based on feedback from the package as perceived by the respondents based on their interaction with the package. The statement item on "this package provides immediate feedback after selecting the option" received a total of 20% Strongly Agreed and 80% Agreed, while none of the respondent Disagreed and Strongly Disagreed to the statement item. The statement item on whether "the package displays the correct or wrong answer chosen" reveals that 57% of the respondents Disagreed with the statement item while 2.9% of the respondents Strongly Disagree to the statement items respectively. However, 22.9% and 17.1% of the respondents were Strongly Agreed or Agreed to the statement item respectively.

Table 3: Screen Design of the Package

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	The presentations of the information in the package attract my attention.	10 (28.6%)	24 (68.6%)	1 (2.9%)	0 (0%)
2	The use of proper lettering (fonts) in terms of style and size make the information legible.	11 (31.4%)	24 (68.6%)	0 (0%)	0 (0%)
3	The colours used for the various presentations are quite appealing.	5 (14.3%)	26 (74.3%)	4 (11.4%)	0 (0%)
4	The quality of the text, images, graphics and video are interesting.	21 (60%)	14 (40%)	0 (0%)	0 (0%)
5	The animations (moving picture) in the package assist in understanding the lessons better.	19 (54.3%)	14 (40%)	2 (5.7%)	0 (0%)
Total		**37.70%**	**58.3%**	**4%**	
Summary of Agree and Disagree		**96%**		**4%**	

Table 3 shows that 97% of the respondents Agreed to the statement item 1, which concerned with the mode of presentation of the information in the package. These respondents believed that the way the information used for the lessons were well presented and it attracted their attention. Only a small fraction of the respondents (2.9%) Disagreed to the statement. 31.4% of the respondents Strongly Agreed that proper lettering styles and sizes are used, and that this makes the information legible. Also 14.3% and 74.3% of the respondents Strongly Agree and Agree respectively to the colour selection for the presentation and they also attested that this makes the package appealing to them. The respondents also found the quality of text, images, graphics and videos were interested. 94.3% of the respondents Agreed that the animation in the package assisted them in understanding the lessons better. Based on the general agreement and disagreement of the respondents on the statements in the table, it can be deduced that most of the respondents (96%) either Agreed or Strongly Agreed to the statement item in Table 3.

Table 4: Students' Preferences toward the Use of the Package Compared to Traditional Methods of Teaching

S/No	STATEMENT	RESPONSE			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	I prefer to learn physics with an interactive package with a teacher acting as a facilitator.	23 (65.7%)	8 (22.9%)	4 (11.4%)	0 (0%)
2	Learning physics with an FCIM package is more preferable than using text books.	21 (60%)	10 (28.6%)	2 (5.7%)	2 (5.7%)
3	The activities provided in this package are more effective compared to normal classroom instruction.	8 (22.9%)	14 (40%)	8 (22.9%)	5 (14.3%)
4	I will suggest to my friends to use computer package in learning physics instead of textbooks.	4 (11.4%)	20 (57.1%)	11 (31.4%)	0 (0%)
5	I prefer the use of this instructional method than normal classroom instruction.	10 (28.6%)	10 (28.6%)	8 (22.9%)	7 (20%)
Total		**37.70%**	**35.44 %**	**18.86%**	**8%**
Summary of Agree and Disagree		**73.14%**		**26.86%**	

Table 4 considered the students' preferences towards the use of the package compare to traditional methods of teaching. Statement item 1 reveals that after the students used the FCIM package, most of them (88.6%) now prefer to learn Physics with the use of the package as the teacher served as a facilitator. Only 11.4% Disagreed with the preference of the package to traditional method of teaching. Similarly, 88.6% of the respondents Agreed to the statement item that "learning physics with FCIM package is more preferable than using text books. 62.9% of the respondents also Agreed that the effectiveness of the activities in the package are better than normal classroom instruction. 68.5% of the respondents promised to recommend the package to their friends to learn physics instead of using textbook. 57.1% of the respondents preferred the use of this instructional strategy than normal classroom instruction.

Discussion

The finding of this study is in agreement with that of Nwokocha *et al.,* (2020) who developed and validated Edutainment Instructional Package on Biology for teaching senior secondary school students in Nigeria and found that the package enhanced students' achievement in Biology better than conventional methods of teaching. The finding agrees with that of Anunobi *et al.*, (2017) who developed and validated web-based courseware for junior secondary school basic technology students in Nigeria and found that web-based learning enhanced students' performance than conventional method of teaching. It also agrees with that of Laleye (2016) who reported that reaction from the validating team and students' field trial validation revealed that the development of computer assisted instructional package is valuable for learning physics concept in Basic science. Similarly, the finding agrees with that of Lakonpol *et al.,* (2015) who found that the developed web-based learning package enhanced cognitive skills for undergraduate students in the field of electrical engineering. The finding is also in agreement with that of Salve-Opina (2014) who developed and validated online learning modules for college English and found that students exposed to the online modules in online portals performed better than those receiving traditional instruction in a classroom. It also agrees with the finding of Liu, *et al.,* (2015) who developed and validated a portable hearing self-testing system based on a notebook personal computer and found that the portable hearing self-testing system based on a notebook personal computer is a reliable and sensitive method for hearing threshold assessment and monitoring.

Conclusion

Generally, based on the responses of the respondents, it can be seen that majority of the respondents agreed to the statements in the tables compared to those that disagreed to the statements. Also, it can be seen that most of the students used for this study responded that the instructions in the package are easy to understand for them. Their responses based on their interaction with the package, the mode of presentation of the information in the package, the preferences of the students towards the use of the package as compare to traditional methods of learning and after the students used the FCIM package, most of them now prefer to learn physics with the use of the package. This implies that the FCIM package is valuable and effective for learning Physics concepts at senior secondary school level in Nigeria.

Recommendations

Based on the findings from this study, the following recommendations were made:

(i) Since most students now prefer to learn physics with the use of FCIM package while teacher served as a facilitator, plans should be made to change the traditional mode of teaching and replaced with FCIM package for better understanding of Physics concepts.

(ii) Government and educational policy makers should plan towards the integration of FCIM package that will contain instructions that are easy to understand for students and also with clear mode of presentation of information in the package.

(iii) Priority should be placed on the preferences of the students towards the use of FCIM package as compare to traditional methods of leaning.

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