Comparison between Israeli and Hungarian high school physics teachers' attitudes towards general relativity assimilation in the curriculum

F Joubran¹ and L Várnai²

¹The Academic Arab College of Education in Israel, Haifa, Israel
²Padányi Katolikus High School, Veszprém, Hungary.

Abstract. On the assumption that any successful change on the curriculum is largely dependent on teachers being positive about it, we assessed and compared among 134 physics high school teachers' attitudes towards general relativity assimilation in the curriculum by an online questionnaire, 71 from Israel and 63 from Hungary. We assessed and compared five issues related to pedagogical knowledge and content knowledge: degree of past and current GR knowledge, expectations of obstacles in implementing GR in the classroom, degree of importance teaching GR as mandatory, degree of importance teaching GR as internal elective and coping with mathematics difficulty. The results showed that teachers in both countries think that teaching general relativity in high school has obstacles like lack of time and content knowledge. However, the high level of general relativity mathematics is not an obstacle in teaching general relativity.

1. Introduction

General relativity (GR) is one of the fundamental theories of physics in the 20th century. It has scientific (gravitational waves and black holes), technological (GPS), philosophical and cultural importance ([1]). Researchers in Norway, Australia ([1], [2]), and Germany ([3]), have conducted research on implementing GR in elementary, middle and high school. They developed and tested novel teaching models regarding gravity as the geometry of a unique connection between space, time and massive objects. Students showed a high level of knowledge and improvements in attitude regarding science. However, GR is not part of physics curriculum in most countries of the world, excluding Australia, Norway, Sweden, Germany, South Korea, and others. We think that prior to beginning the assimilation of GR in our countries - Israel and Hungary; we assume that any successful change in the curriculum is largely dependent on the teachers' positive attitude towards it. ([4]). Teachers' attitudes were assessed and compared by an online questionnaire covering five issues: the degree of past and current GR knowledge, expectations of obstacles in implementing GR in the classroom, degree of importance teaching GR as mandatory, degree of importance teaching GR as an internal elective keeping in mind coping with mathematics difficulty.

2. Methodology

2.1. Population and Sample

The population of the study included high school physics teachers in both Israel and Hungary. The population has been selected after meeting between the two authors at CERN (www.cern.org) international teachers workshop in 2018. The two countries have similar physics curriculum, population
and PISA test score. ([5]) However, they have a different culture and are in different continents. The sample was a convenient sampling of physics high school teachers, 63 of which were from Hungary and 71 teachers from Israel.

2.2. Data collection

The questionnaire (Appendix) included two parts. The first part of the questionnaire consisted of three questions regarding the years of teaching experience, the academic degree and school type (Public, Private and other). The second part consisted of six questions on five issues related to pedagogical knowledge and content knowledge. Three out of the five were closed questions and the other three were a Likert-type scale ranging from 5 (strongly agree) to 1 (strongly disagree). We developed four questionnaires in four languages: Arabic, Hebrew, English and Hungarian. The questionnaire was delivered to all teachers as Google doc by mail.

3. Results

In part 1 of the questionnaire, we compared academic degree (table 1), school type (table 2) and the number of years of teaching experience in high school physics teaching (figure 1).

| Table 1. Teachers’ academic degrees |
|----------------------------------|
| Bachelor Degree | Master Degree | Ph.D. Degree |
|-----------------|---------------|--------------|
| Israel          | 32%           | 52%          | 16%          |
| Hungary         | 3%            | 87%          | 8%           |

| Table 2. Type of schools |
|-------------------------|
| Public school | Private school | Other |
|----------------|----------------|-------|
| Israel         | 73%            | 21%   | 6%   |
| Hungary        | 79%            | 3%    | 18%  |

**Figure 1.** Number of years of experience in high school physics teaching

In the second part of the questionnaire, we compared five different issues in both countries. The first issue was whether the teachers had previous studies of GR (figure 2). The second issue examined how much of a current knowledge teachers possess (figure 3).
Figure 2. A Comparison between teachers in two countries of past studies of GR: Have You Studied GR as Part of Your Qualification

We found that the majority of the Israeli and Hungarian high school physics teachers, 69% and 83% respectively, have studied GR during their initial training in the past. However, regarding to the current knowledge, only 34% and 23% of the Israeli and Hungarian high school physics teachers, respectively, think that their knowledge of GR is sufficient to be transferred to students in the classroom.

Regarding to obstacles of teaching GR, Israeli high school physics teachers think that the main obstacle of teaching GR is time pressure, however, the Hungarian teachers think that the main obstacles of teaching GR are content knowledge and student responsiveness (figure 4).

Figure 3. Degree of Current GR Knowledge

Figure 4. Expectations of Obstacles in Implementing GR in The Class Room
We wanted to know what teachers in both countries thought about possible two options. The first option was teaching GR as a mandatory unit in the curriculum and the second was teaching GR as an elective unit in the curriculum. When we asked the teachers about the importance of teaching GR as mandatory, only 22% and 26% of Israeli and Hungarian teachers, respectively, agreed to its importance (figure 6). However, when we asked the teachers about the importance of teaching GR as elective or internal subject, 62% and 36% of Israeli and Hungarian teachers, respectively, agreed to its importance (figure 5).

Despite the Mathematics difficulty of GR, what is the teachers' attitudes towards having to teach GR with its obstacles? Is it still teachable in high school? (figure 7). We reveal that more than 50% of teachers, 56% of the Israeli teachers and 59% of the Hungarian teachers, think that GR could be teachable in high school despite its mathematical complexity.

---

**Figure 5.** Degree of Importance Teaching GR as Internal Elective

**Figure 6.** Degree of Importance Teaching GR as Mandatory

**Figure 7.** A comparison between teachers' attitude toward the option of teaching GR despite the mathematical difficulty
4. Conclusion
Regarding to the comparison between the two countries, we think that there are some similarities and other differences in teachers' attitudes, due to sociocultural issues and educational system in the two countries. ([6])

We highly recommend the assimilation of GR in high schools due to its scientific and technological importance that could affect students positively especially those who are interested in physics. On the other hand, both researchers and education decision makers should take into account teachers' attitudes in any curriculum changes proposals, such as lack of time and content knowledge.

We think that our research could be considered as a pilot research. For future research we suggest:
- Updating the questionnaire
- To include more countries
- To include a larger sample of teachers in the country
- Integrate semi-structured interviews with small sample of teachers

5. Appendix
Part 1
1. My years of teaching experience are: 1-5, 6-10, 11-20, 21-30, more than 30
2. My qualification is: Bachelor degree, Master degree, Ph.D. degree.
3. I am teaching in: public school, private school, other.

Part 2
1. Have you studied GR in any educational framework? YES or NO
2. If your previous answer was "YES", what is your degree of knowledge in GR?
   Very little, somewhat, good, very good.
3. In your opinion, what are the obstacles that could make GR teaching difficult for the teacher (In Assumption that it is not mandatory in the curriculum)?
   Content knowledge, pedagogical knowledge, lack of time, students' responsiveness.

Please indicate the degree to which you agree or disagree with each statement below by circling the number.

   5 = strongly agree (SA)
   4 = agree (A)
   3 = Uncertain (U)
   2 = disagree (D)
   1 = Strongly disagree (SD)

4. I think that GRT is an important physics Issue that should be taught at high school as a mandatory.
   5  4  3  2  1
   SA  A  U  D  SD

5. I think that GR is an important physics Issue that should be taught at high school as an elective (Not Mandatory ) with internal assessment.
   5  4  3  2  1
   SA  A  U  D  SD

6. I think that GRT could be teachable in high school despite its mathematics complexity
   5  4  3  2  1
   SA  A  U  D  SD

6. References
[1] Kersting M, Hemrikson E, Boe M and Angell C 2018 Phys. Rev. Phys. Educ. Res. 14, 0101301-18.
[2] Kaur T, Blair D, Moschilla J, Stannard W and Zadnik M 2017 Physics Education, 52 0665014.
[3] Zahn C and Kraus U 2014 Eur. J. Phys. 35 055020.
[4] Foppoli A, Choudhary R , Blair D, Kaur T, Moschilla J and Zadnik M 2019 Phys. Edu. 54 015001.
[5] OECD (2016), PISA 2015 Results (Volume I) : Excellence and Equity in Education (Summary), OECD Publishing, Paris, https://doi.org/10.1787/bc6256e2-en

[6] Jones G and Carter G 2018 Handbook of research on science education (pp. 1067–1104). (2018).