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Educational affordances of a specific web-based assistive technology for students with visual impairment

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ABSTRACT

The main aim of this study was to design, develop and test the instructional effectiveness of a web-based English vocabulary drill program developed for visually impaired middle school students. In this respect, the study focused on the educational affordances of the program and its contribution on VI students' spelling and semantics knowledge in English vocabulary. Depending on the purpose and the nature of the study, exploratory case study and single-subject research were implemented. Face-to-face intervention sessions were applied from October 2015 through to February 2016. There were two groups of participants in the study, which were students and experts. The data were collected through interviews, vocabulary and retention tests. Collected data were analyzed with both qualitative and quantitative data analysis techniques. Based on the qualitative data analysis, educational affordances of the web-based drill program were identified as instantaneous access to content, individualized instruction and tracking progress. Quantitative findings revealed that students showed substantial progress on the vocabulary tests and maintained their achievements after the study.

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Assistive technology; visually impaired education; accessibility; foreign language learning; drill and practice

Introduction

Visual Impairment (VI) is a cover term used for describing varying degrees of vision loss from low vision to through total blindness (Bailey & Hall, 1990). The eye has different parts working together, if one of the parts does not work well then visual impairment occurs. According to the data of the World Health Organization (WHO, 2014), 285 million people are recorded to be VI worldwide; 39 million are blind and 246 million have low vision. The magnitude of VI is a distinct and multidimensional phenomenon that cannot be ignored in today's society.

Today's fast moving and competitive environment causes VI people to face challenges in education (Presley & D'Andrea, 2009) which are limited access to information (Araluc, 2002; The Grundtvig Learning Partnership, 2008–2010) and teachers' lack of knowledge (Candela, 2003; Jennings, Long, & Jackie, 2002; Kapperman, Sticken, & Heinze, 2002; Parker et al., 1990). Teachers' lack of knowledge is also associated with their inability to use assistive technology (Candela, 2003; Kapperman et al., 2002).

With the improvements seen in technology, it has become more possible to create the required methodological and pedagogical conditions for people with vision loss. However, despite the existing technologies, VI people are faced with problems while learning a foreign language (FL) since text-to-

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speech technologies lessen their exposure to the written form of words (Gompel, Janssen, Van Bon, & Schreuder, 2003; Stein, Neßelrath, & Alexandersson, 2010). The current study attempts to overcome the problems of VI students in spelling English by designing and developing a web-based assistive technology. Educational affordances of that specific technology and its contribution on VI students' spelling and semantics knowledge in English vocabulary were investigated through research. Educational affordance is described as the relations between the properties of an educational intervention and the characteristics of the learner (Kirschner, 2002). In this study, the term ''educational affordances'' refers to properties of a specific web based assistive technology for VI students. As indicated by Bower and Sturman (2015), understanding the educational affordances of any technology is necessary since it ensures educational practitioners have an analytic approach that is adaptable to changes in new technology. The research questions driving the current study were ''(1) What are the educational affordances of a specific web-based drill program for students with visual impairment in English spelling?'' and (2) What is the contribution of web-based drill program on VI students' spelling and semantics knowledge in English vocabulary?

Background

Before 1980s, VI people were thought as being disadvantaged in foreign language (FL) learning due to their lack of vision (Brown, 1994; Turnbull, Turnbull, & Wehmeyer, 2007; Warren, 1994). This understanding has started to change dramatically in recent years and thus many pedagogical and technological solutions have been applied for VI people in FL learning.

Researchers now even consider VI people to be advantaged in FL learning due to their aural sensitivity (Araluc, 2002; Nicolic, 1987) and intense memory training (Araluc, 2002; Couper, 1996; Nicolic, 1987). Studies conducted in neuroscience also support the advantages of VI people based on their superior verbal memory when compared to their sighted counterparts due to activation in the occipital cortex, the visual processing center of the brain (Amedi, Raz, Pianka, Malach, & Zohary, 2003; Cattaneo & Vecchi, 2011; Hull & Mason, 1995; Pring, 2008; Raz, Amedi, & Zohary, 2005; Röder, Rösler, & Neville, 2001).

In the English language, it is not possible to understand the orthographic form of the words based simply on their pronunciation. Listening to text read through text-to-speech technology prevents VI people from learning the orthographic forms. For example, homophones mainly create problems like faze/phase; feat/feet; find/fined, etc. Thomas and Dieter's (1987) study indicated that the correct writing of words is necessary in order to gain good orthographic knowledge. Lack of orthographic knowledge creates problems in spelling (Arter & Mason, 1994; Couper, 1996; Moodley, 2004; Nater & Thale, 1994; Orsini-Jones, 2009). Orsini-Jones (2009) pointed out that VI people encounter problems while improving their reading and writing skills due to differences between the spelling and pronunciation of words. Since the existing computer technologies are incapable of meeting the needs of the VI, orthographic knowledge and spelling accuracy continue to be problematic.

Assistive technology

Assistive technology has had a huge impact and has contributed to the FL learning needs of VI people. Assistive technology, in the social context, aims for the full and equal participation of those with disabilities in society and to overcome the gap between what a disabled person aspires to achieve and what society generally allows (Hersh & Johnson, 2008). In order to compensate for their visual loss and deal with their additional challenges, VI people require the availability of assistive technology (Douglas, 2001; Douglas et al., 2009; Istenic & Bagon, 2014; Sousa, 2013). The most widespread assistive technology necessary for VI people in order to access curriculum or any other educational interventions effectively and efficiently are braille printers, text-to-speech technology, and screen magnification software.

A considerable amount of research study has emphasized the educational affordances of assistive technologies (Douglas et al., 2009; Kelly, 2009; Michaels & McDermott, 2003; Morrow, 1999; Sousa, 2013; Tobin, Bozick, Douglas, Greaney, & Ross, 1997). The crucial educational affordances of assistive technologies are mostly classified as instantaneous access to information (Hersh & Johnson, 2008; Kelly, 2009; Michaels & McDermott, 2003; Nicolić, 1986; Sreenivasan, 1996; Tobin et al., 1997) and individualized instruction (Messinger-Willma & Marino, 2010; Morrow, 1999; Tobin et al., 1997).

The first and primary educational affordance of assistive technology is ensuring access to information which facilitates the learning progress of VI people. Assistive technology is a way to reduce the handicapping effect of VI (Tobin et al., 1997) since VI people can instantly access information presented to the sighted (Kelly, 2009). The second educational affordance of assistive technology is ensuring individualized instruction which has a major importance in special education (Tobin et al., 1997). Kashdan and Barnes (1998) indicated that "all new English learners with visual limitations need some form of individualized instruction and problem-solving specifically adapted to their particular needs" (p. 4). Assistive technology can address issues related to the use of educational tools in meeting the individual requirements of VI people which is critical in diminishing the challenges (Morrow, 1999). In addition to the affordances mentioned, there have been limited studies that have investigated the contribution of assistive technologies in terms of improved educational performance (exceptions include Koenig & Ashcroft, 1983; LaGrow, 1981). Those studies revealed that assistive technology has a positive impact on the educational performance of VI people.

In essence, assistive technology for VI individuals is fundamental, and is considered as equivalent to pencil and paper for sighted students (Sousa, 2013) and is therefore powerful in changing how VI people are provided with instruction.

Methods

Design and development of web-based assistive technology

During the design and development process, the researchers conducted a comprehensive collaborative investigation with experts in VI education. Since those students are VI, visualized materials were not employed and the content was prepared as purely auditory. Also, auditory feedback was provided for the orthographic errors of the participants. In order to reach the web-based drill program, Internet connection, a computer with headset, and screen reader program were needed. Students used Jaws for Windows screen reader program with Turkish language feature in order to access the different sections of the web-based drill program. Despite using Jaws screen reader, the web-based drill program also provided in-built auditory feedback and guidance for critical parts. For the spelling, voice of a native English speaker was recorded and embedded to the program. In brief, Jaws was used to access the Web-based drill program and the English content was provided with embedded recorded voice.

The web-based drill program included different sections to ensure VI students practice spelling with the required vocabulary. The main sections of the program are:

- I am Learning Vocabulary: Words are given unit by unit. All of the words are read and spelled by the program. Students have the chance to listen several times.
- I am practicing: Words are given randomly, read by the program and the students try to write what they heard ten times. Three types of feedback are offered to the user. If the user input is:
  (1) Correct: Program gives positive feedback and directs to the next word.
  (2) Partially correct (maximum three errors): Program gives encouraging feedback. User may try again.
  (3) Incorrect: Program gives short feedback and spells the word in English. User may not try again.
- I am trying my Speed: Provides practice for improving keyboard skills whilst learning spelling. First they are given 15 s for each single word, then ten seconds, and finally seven seconds. System provides a score for each correct answer.

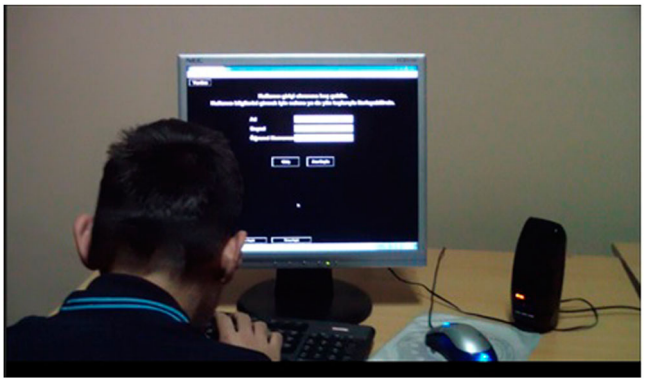


Figure 1. A picture from training session.

- I am playing a Game: Scenario-based task completion. Scores increase gradually based on levels.

When the development process was completed, approval from the university's Institutional Review Board (IRB) and Ministry of National Education were obtained. Face-to-face interventions were implemented in Turkey twice a week between October 2015 and February 2016. Each intervention lasted between two and three hours and was conducted after school hours. The study was implemented by two researchers at two public schools for VI but mostly at School "A" due to the convenience of the laboratories and access to the teachers. The computer laboratories of the school were used during all implementation stages (Figures 1 and 2).

Research method and setting

The method of the current study includes two steps as a qualitative exploratory case study within a single-subject research design. Firstly, in terms of exploratory case study, interviews were conducted in order to understand the affordances of the web-based drill program based on the experiences of both students and experts.

Secondly, in terms of single-subject research design, multiple probe design across behaviors model was applied. This model investigates the effect of one independent variable over at least three different behaviors. The dependent variable of the study was the students' achievement at vocabulary units (friendship, tourism, chores, and science) in terms of both spelling and semantics. For each unit, words (total 40) were included. The independent variable is the web-based drill program. The study followed four progress stages, which were baseline, training, generalization, and maintenance.

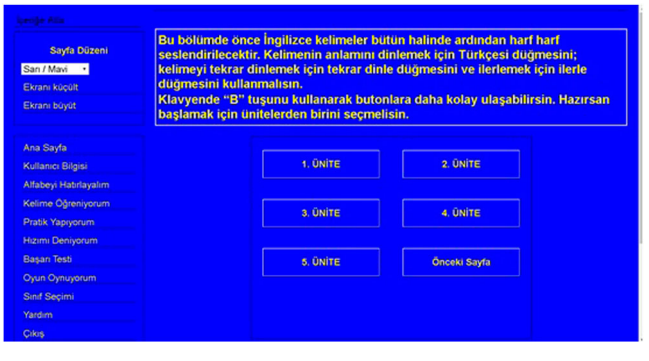


Figure 2. A screenshot of web-based drill program.

- Baseline: Three repetitive baseline data were gathered individually from students in a computer laboratory setting. Those baseline data were pre-test scores of the students. While collecting baseline data for the friendship unit, one probe data was also gathered for the other three units. Similarly, when collecting baseline data for the tourism unit, one probe data was gathered for the other two units, and so on.
- Training: At least three data items were gathered in order to understand the effect of intervention on student achievement. This level was conducted until stability for the data was assured.
- Generalization: One data item was gathered in order to understand whether or not students can use their knowledge in another situation. Students were required to write all 40 words randomly.
- Maintenance: This level was conducted in order to understand when the intervention had reached an end point, and whether or not students were able to remember the words. After completing each unit's intervention, at least a break of six weeks was given; then three data points were gathered every two weeks.

Participants

The first group of participants of the study were seventh and eighth-grade middle school students. Based on purposive sampling, a total of 15 participants took part in the study. Convenience sampling was implemented in this study which is one of the purposive sampling strategies and relies on data collection from members who are available to participate in a study. The study was conducted after official school hours in the evening which made convenience sampling a necessity. Semi-structured interviews were conducted with the students. Frequent vocabulary and retention tests were implemented in order to test the effectiveness of the web-based drill program. However, those tests were conducted with only six of the students since only they were able to attend all the intervention sessions. The remaining nine students attended at least one month of the study. All of the participants had basic computer skills including keyboard usage since they took computer courses during primary school years. The difference was only related to their speed while using the keyboard.

The second group of participants were experts. Expert was used as a general label to refer English teachers, computer teachers and programmers who are VI or at least have experience in VI education and accessibility issues. Purposive sampling strategy was also used in the group of four expert participants (Tables 1 and 2).

Table 1. Information about the students.

Participant*	Cycles attended	Visual ımpairment %	Gender	Grade
WP1	All	100	Male	8th
WP2	All	100	Male	8th
WP3	All	100	Male	8th
WP4	All	80	Male	8th
WP5	All	80	Male	8th
WP6	All	90	Male	8th
PP1	Second	100	Male	7th
PP2	Second	100	Female	8th
PP3	Second	100	Female	8th
PP4	Second	100	Male	7th
PP5	Second	100	Male	7th
PP6	Second	90	Female	7th
PP7	Third	100	Female	8th
PP8	Third	100	Female	8th
PP9	Third	100	Male	8th

*WP(#) = whole participant, attended all interventions of the study.
*PP(#) = partial participant, attended at least one month of the study.

Table 2. Information about the experts.

Participant	Cycles contributed	Visual ımpairment %	Gender	Job
E1	All	100	Male	Primary School teacher & Computer Programmer
E2	All	100	Female	English Teacher
E3	All	NO	Male	English Teacher
E4	Second (formative evaluation)	100	Male	Computer Teacher

Data analysis

Collected data were analyzed with both qualitative and quantitative data analysis techniques. For qualitative data analysis, content analysis was performed in order to define the patterns most frequently used. In order to establish reliability, intercoder agreement was used as a strategy. The researcher discussed with two intercoders separately in order to finalize the codebook. For quantitative data analysis, experimental criterion was employed as an evaluation method and data were analyzed with the aid of visual graphs. In order to visually analyze the data, time series graphs were used which requires the gathering of data within regular time intervals. Graphs were developed based on the intervention times. Interobserver reliability was ensured in this study due to single subject research design. Two researchers observed the four progress stages, which were baseline, training, generalization, and maintenance and fill in a test form independently. Interobserver reliability was calculated with the formula of Agreements / Agreements + Disagreements × 100 (Kazdin, 1982). When the tests of two independent researchers were compared, reliability was measured as 100%.

Results

Qualitative data results

From coding of both the student and expert interview data, three main categories emerged.

Instantaneous access to information

The first issue in VI education mentioned by participants was accessing content. The experts mainly indicated that in mainstream education, they face problems in providing accessible content due to the generic use of colorful materials. The other problem is trying to teach the content to VI learners in the same amount of time with sighted students. Considering the negative aspects, all of the participants were satisfied with the web-based drill program in the current study as it provides instantaneous access to the content. All of the experts stated that current study was appropriate in terms of accessibility issues and very good in providing the content with clear instructions, clear functions, and easy to use navigation features. This category was discussed by the participants within two sub-categories, as practicality and time efficiency.

Practicality. This sub-category of instantaneous access to information mainly related to the evaluation of whether or not the designed and developed program contributed to the target setting and whether or not the target users can work with the intervention effectively. Based on the interviews, it is possible to say the program has an actual practicality. Ten of the students emphasized that the program was clear, accessible and time-efficient. Their comments were mainly focused around one important factor, which was adequate practice opportunity. Nine of the students especially mentioned about that factor, and indicated that compared to their face-to-face class environment they have a better chance to practice in order to absorb the lesson. One of the students stated that ‘‘In this environment we are making enough practice easily, I think I am learning. It makes us form a habit while writing. Teaches spelling’’ (WP4).

Time Efficiency. In terms of time efficiency, seven students made comments. They were mainly satisfied since they had the chance to learn the words in a short amount of time when compared to the face-to-face class environment.

Individualized instruction

As supported with the results, VI individuals may not benefit from the group education in a meaningful manner which as a result demotivates them. Ten students mentioned the benefits of this factor since in the current study they had chance to learn based on their own pace and different vision levels. According to the students' interviews, individualized instruction is of paramount significance in VI students' learning because they consider their individual differences present difficulties in traditional education. One of the students stated that:

> In class, the teacher reads a book, and at the same time wants us to write. But we cannot catch the teacher every time. Thus, we get bored easily. But here (web-based) we are alone, we can practice based on our pace if we do not learn … I gained a positive attitude and I understand that English can be learned through having fun. (PP2).

Tracking progress

This was an important factor for the students because by following their own progress they can estimate their level and study more through self-encouragement. Ten of the students emphasized that they do not have that chance in their regular class environment, since tracking progress in that environment was under the control of the teacher. Students favored two features of the program in terms of tracking progress as auditory feedback and scores.

Auditory Feedback. The study results revealed that auditory feedback was prerequisite in the teaching and learning process of VI students. By providing regular auditory feedback it was possible to catch the students' attention and also keep their attention active.

Scores. Students mentioned that gaining scores was crucial in order to figure out their performance during the intervention, and which motivated them to study more. They were satisfied by receiving scores in different sections of the program which informed them about how they were progressing throughout the study.

Quantitative data results

Interview results revealed that the program was beneficial for the students due to the affordances mentioned and as a result they perceived that they had made good progress throughout the study. Ten of the students noted that they improved their knowledge in terms of spelling and semantics; which, considering the goals of the study, was very promising. Further examination of the results revealed that students thought that the current study was beneficial in terms of teaching them spelling and semantics. Results of the quantitative data analysis are presented in this section which provides empirical data for better educational performance.

Students were required to reach 80% success criterion for each unit. For student WP1, when the baseline condition was compared to the training condition it was seen that WP1 met the success criterion and was able to maintain 100% success after completion of the intervention for all four behaviors. Comparison of WP2's baseline and training condition revealed that WP2 was successful with all of the behaviors and was able to maintain his success to at least 80% during maintenance. Similar to WP2, WP3 also increased success rate after the intervention according to the baseline condition and was also at least 80% successful in the maintenance phase. One critical score was the third maintenance section of semantics which was 70% for WP3. This decrease was related to the long duration of the study. The scores for WP4 were not as stable as WP1, WP2 and WP3; however, WP4 was successful at the training phase and continued his success to at least 80% in maintenance. Comparison of WP5's baseline and training condition revealed that WP5 was successful with all behaviors and was able to keep his success to at least 80% during maintenance. WP6 was also successful during training sessions when compared to his baseline condition. He was able to reach at least 80% success for both skills, and mostly continued his success during maintenance.

Thus, the baseline data for all six students were stable before the intervention. All of the students showed immediate increases in spelling and semantics achievement following the introduction of

the intervention. Training changes for all students were seen in the desired direction. The desired change of the behaviors during training was replicated with an additional phase named maintenance, and still the positive change in all behaviors was maintained by all of the students.

The following six graphs show the vocabulary and retention test results for all behaviors for each individual student. The horizontal axes of the graphs represent the implementation sessions, whilst the vertical axes represent student achievement scores for each unit (Figures 3–8).

Generalization data for six participants were gathered at the same time for all of the vocabulary taught by using MS Word program. Students were required to listen to the teacher and then write the spelling and semantics of the word. The following figures represent the generalization data results (Figures 9 and 10).

Discussion

Affordances of this current study support the previous research in assistive technologies for VI learners in terms of instantaneous access to content and individualized instruction. This study combines the developed assistive technology with an adequate teaching strategy and assessment plans. When considered as a whole, the study had an additional major affordance, which was tracking progress.

Instantaneous access to content is a feature of the program that reduces the handicapping effect of VI. One of the primary challenges that VI learners face is access to information, which increases the demand on assistive technologies (Douglas et al., 2009; Michaels & McDermott, 2003; Sousa, 2013; Tobin et al., 1997). In parallel to this argument, all participants of the current study mentioned instantaneous access as a major affordance since it allowed students to practically access information and with time efficiency. The first aspect of facilitating learning progress is practicality of the environment. In terms of the program, its practicality relates to its effectiveness in meeting target students' wishes and needs. As pointed out by Nieveen (1999), the practicality of an instructional tool relates to its effectiveness. Similarly, Jitendra, Edwards, Sacks, and Jacobson (2004) highlighted this issue and indicated that practicality is the critical issue in vocabulary instruction through computer-aided environments. According to this current study's findings, the practicality features of the program ensure that students have adequate practice opportunity. Especially, those students who missed out on content from face-to-face classroom instruction and were unable to meet with their teacher emphasized that during the study they felt equal to the other students since the practicality feature of the program enabled them to access content whenever they needed. Repetition was also attributed as a strong point of the study since undertaking adequate practice through different activities contributes greatly in terms of improving students' word knowledge. This item corroborates the arguments of Pokrivčáková et al. (2015) who stated that continuous repetition of educational materials must be present during the whole foreign language education of special needs' students in order to prevent failure and other issues.

The other issue regarding practicality was time efficiency. This study ensured that students achieved an adequate level of repetition in a timely manner. This issue is critical since it concerns one of the barriers that VI students face in their traditional education. Due to the time-related issues, VI students cannot find the opportunity to undertake practice in class, which negatively affects their learning process. Providing students with an effectively designed environment that ensures adequate and efficient repetition time is one of the ways to address such barriers. Similarly, the results of the experts' interviews revealed that due to the practicality features of the program, students were able to learn content in a shorter period of time when compared to face-to-face class instruction. This also supports the arguments of Watkins and Slocum (2004) who underlined that the teaching of basic skills should be achieved in the minimum time possible.

As an affordance, individualized instruction was repeatedly mentioned by both students and experts as they believed it to have many advantages in VI education. This finding corroborates the arguments of another study that VI learners often need individualized instruction because in the regular class they cannot master the required skills since the content cannot be provided in a

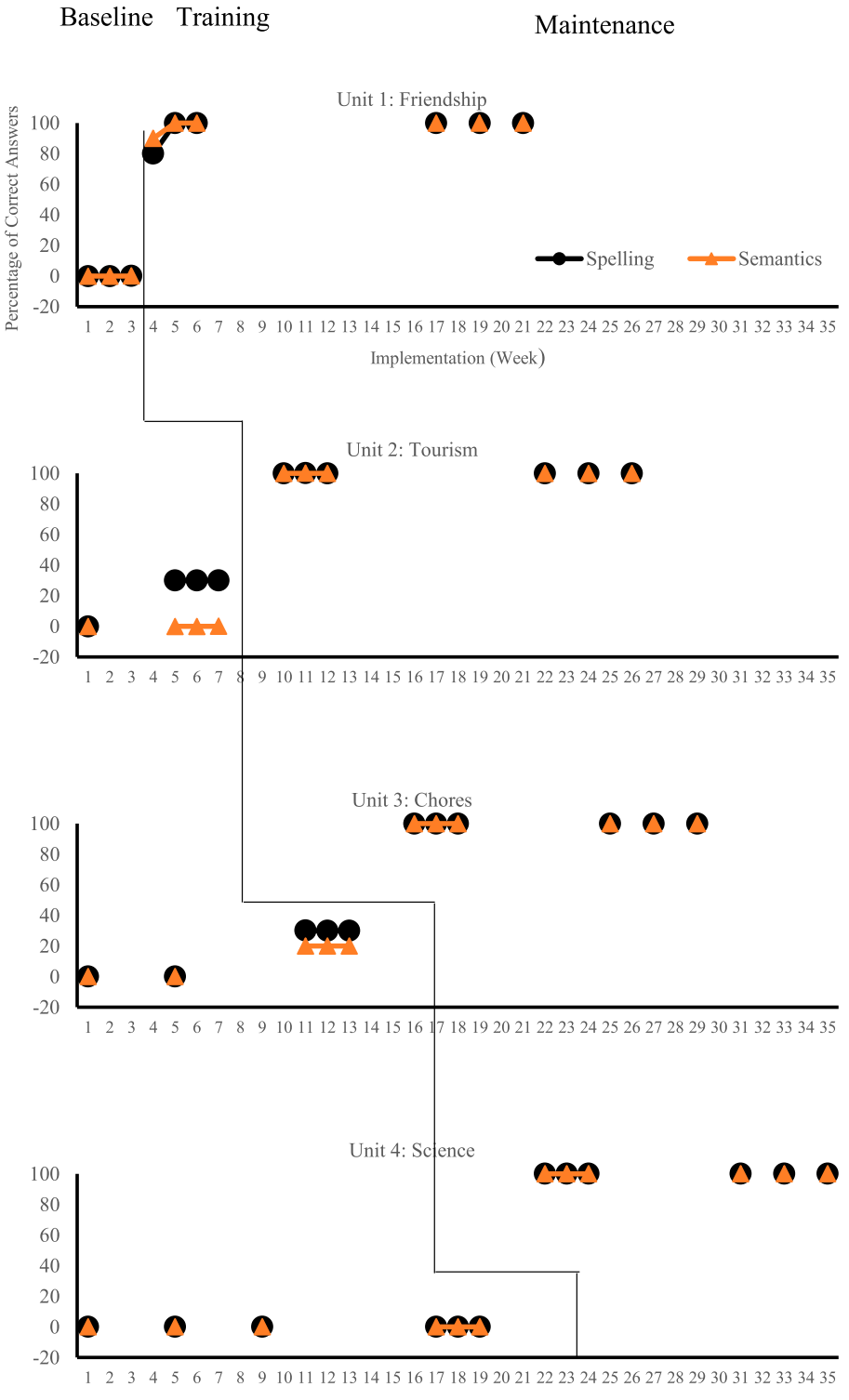


Figure 3. Achievement percentages of WP1.

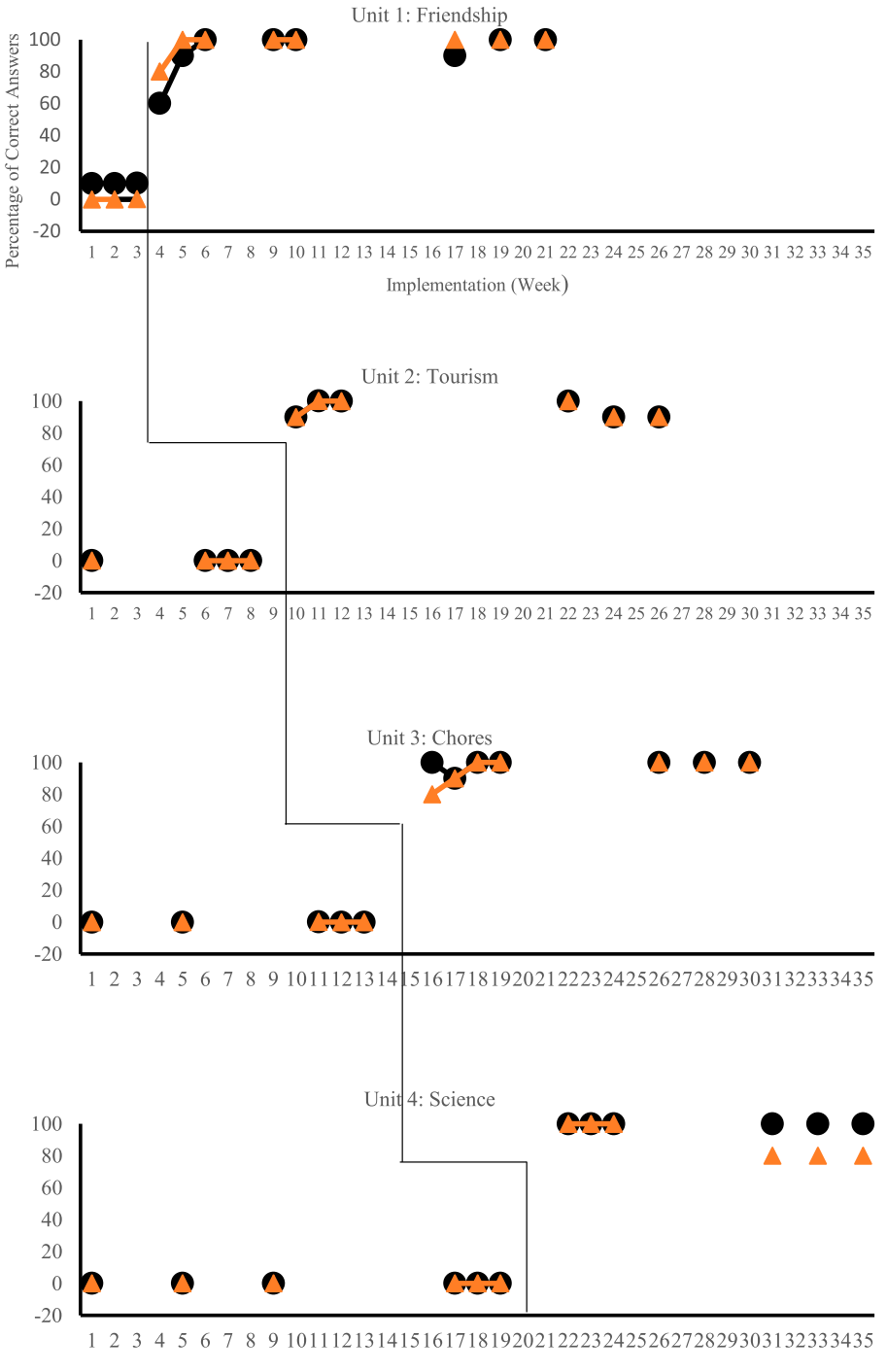


Figure 4. Achievement percentages of WP2.

meaningful manner ("Learning about Blindness", 2017). In line with that, students in this current study expressed experiencing difficulties in the traditional classroom while following content during group instruction due to diversity in intellectual strengths of the class. In contrast, students stated that they benefitted from this study since they were able to study at their own pace and in

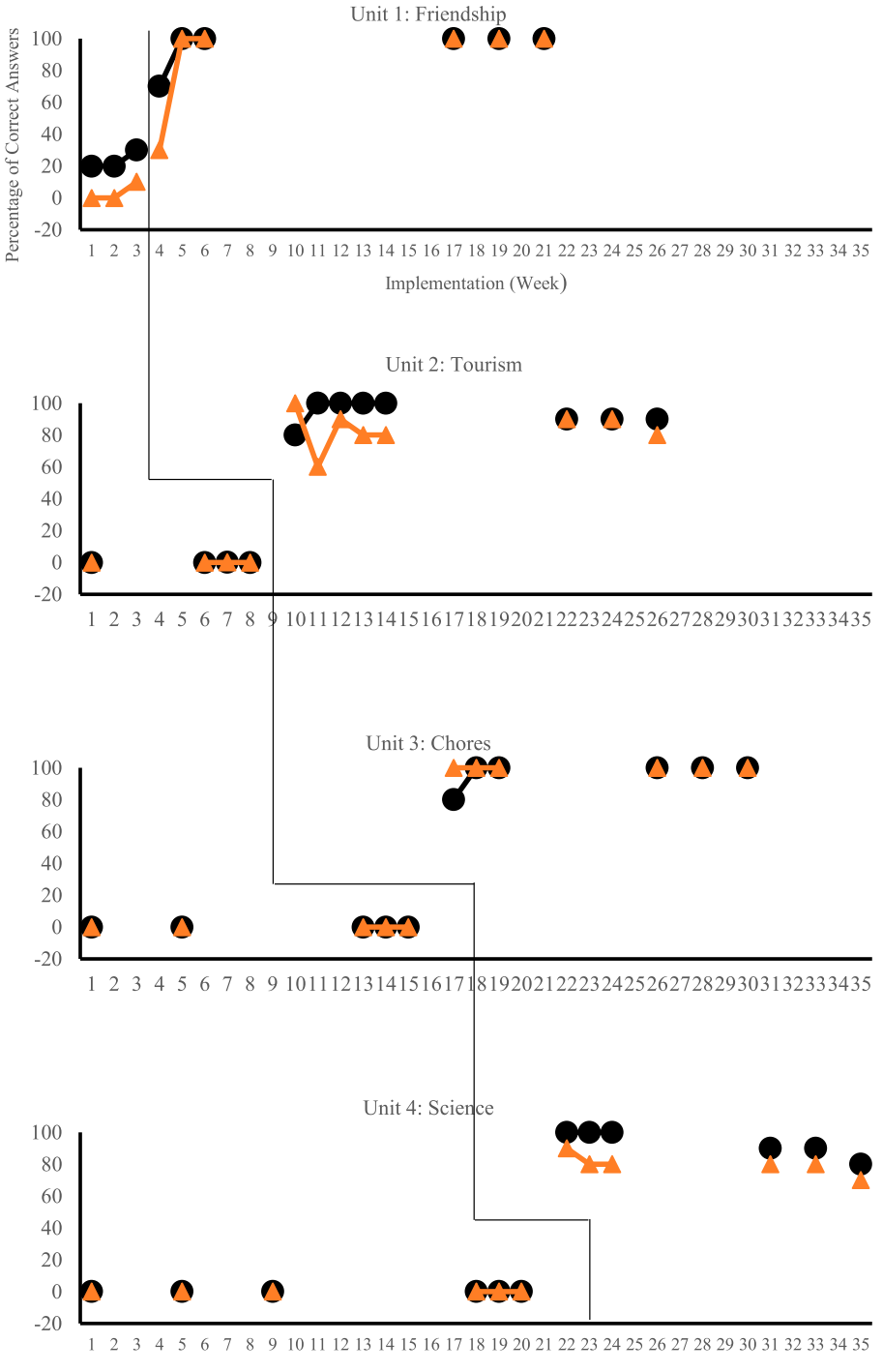


Figure 5. Achievement percentages of WP3.

their own way. According to this study's findings, the reason behind this was students having been provided with the opportunity for self-paced learning which was closely related to their being successful. As discussed by Stainback and Stainback (1992), when students are not treated as individuals

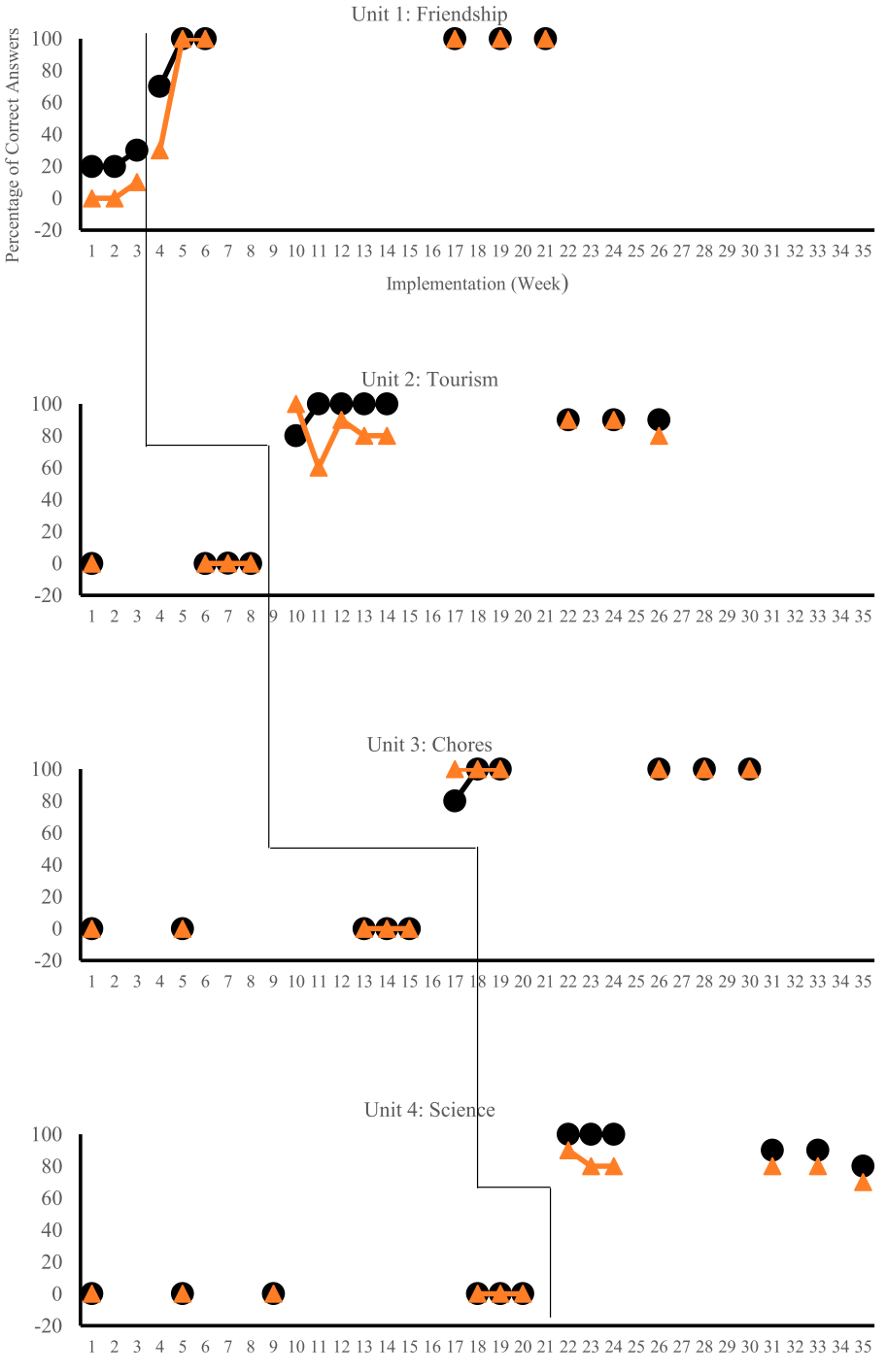


Figure 6. Achievement percentages of WP4.

it is not possible for them to be successful. Similarly, Pugach and Warger (1996) pointed out that if the unique learning needs of students are not recognized, they cannot reach their potential.

The other affordance mentioned by the students was tracking their own progress, thus they were able to figure out their own level and encourage themselves to study more. As Newton and Dell

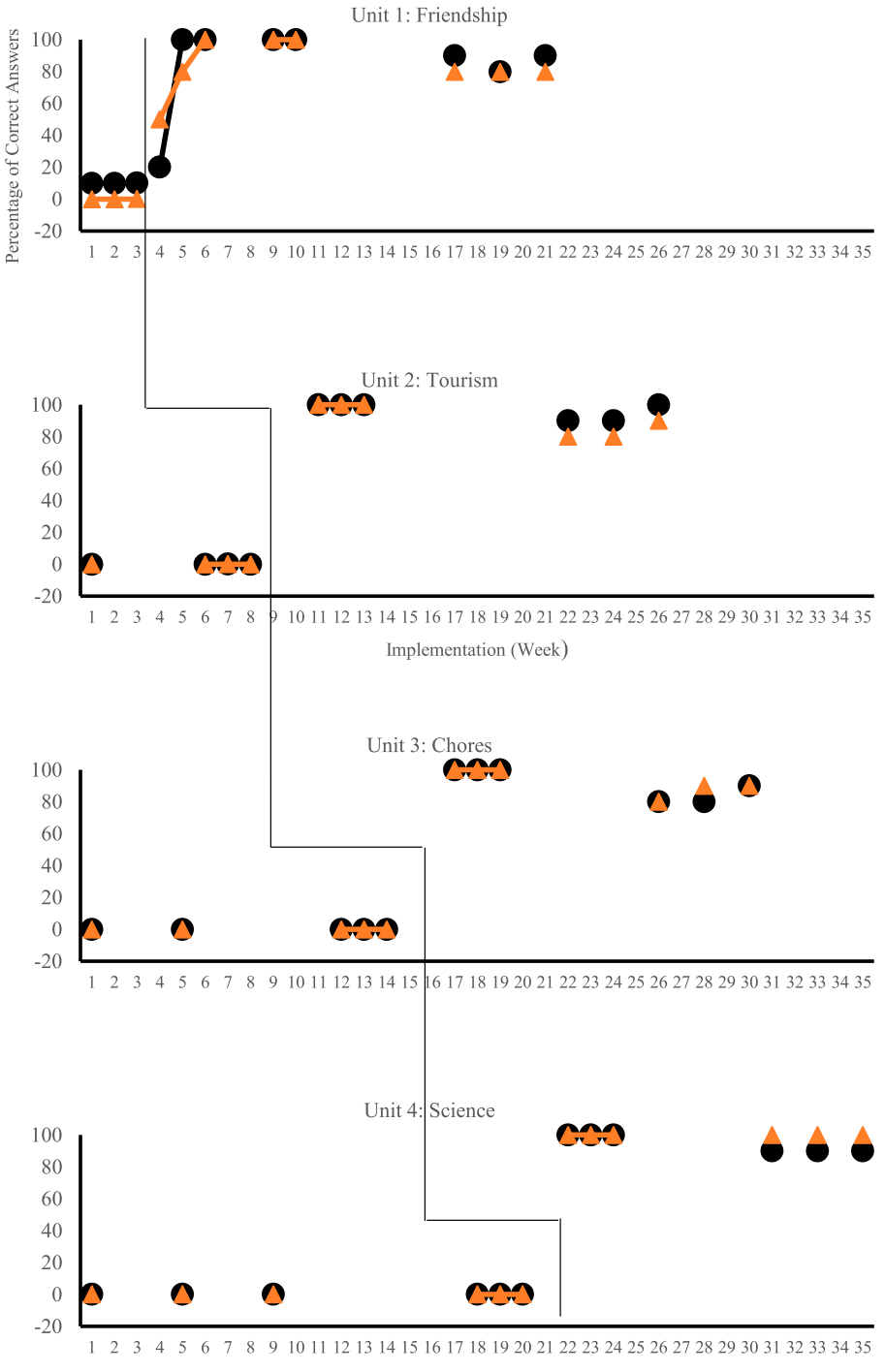


Figure 7. Achievement percentages of WP5.

(2011) pointed out, tracking assignments or grades is one of the ways to help disabled learners become organized which is very hard without an assistive technology. The auditory feedback provided by the program was especially highlighted by the students as an affordance since it ensures students are made aware of their performance. Considering VI students' individual needs, it was

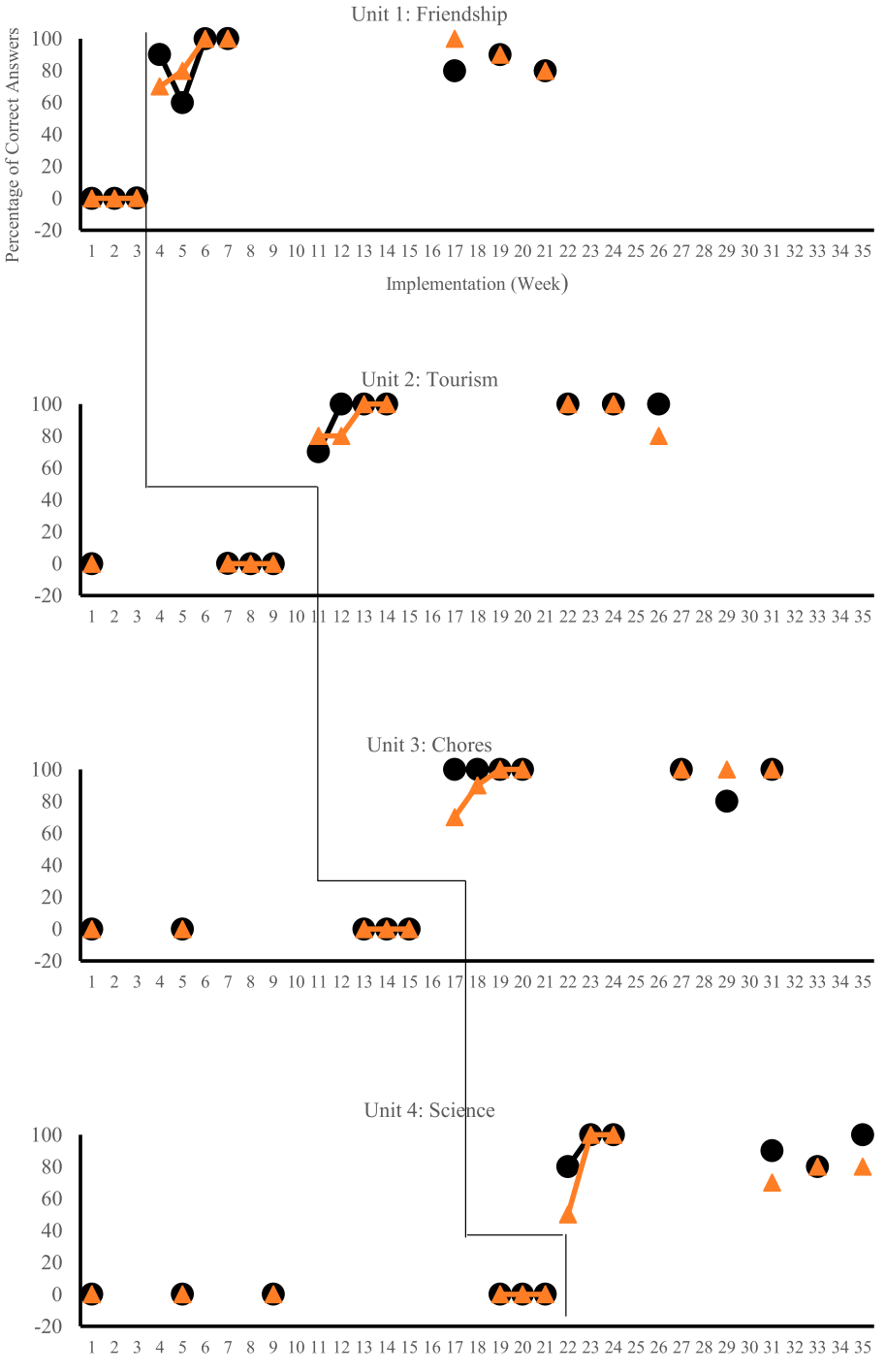


Figure 8. Achievement percentages of WP6.

seen that auditory feedback was a prerequisite in their learning process. The significance of auditory feedback was also highlighted by Stein et al. (2010) who indicated that auditory feedback may be an alternative solution to teach spelling to VI students. In another study, McGookin, Brewster, and Jiang

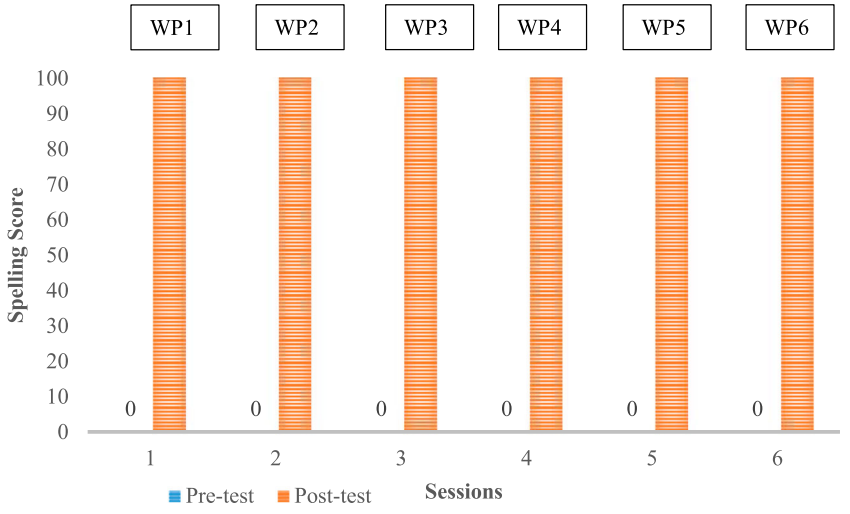


Figure 9. Percentage of correct spelling responses during generalization.

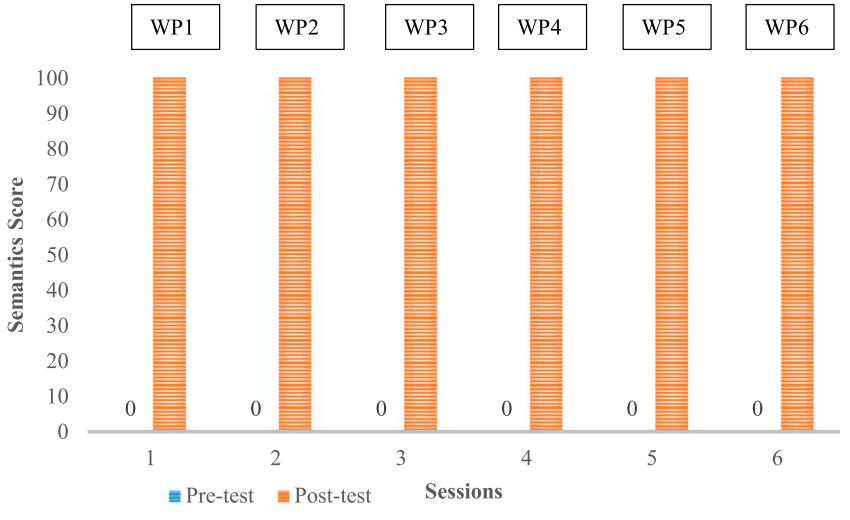


Figure 10. Percentage of correct semantics responses of during generalization.

(2008) found that auditory feedback was helpful in improving dragging performance of VI students with severe impairments.

Additionally, students stated that they were able to improve their vocabulary knowledge and their computer literacy at the same time. Achievement of the students can be associated with the appropriate intervention implemented during the study. By properly designing the program, providing students with accessible content and with an appropriated teaching strategy, it is possible to stimulate success. This result implies that VI students can be successful in reaching their potential when provided with adequate intervention. As mentioned in the literature, VI individuals are able to achieve a similar level of intellectual and educational success as the sighted (Cattaneo & Vecchi, 2011; Pring, 2008) when they receive appropriate intervention (Milian & Ferrell, 1998). The visual analysis of the students' single-subject data allowed a conclusion to be drawn that all six students showed substantial progress with the vocabulary test based on the 80% success criterion. In the literature,

there have been many studies and projects in the computer-assisted vocabulary learning (CAVL) field conducted for the vocabulary improvement of VI learners (Hub, Diepstraten, & Ertl, 2005; Jayakody et al., 2016; Stein et al., 2010; Stein, Neßelrath, Alexandersson, & Tröger, 2011); however, those studies were limited to the investigation of the design process. Different from those studies, this current study investigated the achievement process of students in addition to designing and developing a program.

Conclusion and suggestion

Qualitative data analysis support the educational affordances mentioned in the literature. Additionally, the current study found that tracking progress is also an affordance of assistive technology. Results of the study showed a long-term benefit of the study in enhancing vocabulary knowledge.

These promising results of the program relate to its proper design and development process considering the target groups' specific needs. Based on the results of the current study, the following items are suggested:

- This study investigated the contribution of the program by implementing repetitive vocabulary tests. Further studies can replicate the vocabulary tests which will provide more evidence-based practice.
- This study concentrated on the teaching of vocabulary in terms of spelling and semantics. The web-based drill program developed in this study can be utilized in teaching orthography, phonology, semantics and syntax simultaneously. Trying to teach all aspects of vocabulary learning can be studied and the contribution of the program can be further examined.
- Further research is needed to investigate the effect of tracking students' own progress on achievement. Experimental studies can be conducted by comparing face-to-face class and computer-based environments in terms of self-tracking progress.
- One limitation of this study was the Internet dependency. Hence, future studies should concentrate on developing mobile applications that supported by operating systems without Internet dependence.

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