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# Physics in Movies: Awareness Levels of Teacher Candidates

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The aim of this study is to draw attention to the informal education aspect of the movies shown and to determine the awareness levels about physics in movies of a small group composed of university students. That is an evaluation had been made among the films dealing explicitly with the basic content of physics, except for science fiction movies, and two films that attracted great attention in the process notation were chosen. In this study, the sample group was composed of six students who continue physics education at university and have high academic success levels. At the beginning of the sessions, the group had been informed about the aim and process of the study. The movies, which were watched by researchers and scientifically mistaken scenes had been determined beforehand, were then watched in two different sessions together with the student group. In each session, students were made to discuss the scenes dealing with physics and whether they were consistent or contrary to physics rules. The scenes in question were stopped upon the demands of students, the time interval of the scene was noted, and the discussions were recorded by a voice recorder. The researchers did not intervene in the discussions directly, but only canalised students to make the discussions deeper when needed. Through this study, it was realised that the awareness level about physics in movies of the students was quite high. This study is highly important in stressing the informal education mission of the movies and students' critical questioning of the scientific correctness in the films. This result points out that while writing a scenario, scriptwriters should take a serious academic consultancy service.

*Keywords*: physics education, informal education, awareness, pre-service teachers, movie

## INTRODUCTION

Learning is not a phenomenon associated only with school life, it is a lifelong process. In this respect, it covers both formal education and informal education. This is because of the fact that human beings always learn and apply what they learn in their lives. They do not only learn by listening to the lectures of teachers, they continue learning from their parents, relatives, friends, neighbours, radio, television, cinema, theatre, museums, books, journals and magazines at home as of their births (Türkmen, 2010). Informal education, for which we provided several learning channels or education environments above, can be defined as acquiring desired or undesired behaviours in the course of time in its broadest sense (Griffin, 1994).

Today, the concept of informal education has been closely associated with the concepts of Community Education, Adult Education and Lifelong Learning (Türkmen, 2010). Besides, there is another phenomenon called as Non-Formal Education. Although it seems to have the same meaning with informal education at the beginning, there is small difference between them. According to Türkmen (2010), their objectives are the same but non-formal education basically includes organised educational activities realised out of the formal environments (out of school in general) while

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***State of the literature***

- When the limited studies examining the effect of informal education on science education was investigated, it was seen that the museums, afterschool programs, media, journals cultural communication, and cinema have been addressed.
- The examination of the relevant literature revealed that web-based learning was also addressed within the scope of informal education, but these studies were excluded due to the fact that this topic is more associated with distance education.
- The relevant studies only emphasized movies such as the Matrix, Star Wars, and The Terminator etc., which became popular and gained appreciation when they were first released and are still watched repeatedly and have a significant role in informal education.

***Contribution of this paper to the literature***

This study is important for the impact it made on the educative role of motion-pictures and as the audience group critically questions the level of scientific realism in the motion-picture.

- It would be good for scenarists to take a serious academic consultation service during the scriptwriting processes of motion-pictures, which includes, or is thought to include, scientific realism in terms of physics.
- This study may be repeated without informing the participants about the awareness of the physical facts and events in the movies before watching them. Then the findings and results obtained may be compared with those of this study.

informal education is a process continuing for a life time.

Informal education channels can be listed as non-governmental organisations: *public education centres, institutes, science centres, science fairs, exhibitions, youth clubs,* as well as *family, friends, written and visual media, museums, cinema,* and *theatre*. When the limited studies examining the effect of informal education on science education was investigated, it was seen that the museums (Bamberger and Tali, 2009; Holmes, 2011; Karataş, 2011; Tressel, 2006), afterschool programs (Bartley et al, 2009), media (Rockman et al, 2007), journals (Kavak et al, 2006), cultural communication (Dhindsa and Salwana, 2012), and cinema have been addressed. The examination of the relevant literature revealed that web-based learning was also addressed within the scope of informal education but these studies were excluded due to the fact that this topic is more associated with distance education. On the other hand, this study aimed at drawing attention to motion picture dimension of informal education.

Motion picture dimension of informal education has been studied usually through sci-fi movies (Al-Khalili, 2003; Allday, 2003; Arroio, 2010; Barnett et al, 2006; Brake and Thornton, 2003; Dark, 2005; Everitt and Patterson, 1999; Rogers, 2007; Rose, 2003; Smith, 2009; Taylor, 2003). According to Asimov (1968), one of pioneer for using sci-fi as teaching aid, sci-fi stories can be used for illustrating scientific contents and initiating useful discussions between students. Based on this foresight sci-fi movies having similar benefits is conceivable. Studies in this area has been also presented that using sci-fi movies as educational tool increase motivation towards the course (Dark, 2005; Barnett et al, 2006; Smith, 2009), ease transfer of knowledge (Dark, 2005; Barnett et al, 2006) and help finding out misconceptions (Dark, 2005). Watching well-designed movies with regard to scientific content and discussing about the scientific content of movies can provide benefits before mentioned however watching badly-designed movies with regard to scientific content can cause misconceptions (Barnett et al, 2006). One of the reasons why right or wrong explanations in sci-fi movies are persistent in students' mind is being transferred of explanations through actors/actresses in the role of scientist (Barnett et al, 2006) except that situation is different in movies about daily life. Because of events in movies about daily life has been presented as they could be in real world, mistakes in these movies could be just as dangerous as mistakes in sci-fi movies.

The conformity of motion-pictures produced in genres other than science-fiction with scientific facts and awareness formed by this situation should also be studied because such movies may affect people's perception of reality. For instance, most people think that in a traffic accident, a car can easily catch fire and may explode before long, like in the movies; therefore they do the rescue work recklessly and quickly. This situation causes many accident victims to put themselves in great danger. There might be some negative reflections of reality perception. Reality perception also affects behaviour, in this respect.

By the reason of studies in this area has been focused on sci-fi movies and perceiving mistakes in movies about daily life as they could be in real world is more possible, in this study movies about daily life has been used and awareness and awareness levels of physics teacher candidates related scientific mistakes in these movies has been investigated.

## METHOD

This research was conducted with a screening model realised through qualitative techniques. Attendees were selected according to qualitative techniques. Selection of

**Table 1.** Information on the tape recorder files

| **Movie** | **Record Information [Duration (mm:ss)]** | | | | | |
|---|---|---|---|---|---|---|
| | *Rec 1* | *Rec 2* | *Rec 3* | *Rec 4* | *Rec 5* | *Rec 6* |
| Movie 1 | 25:41 | 16:34 | 25:30 | 09:54 | 13:40 | - |
| Movie 2 | 21:28 | 15:10 | 09:50 | 25:28 | 23:16 | 14:29 |

**Table 2.** Awareness levels according to the assessment criteria of the data

| **Awareness Levels** | **Criteria** | | | | | |
|---|---|---|---|---|---|---|
| | *Awareness Status* | | *Explanation of Awareness* | | | |
| | Yes (1) | No (0) | True (3) | Partly-True (2) | False (1) | No (0) |
| 0 | | * | | | | * |
| 1 | * | | | | | * |
| 2 | * | | | | * | |
| 3 | * | | | * | | |
| 4 | * | | * | | | |

attendees is considerably different in qualitative and quantitative researches (Patton, 1990; Bogdan and Biklen, 1992; Denzin, and Lincoln, 2000). This results from the difference in the purposes of qualitative and quantitative studies. Attendees of the research should be able to provide substantial case data in line with the purposes of the qualitative research (Patton, 1990). Thus, a purposeful sampling was carried out on the basis of the below-mentioned criteria. In this framework, attendees were selected in accordance with certain criteria. These are;

*Attendees should have received education in the field of Physics as the study aimed at focusing on the physical phenomena in the movies,*

*Attendees should be accessed and communicated easily owing to the fact that data could be collected in sessions.*

*Students should be voluntary as it is important for them to be willing to provide data during the research,*

*They should have good communication skills as it is important for them to express themselves well,*

*They should study at upper grades as it is important for them to complete the basic science courses,*

*They should be successful academically during their university education as it is important for them to have high possibility of providing substantial case data.*

According to criteria abovementioned six pre-service Physics Teachers, receiving undergraduate education and received education about fundamental physics subjects, participated in the research.

First of all, an assessment was carried out in the study among the films of other genres except for science fiction which obviously contain basic physical topics in order to determine the awareness status and levels of attendees about the non-scientific scenes of movies, in particular. As a result of this assessment, two action movies called *Speed* released in 1994 and *Wanted* released in 2008 which were watched by many people, received awards and nominated to many other awards when they were first released were selected. First film lasts for 116 minutes while the other lasts for 110 minutes. In the selection of the movies, their popularity levels, not being a science-fiction movie, having Turkish dubbing and including basic scientific mistakes were taken into consideration. Turkish dubbed movies were selected as a subtitle would draw the attention of students from the visual elements.

In the research, two application sessions were held every other week. Prior to the applications, students were provided with the "*Film Assessment Forms*" which were previously developed by researchers. They were asked to note the scientific mistakes that they found in the films together with their exact times while they were watching movies. Original DVDs of films were obtained and students were made watch the films in the physics laboratory through a projector for an academic research purpose during sessions. Films were paused every 15-20 minutes and students noted the mistakes that they had found until that minute and discussed them. Scene transitions were paid attention while pausing the films. When movies were paused, they shared opinions and discussed about mistakes in previous session. Besides, group discussions of students were recorded via a tape recorder. Detailed information concerning the tape recorder files of group discussions were given in Table 1. Each session was completed by continuing the films from the point that they were stopped following the end of group discussions. Researchers never intervened in the discussions directly but only provided guidance to deepen the discussion when required. Some scenes were watched repeatedly by the students upon their requests during the discussion.

Data collected at the end of application were obtained from the documents containing the notes of students and the tape recorder manuscripts of the discussions. Strauss and Corbin (1990) recommend two types of data analysis methods to organize the collected data and to create a meaningful whole: descriptive analysis and content analysis. Purpose of the descriptive

**Table 3.** Distribution of mistakes detected in the first film by the scenes

| Scene Description | Mistake Description |
|---|---|
| *S1: Explosion of Elevator's Ropes* | M1: People could stand still while the elevator was falling down.<br>M2: Inconsistency seen in the electrical system of the elevator following its explosion.<br>M3: The time elapsing until the elevator stopped. |
| *S2: Arrival of the car to the scene* | M4: The car moved up from the ground without any platform.<br>M5: The rope of the lifter holding the elevator was not tense. |
| *S3: Explosion and fall of the Elevator* | M6: The lifter continued sliding while people were descending from the elevator. |
| *S4: Escape of the bomber* | M7: The door remained intact while the concrete structure next to the door broke into pieces.<br>M8: The police got off the ground with the effect of the explosion. |
| *S5: Explosion of the bus* | M9: The reflection of the fire on the telephone box.<br>M10: Paper stuck flat to the window of the bus and then flew away. |
| *S6: The police caught and got on the bus* | M11: The man flew out of the car when the sports car bumped into the barrels.<br>M12: The vehicle in the tow truck flew out.<br>M13: The bus did not get damaged in the fierce collisions. |
| *S7: Moving of the car on the road* | M14: Movement of the shopping cart into which the bus bumped.<br>M15: The car jumped through the gap in the road.<br>M16: Movement of the bus when the tires blew out at the entrance of airport. |
| *S8: Evacuation of passengers from the bus and its explosion* | M17: The board acting as a bridge fell to the pavement and sparked.<br>M18: The path of the platform enabling the evacuation of the police of driver girl and its sparkling. |
| *S9: Subway scene* | M19: The glasses did not explode when the driver of the train was shot.<br>M20: Movement of the police when the train accelerated.<br>M21: The train leapt out of the surface. |
| *S10: Derailment and stop of the subway* | M22: A part of the train which did not touch the ground sparked and did not leave any traces on the pavement. |

analysis is to summarize and interpret the data while the purpose of the content analysis is to interpret the data by conceptualizing and grouping them.

Data were examined in this study through the content analysis. Awareness levels were classified into groups according to certain criteria to facilitate the summarizing and interpretation of these data. Awareness levels were defined to categorized awareness of attendees. Two components were defined to determine awareness levels: (a) Awareness Status, (b) Explanation of Awareness. Awareness Status codes were being identified according to exist of awareness or not. If an attendee noted the mistake on "*Film Assessment Forms*", "1" was given as Awareness Status code. Otherwise "0" were given. Explanation of Awareness codes were being identified according to exist of explanation of awareness or not and to be explained rightly. If an attendee noted on "*Film Assessment Forms*" or mentioned during group discussion the explanation of mistake, among "0" and "3" were given as Explanation of Awareness code according to researchers' joint evaluation. By the two components, Awareness Level codes were determined among "0" and "4". These codes were scaled from the situation of lack of awareness to the situation of existence of awareness and scientifically true explanation. For instance, an awareness level scaled as "4" points out the fact that there is an awareness about the scene containing scientific mistake and this mistake could be expressed appropriately based on scientific theories. These criteria and categories were given in Table 2.

In the analysis, awareness status of students stated in the Table 2 and the awareness levels determined depending on the explanations made by the attendees on this awareness status were addressed separately and later, they were assessed holistically.

## RESULTS

In this section, documents completed by the students during the application and the tape recorder manuscripts were examined, and the findings were highlighted.

**Table 4.** Awareness levels of students in the first film

| Scene Code | Mistake Code | Attendee Code | | | | | | Awareness Ratio (%) | Sum of Awareness Levels |
|---|---|---|---|---|---|---|---|---|---|
| | | *A1* | *A2* | *A3* | *A4* | *A5* | *A6* | | |
| | M1 | 4 | 4 | 4 | 4 | 0 | 4 | 83.3 | 20 |
| S1 | M2 | 0 | 4 | 0 | 0 | 0 | 0 | 16.7 | 4 |
| | **M3** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| S2 | **M4** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| S3 | **M5** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| | M6 | 4 | 4 | 0 | 0 | 0 | 2 | 50.0 | 10 |
| S4 | M7 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| | M8 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| S5 | M9 | 4 | 0 | 0 | 0 | 0 | 0 | 16.7 | 4 |
| S6 | M10 | 4 | 4 | 4 | 3 | 0 | 4 | 83.3 | 19 |
| | **M11** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| | M12 | 4 | 4 | 4 | 0 | 0 | 4 | 66.7 | 16 |
| | M13 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| S7 | M14 | 3 | 3 | 0 | 0 | 0 | 2 | 50.0 | 8 |
| | M15 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| | M16 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| S8 | M17 | 0 | 2 | 0 | 0 | 0 | 0 | 16.7 | 2 |
| | **M18** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| S9 | M19 | 3 | 0 | 3 | 0 | 0 | 0 | 33.3 | 6 |
| | M20 | 4 | 0 | 4 | 4 | 4 | 0 | 66.7 | 16 |
| S10 | M21 | 4 | 0 | 0 | 4 | 4 | 0 | 50.0 | 12 |
| | M22 | **4** | **4** | **4** | **4** | **4** | **4** | 100.0 | 24 |
| **Sum of Awareness Levels** | | **58** | **49** | **43** | **39** | **32** | **40** | **-** | **261** |
| **Awareness Ratio (%)** | | **68.2** | **59.1** | **50.0** | **45.5** | **36.4** | **50.0** | **51.5** | **-** |

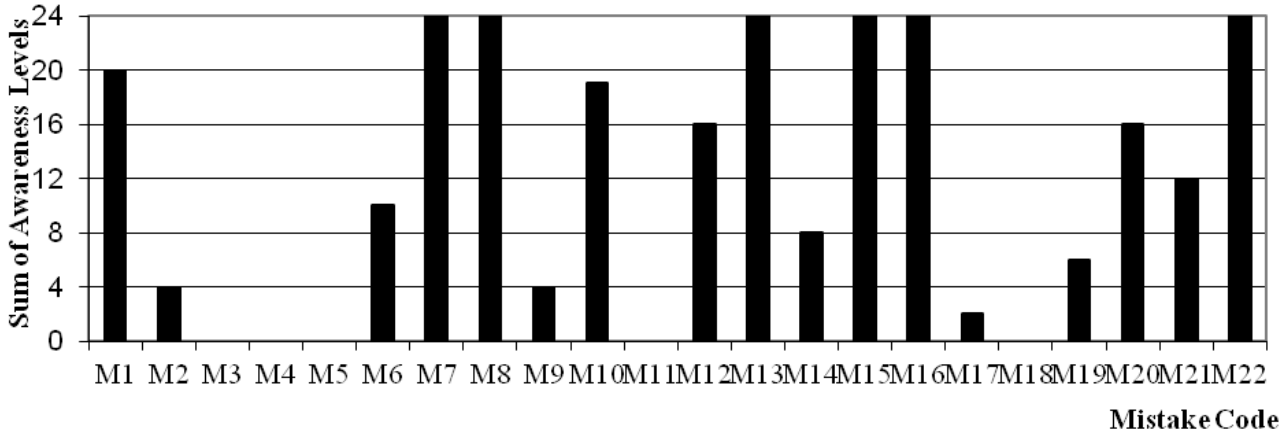


**Figure 1.** The sum total of students' awareness levels by the mistakes in the first film.

### Results Obtained from the First Movie

In the first application of the study, the movie called *Speed* was used. The film was first watched by the researchers and the existing scientific mistakes were detected, and later, the film was watched together with the attendees. In the meantime, researchers did not participate in the discussions directly but only observed them. They only led the discussions when required. Scientific mistakes found in the first movie were grouped on the basis of scenes and displayed in Table 3.

Distribution of the attendees' awareness levels for the first film by the scientifically faulty scenes and the mistake codes specified in Table 3 is indicated in Table 4.

According to Table 4, two mistakes in S4 were realised by the all students. Likewise, mistakes numbered 13, 15, and 16 in S7 and the mistake numbered 22 in S10 were realised by all students, while the mistakes numbered 3, 4, 5, 11, and 18 were not

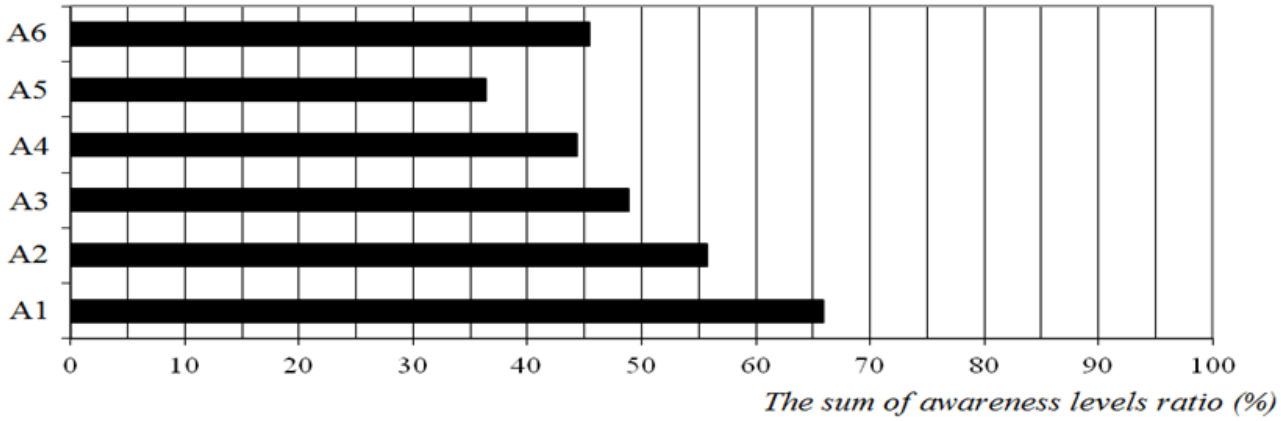


**Figure 2.** Ratio of sum total of students' individual awareness levels in the first film.

realised by any students in the application. The other mistakes have various percentages of realisations. It is a remarkable fact that most of the mistakes have a realisation of more than 50%. As well, general awareness percentage of the mistakes was detected as 51.5%. For any mistake in the first film, the half of the maximum value (6x4=24) of the total awareness level of the group is 12. The numbers of mistakes having awareness levels below or above this value were found to be equal to one another. The sum total of awareness levels of all students by the scientific mistakes is demonstrated in Figure 1.

Figure 1 indicates the awareness levels of students according to the mistake codes defining the faulty scenes in the first film. Mistakes (7, 8, 13, 15, 16, and 22 coded mistakes) realised by all of the students have the highest awareness level "4". On the other hand, it was expected that the awareness levels of mistakes (3, 4, 5, 11, and 18 coded mistakes) which were realised by none of the students correspond to "0".

There was a full awareness of the following mistakes:

*M7: The door remained intact while the concrete structure next to the door broke into pieces.*

*M8: The police got off the ground with the effect of the explosion.*

*M13: The bus did not get damaged in the fierce collisions.*

*M15: The car jumped over the gap in the road.*

*M16: Movement of the bus when the tires blew out at the entrance of airport.*

*M22: A part of the train which did not touch the ground sparked and did not leave any traces on the pavement.*

When these mistakes are examined, it is seen that S7 and S8 are related to what happens during the explosion. Students are aware of the fact that these explosions are exaggerated and unrealistic. M13 is associated with the collision while M16 is associated with the push affecting a moving element. Both of these mistakes are related to the topic of linear momentum, directly or indirectly. M15 is about the objects moving above the ground. Lastly, M22 is assessed as a mistake resulting from visual effects added in the film, either for action and visuality, or to arouse excitement.

There was no awareness of the following mistakes:

*M3: The time elapsing until the elevator stopped.*

*M4: The car moved up from the ground without any platform.*

*M5: The rope of the lifter holding the elevator was not tense.*

*M11: The man flew out of the car when the sports car bumped into the barrels.*

*M18: The path of the platform enabling the evacuation of the police of driver girl and its sparkling.*

When these mistakes are examined, it is seen that M3, M4, and M18 are directly related to the topics of motion while M11 is related to the Law of Inertia. M5 is about statics. In the light of these findings, it is striking that the mistake codes in which there was no awareness are related to the topics of mechanics. In the next phase, individual awareness levels of students were examined. The ratio of the sum total of students' individual awareness levels is indicated in Figure 2.

When the individual awareness of students indicated in Figure 2 is examined, it is evident that all students had awareness levels of 50% and above, except for two of them. While the sum totals of two students' awareness levels are above 44%, which is half of the maximum sum total that any student can have, the sum totals of four students are below this value. Considering that the sample consisted of the selected and voluntary students, this finding shows that the group was a conscious group and could use their existing cognitive competences.

### Results Obtained from the Second Movie

The second film used in the study was *Wanted*. This film was also watched by the researchers prior to the application and its scientific mistakes were detected. In the second session, held one week after the previous application, the film was watched by the students. As in the first film, students also noted the scientific mistakes that they detected while watching the film on the Film

**Table 5.** Distribution of mistakes detected in the second film by the scenes

| Scene Description | Mistake Description |
|---|---|
| *S1: The man jumps from one building to the other* | M1: The man got support from the elevator cabin to move.<br>M2: While the man was running, the papers in the next room lifted off the ground.<br>M3: The broken glasses did not harm the man who broke the glass.<br>M4: The man followed a linear orbit in the air. |
| *S2: Shooting of the man and movement of the bullet* | M5: When the bullet pierced through the man, the blood spurted from the front.<br>M6: Bullet fragments opened in the form of a screw and sloped down. |
| *S3: Scene of escape with the car* | M7: The man got onto the car which bumped into him, without a leg fracture.<br>M8: The front door of the car could be easily removed by shooting its four corners.<br>M9: The car lifted off the ground before crashing into another car. |
| *S4: Shooting the mosquito with gun* | M10: Movement of the mosquito while the bullet was passing by the mosquito.<br>M11: Its pulses reach to 400 in a minute. |
| *S5: Rapid healing of wounds* | M12: Wounds heal rapidly when the leukocytes are stimulated by external factors. |
| *S6: Hunting on the train* | M13: The woman, falling on the train from a rather high point, stood in balance. |
| *S7: Assassination scenes* | M14: The smoke coming out of the roof ventilation of the car moves upwards.<br>M15: The movement of the car when it used another car as a ramp. |
| *S8: Train accident* | M16: Glass from the wagon which fell down sharply did not break into pieces.<br>M17: When the father and son sank into the water, they initially remained on the surface for a while. |
| *S9: Weaving mill scene* | M18: The man did not get harmed when he fell against the glass door and broke it.<br>M19: The bullet pushed the knife. |
| *Generally in the film* | M20: Guided and circular movement of bullets. |

**Table 6.** Awareness levels of students in the second film

| Scene Code | Mistake Code | Attendee Code | | | | | | Awareness Ratio (%) | Sum of Awareness Levels |
|---|---|---|---|---|---|---|---|---|---|
| | | A1 | A2 | A3 | A4 | A5 | A6 | | |
| S1 | M1 | 3 | 3 | 0 | 0 | 1 | 3 | 66.7 | 10 |
| | M2 | 4 | 4 | 4 | 4 | 4 | 4 | 100.0 | 24 |
| | M3 | 3 | 4 | 1 | 0 | 0 | 0 | 50.0 | 8 |
| S2 | M4 | 1 | 0 | 0 | 1 | 2 | 0 | 50.0 | 4 |
| | M5 | 1 | 0 | 0 | 0 | 1 | 1 | 50.0 | 3 |
| | **M6** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| S3 | M7 | 4 | 4 | 4 | 4 | 0 | 4 | 83.3 | 20 |
| | M8 | 4 | 4 | 0 | 0 | 2 | 3 | 66.7 | 13 |
| | M9 | 0 | 4 | 4 | 0 | 1 | 4 | 66.7 | 13 |
| S4 | M10 | 4 | 0 | 4 | 0 | 0 | 4 | 50.0 | 12 |
| | M11 | 2 | 0 | 0 | 3 | 0 | 2 | 50.0 | 7 |
| S5 | **M12** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| S6 | M13 | 0 | 4 | 4 | 4 | 4 | 0 | 66.7 | 16 |
| S7 | **M14** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| | M15 | 0 | 3 | 3 | 0 | 1 | 0 | 50.0 | 7 |
| S8 | M16 | 4 | 4 | 0 | 0 | 4 | 4 | 66.7 | 16 |
| | M17 | 0 | 0 | 0 | 0 | 4 | 0 | 16.7 | 4 |
| S9 | **M18** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| | **M19** | **0** | **0** | **0** | **0** | **0** | **0** | **.0** | **0** |
| *Generally in the film* | M20 | 4 | 2 | 4 | 4 | 4 | 4 | 100.0 | 22 |
| **Sum of Awareness Levels** | | **34** | **36** | **28** | **20** | **28** | **33** | **-** | **46.7** |
| **Awareness Ratio (%)** | | **55.0** | **50.0** | **40.0** | **30.0** | **55.0** | **50.0** | **46.7** | **-** |

Assessment Forms. Benefiting from the data obtained from these documents and the students' tape recorder manuscripts, the awareness status of students and their awareness levels, determined by their scientific explanations concerning the mistakes, were detected on the basis of the mistakes specified depending on the described scenes.

Distribution of the attendees' awareness levels for the second film by the scientifically faulty scenes and the

mistake codes specified in Table 5 is indicated in Table 6.

Table 5 shows that faulty scenes, except S5, are generally related to mechanics. However, the fifth scene (S5), which is an exception within this scope, is related to biology. Likewise, the scenes coded as **M11**, related to S4 and the scenes coded as **M12**, related to S5 are also of subjects related to biology. Within this context, pre-service physics teachers are expected to have higher awareness levels with respect to the mistake codes.

Table 6 shows the awareness levels of the students concerning the second movie, according to the related mistake codes. For each mistake in Table 6, the data obtained from the feedback of students were assessed for five different levels. The highest awareness level was accepted as "4" while the lowest awareness level was accepted as "0". Thus, the total sum of awareness levels of all students can be 6x4=24 at maximum and 6x0=0 at minimum. On the basis of the students, the sum total of awareness levels of any student in the whole movie can be 22x4=88 at maximum and 22x0=0 at minimum.

According to Table 6, the mistakes numbered 2 and 20 were realised by all students; however, the mistakes numbered 6, 12, 14, 18, and 19 were not realised by any students. These mistakes are those which were previously found by the researchers; however, they could not be found by the students during the application. Table 6 indicates that mistakes other than these have various awareness levels. When overviewed, most of these mistakes have awareness levels of 50% or above, which is both a remarkable and pleasing finding. Moreover, the general awareness percentage of the mistakes was found out to be 46.7%.

For any mistake in the second movie, half of the maximum value of the total awareness level of the group (6x4=24) is 12. The number of mistakes having an awareness level below this value is 12, which means the number of mistakes having a total awareness level below 12, which is half of the maximum value of the total awareness level for any mistake, was found to be higher. Awareness levels of all students according to scientific mistakes are indicated in Figure 3.

Figure 3 indicates the awareness levels of students depending on the mistake codes defining the faulty scenes in the second film. Mistakes (2 and 20 coded mistakes) realised by all of the students have the highest awareness level "4". Furthermore, the fact that the awareness levels of mistakes (6, 12, 14, 18, and 19 coded mistakes) which were not realised by any of the students correspond to "0" can be evaluated as a result expected to be a nuance. The fact that only the following mistake has the full awareness level is remarkable:

*M2: While the man was running, the papers in the next room lifted.*

When this mistake is examined, it is discovered that the storyline includes Bernoulli's Principle, which is related to pressure and fluid mechanics. Students are aware of the fact that this situation is not realistic.

There was no awareness of the following mistakes:

*M6: Bullet fragments opened in the form of a screw and sloped down.*

*M12: Wounds heal rapidly when the leukocytes are stimulated by external factors.*

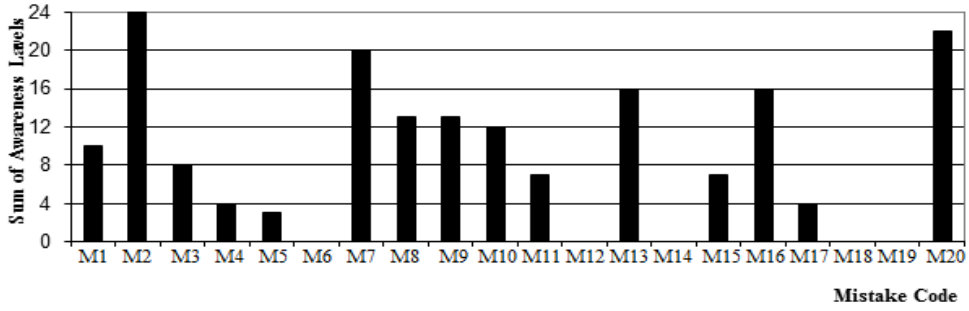


**Figure 3.** The sum total of students' awareness levels by the mistakes in the second film.

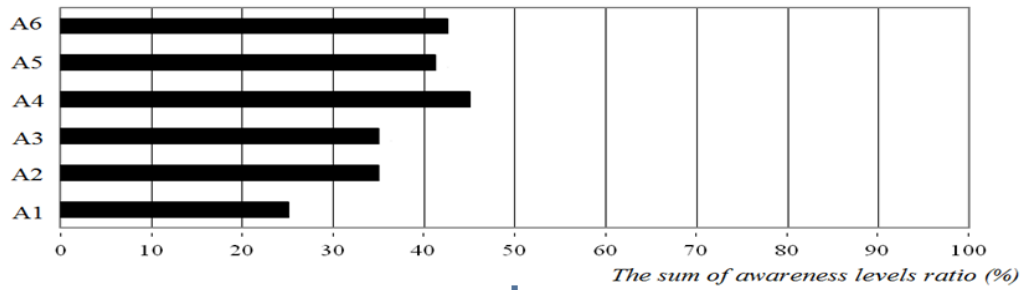


**Figure 4.** Ratio sum total of students' individual awareness levels in the second movie.

*M14: The smoke coming out of the roof ventilation of the car moves upwards.*
*M18: The man did not get harmed when he fell against the glass door and broke it.*
*M19: The bullet pushed the knife.*

When these mistakes are examined, M6 is seen to be related to motion on the earth. Furthermore, M19 is related to momentum and M14 is related to fluid mechanics and relativistic motions. M12 and M18 are seen to include biological and medical topics, rather than physics. Particularly because the mistake numbered 12 is related to biology and participants are pre-service physics teachers, the fact that the awareness level for this mistake is zero should not be regarded as strange.

In the next stage, the awareness levels of the students are examined individually. When the total sum of the awareness level is evaluated on the basis of all students, none of the students' awareness levels could pass above 40, half of the total maximum point. The ratio of the sum total of students' individual awareness levels is indicated in Figure 4.

Figure 4 indicates that the total individual awareness level of the students is below 50%. Considering that the sample consisted of selected and voluntary students, this situation seems to be curious as the students may be thought to have difficulties in realising the scenes which are far from reality, with the effect of visuality.

## DISCUSSION

It is beyond any doubt that successful motion-picture, which are appreciated by a vast number of audience groups and attract a considerable number of audiences, leave an important impact on audiences. These works form a significant resource for the lifelong-education period of the individuals.

Fantastic and science fiction movies may contribute positively to the development of a person's imagination or a person's genius. An article published by Brake and Thornton (2003), the focusing role of science fiction on the relationship between science, society, and culture is emphasised. For instance, in his published article, Al-Khalili (2003) discussed travelling in time and states that the audiences of movies such as *Back to the Future*, *The Terminator*, or *Time Machine* become more excited by the question of whether or not this idea can be realised. Dennis (2002) reported that "Hollywood Physics" could be used for attracting attention to physics. Similarly, in his work where he studies the relation between science and science fiction, Taylor (2003) talks about the importance of imagination, and referring to the film series of *Star Trek,* underlines that such works have made significant contributions to life-long learning. Efthimiou and Llewellyn (2004; 2006) reported that using movies in physics course effects not only students' attention but also achievements positively. In another study, Allday (2003) reports that the film series of *Star Trek* and *Star Wars* rendered science fiction favoured; however, he also points out the importance of the difference between fiction and physics (with his own words, "good" or "bad" physics) in the content of science fiction movies and remarks that the limits of this difference need to be known. Efthimiou and Llewellyn (2004) also suggested using physics in movies to increase the awareness of science. As it can be understood, the common character of these studies is that they are focused on science-fiction and stress the perception of awareness. To use physics in movies to increase the awareness of science, primarily awareness and awareness level of science in movies could be measurable. This study offers a suggestion for measurement and evaluation method.

## CONCLUSIONS

In this study, the awareness level of the group was found to be considerably high. Based on the findings obtained in the research, it was concluded that the level of scientific realism in the motion-pictures is critically questioned by the conscious audience and that the audience is aware of the role of reality and fiction in the scenes. This general conclusion corresponds to the conclusions reached in the studies within the body of literature (Al-Khalili, 2003; Allday, 2003; Arroio, 2010; Barnett et al, 2006; Brake and Thornton, 2003; Dark, 2005; Everitt and Patterson, 1999; Rogers, 2007; Rose, 2003; Smith, 2009; Taylor, 2003).

This study is important for the impact it made on the educative role of motion-pictures as the audience group critically questioned the level of scientific realism in the motion-picture. In this respect, the following recommendations can be provided for motion-pictures to be produced in the future and for the similar academic studies:

*It would be good for scenarists to take a serious academic consultation service during the scriptwriting processes of motion-pictures, which includes or is thought to include scientific realism in terms of physics.*
*Motion-pictures, chosen in accordance with a purpose, may contribute as a teaching tool for physics education. The study published by Arroio (2010) relates to this subject and also supports this study. The research in question suggests that cinema can be used as a context-based learning tool in science education.*
*This study may be repeated without informing the participants about the awareness of the physical facts and events in the movies before watching them. Then the findings and results obtained may be compared with those of this study.*

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