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Examining Students' Perceptions About an Adaptive-Responsive Online Homework System and its Influence on Motivation and Learning

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Abstract

Advances in technological education have made online homework an integral part of science courses in general which is especially true for general chemistry courses. Online homework, if used correctly, has the potential to improve students' experience, and learning and performance in general chemistry courses. The purpose of this research investigation is to study students' levels of perceptions about an adaptive-responsive online homework in terms of (1) examining students' motivation, learning, and understanding of concepts, (2) determining the aspects of adaptive-responsive online homework that are useful to students' learning, and (3) understanding the features in online homework that causes improvement in students' motivation. The investigation took place at an urban, commuter, minority serving, and public college. The study subjects were recruited from student enrolled in general chemistry courses consisting of 207 research participants (N = 207). Our data suggest that students display positive levels of perceptions about the adaptive-responsive online homework and its use. Students also hold perceptions that show positive attitudes towards the online homework system and that it positively affected their motivation. Also, students list several useful aspects of the online homework system such as explanations of concepts, knowledge checks, review questions for tests, and tutorials. The adaptive-responsive online homework, according to the participants in our study, helped motivate students by helping them learn the concepts, continuously assessing their learning, checking their knowledge, and updating the topics accordingly.

Keywords:
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Motivation
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1. Introduction

1.1. Online Homework and Assessment and Learning in Knowledge Spaces (ALEKS)

Online homework is merely an alternative to the traditional paper-based homework system. With online homework programs, instructors have the opportunity to develop, distribute, and grade students' homework through the silicon-based web system (Fynewever, 2008). Providing students with an effective and engaging learning experience in general chemistry courses, a large enrollment course, can be an arduous task. Online homework is popular with instructors because it provides individualized feedback to students especially in large classes which might prove challenging for instructors if done by traditional homework (Bonham, Deardorff, & Beichner, 2003). It makes it easier for instructors to track students' progress and provide students with up to date grades and feedback. Online homework systems became very popular amongst universities especially in the sciences.

The reason universities implemented online homework is primarily because it is a more affordable alternative. Not only did it make it easier for instructors by automatically grading students' assignments, but it also provides students with instantaneous feedback. Online homework systems can be used to support some key principles of good practices in undergraduate education which include: providing prompt feedback, promoting active learning, and underscoring time on task (Chickering, Gamson, & Poulsen, 1987). Online homework programs provide students with a sense of achievement, hence motivating them to finish all their assignments in time and as precisely as possible. Some research findings suggest that online homework has positive impact on students' attitudes (Richards-Babb, Drelick, Henry, & Robertson-Honecker, 2011). Additionally, students have the perceptions about online homework as a useful course component (Revell, 2014). Web based assignments allow students to keep up with homework from the comfort of their own homes, become more computer savvy, as well as carry less notebooks and books. General chemistry students using an online homework programs have been proven to perform better in classes as well as heighten students holding in the course (Richards-Babb & Jackson, 2011).

Assessment and Learning in Knowledge Spaces system (ALEKS) is a cutting-edge adaptive-responsive learning platform at thousands of K-12 schools, colleges, and universities worldwide. ALEKS utilizes the techniques of adaptive-responsive questioning to distinguish what a student knows and doesn't know in a course in a quick and timely fashion. The system then reports to the student on his or her questioning results. The student periodically gets reassessed to ensure the topics are learned as the student works through a course. ALEKS periodically reassesses the student to ensure that topics learned are retained. Furthermore, ALEKS provides a detailed, graphed report of what the student knows, does not know, and is ready to learn. Based on that report, the student can choose from the list of lessons to be learned. As he or she shows a mastery of a problem, it gets added to the student's knowledge state, and another problem type can be chosen.

Traditional online homework systems use traditional-responsive where all of the students complete the same set of problems regardless of their mastery of the content levels, whereas, Assessment and Learning in Knowledge Spaces (ALEKS), an adaptive-responsive online homework system, continuously tailors the learning activities and assessment for the individual student based on mastery of content (Eichler & Peeples, 2013). ALEKS online homework platforms rely on Knowledge Space Theory (KST) in individualizing each student's learning activities and learning pathways. In summary, KST continuously monitors and updates a student's current knowledge-space based on performance and assessment (Grayce, 2013). Knowledge Space Theory relies on a combinatorial viewpoint on the assessment of knowledge, and thus departs from common, numerical evaluation (Doignon & Falmagne, 1999).

In ALEKS online learning platform, the individual student's learning environment is designed to the student's zone of proximal development to ensure meaningful learning (Ausubel, 1968).

ALEKS continuous and periodic assessment of student's content competency has been shown to benefit learning and knowledge retention (Nunes & Karpicke, 2015).

1.2. Motivational Theories

Why exactly people want what they want and loath the things they do not want is something of a mystery. It is a black box that has not been fully penetrated. Over the years, psychologists have postulated different theories of motivation in order to understand our nature, chief among which is Maslow's hierarchy of needs, which stats that people are motivated to achieve certain needs, when one need is fulfilled a person seeks to fulfil the next one, and so on (Maslow, 1943).

Motivation is defined as "a theoretical construct used to explain the initiation, direction, intensity, and persistence of behavior, especially goal-directed behavior" (Brophy, 2013). Motivation drives and influences students' decisions to act to accomplish results such as learning (Burden & Williams, 1997) and it involves goals that cause a purposeful action (Hartnett, 2016). Motivated students tend to pay attention, ask questions, work harder, answer questions, and are eager to learn (Turner & Patrick, 2008). Student motivation is an important component of quality education (Williams & Williams, 2011). Motivation, according to experts in the field of education, plays a significant role in influencing learning (Lim, 2004).

One theory that tries to explain human motivation is the self-determination theory (SDT). Self-determination theory is a theory of motivation with two basic tenants: intrinsic and extrinsic motivation (Deci & Ryan, 1985). The theory was initiated as a response to the idea that people's motivation is entirely based on environmental reward or punishment. SDT comes and counters this antiquated idea and explains that people can feel recompensed for ceasing a task by simply doing that task without a need for any awards or recognition. The name self-determination was derived from the two assumptions on which the theory was built; intrinsic motivation and the fulfilment of the three psychological needs. Being the helpful natural drive that it is, intrinsic motivation helps in overcoming problems and overall enriching the quality of one's life. At the same time, the three psychological needs that are assumed are autonomy, competence and relatedness. The sturdiest two assumptions are the freedom of will (autonomy) and mastery of a pursuit (competence); the weakest of the assumptions is the feeling of belonging (relatedness) (Ryan & Powelson, 1991). In spite of having a natural predisposition to enhance one's performance and reach the highest optimal level of success, people still find a way to undermine those natural tendencies.

To understand what intrinsic motivation is one must first recognize that humans have an inborn tendency to be intrinsically motivated. Now, what does it mean to be intrinsically motivated? The concept of intrinsic motivation describes an innate attraction towards exploration, mastery, challenge, and integration which are all vital to cognitive growth and development. This inborn attraction is a main source of enjoyment throughout one's life. However, being born with intrinsic motivation does not necessarily mean that it is easy to maintain and enhance. According to Ryan. and Deci (2000) "the maintenance and enhancement of this inherent propensity requires supportive conditions, as it can be fairly readily disrupted by various non-supportive conditions." This statement highlights that there are factors that can help sustain intrinsic motivation and that, without them, it can be very easy for this inherent proclivity to fade away.

One way that intrinsic motivation relates to STD is through the cognitive evaluation theory (CET). CET is a sub-theory within SDT that aims to enable intrinsic motivation rather than weaken it; this theory was presented by Deci and Ryan (1985). The theory explores the different ways that social and life events such as everyday communication, rewards, or even feedback effect intrinsic motivation. According to the CET, positive feedback, optimal challenges and overall freedom from anything demeaning are all ways that intrinsic motivation can be enabled.

On the other hand, negative performance pointers play a huge role in diminishing intrinsic motivation (Deci, Cascio, & Krusell, 1975). The theory further explains the feeling of competence alone is not enough to reach optimal intrinsic motivation. Rather, a sense of autonomy must be accompanied with it as well. Autonomy, the ability to make choices according to one's own free will, can be easily weakened which undermines intrinsic motivation. There is controversy on the effect of reward on weakening autonomy but the meta-analysis (Deci, Koestner, & Ryan, 1999) put that controversy to rest, as it proved that all anticipated concrete rewards that relied on assignment performance challenge intrinsic motivation. Intrinsically motivated students are described as task-oriented. Learning a subject brings them enjoyment and satisfaction. Extrinsically motivated students are described as ego-oriented. They learn the subject because of external incentives such as punishments or rewards (Ward & Bodner, 1993).

Extrinsic motivation is subdivided into four major categories. The first category is external regulation. Externally regulated individuals' complete tasks because they expect to be either rewarded or punished for completing the task or lack thereof, respectively. External regulation has an external perceived locus of causality (PLC). Extrinsic and intrinsic motivations are opposites of each other where they vary in the degree of PLC and regulatory processes of internalization and integration. Students that are externally regulated are prepared to learn a specific subject for one of two reasons. The student either wants to attain a high grade hence, securing a gratifying feeling for working towards it, or is afraid of scoring a low grade hence trying to avoid the feeling of guilt for getting that grade. The second category is introjection regulation which has a somewhat external PLC in comparison to external regulation. Which

depend solely on approval from others (Ryan & Deci, 2000).

The third type of extrinsic motivation is identified regulation which involves a somewhat internal PLC. Individuals with identified regulation perform tasks because this specific task is of personal importance to them and can potentially help them reach their goals. A student might be motivated to learn or excel in a subject because the student believes that knowledge of that subject is crucial for their future. The integrated regulation is the most self-regulated subtype of extrinsic motivation, the closest to intrinsic motivation, and has internal PLC. Students who are inherently regulated have internalized and homogenized the value of the task. Research shows that students who are autonomously regulated have higher academic performance, are more engaged in learning, and give their teachers higher ratings (Hayamizu, 1997; Miserandino, 1996).

1.3. Guiding Research Questions

We wanted to examine whether artificially intelligent learning systems such as ALEKS might support and enhance students' perceptions about whether ALEKS online homework platform helps students improve their problem solving skills and understanding of content. We also wanted to study whether ALEKS online homework platform increases students' self-adequacy in their knowledge of chemistry concepts as well as provide them with the basic skills to decipher chemistry problems. As for motivation, students taking the course had the opportunity to both form study groups and discuss ALEKS problems during office hours, which could positively influence students' perception of competence and relatedness. However, completing ALEKS assignments was a mandatory part of the course and held a risk of reducing students' grades if assignments were not taken seriously. Hence, we wanted to examine whether this has a negative effect on students' perception of autonomy.

Our research was structured to address the following specific questions:

1. What are the students' levels of perceptions about the motivation of ALEKS online homework platform?
2. What are the students' levels of perceptions about whether ALEKS online homework platform helps students improve their problem solving skills and understanding of content?
3. What are the ways ALEKS helped motivate students as online homework platform?
4. What are some of the aspects of ALEKS that students find most useful?

2. Methods

Our purpose for this research is to investigate the students' perceptions of responsive-adaptive online homework, ALEKS, implemented in the general chemistry courses here at the City College of New York. Students in all sections of general chemistry completed weekly online homework assignments, using the commercially available ALEKS online homework platform. The topics that used ALEKS in this study are the standard topics covered in the two semester sequence of general chemistry courses. Our research design is based on examining students' perceptions about ALEKS by using a survey that provided us with data to aid in our investigation. The survey was given to two experts who agree that the questions adequately capture the investigation about ALEKS. As for reliability, the reliability coefficient was found to be 0.78 through the use of test-retest reliability method. Furthermore, we conducted interviews on a subset of the participants to illicit more information and some clarifications, which was valuable in coding the data using rubrics.

In order to answer our research questions, we set out to collect data through a questionnaire given out to The City College of New York students enrolled in general chemistry courses at the City College of New York. Majority of students were Science, Technology, Engineering and Mathematics (STEM) majors. The participants were recruited from students enrolled in general chemistry I and II courses consisting of 207 participants (N = 207). In order to properly examine the students' perceptions about ALEKS impact on students' motivation, understanding of content, and problem solving skills, data were collected in several ways. Data collection was broken down into a Likert-type questionnaire, a short answer questionnaire, and student interviews. The surveys were anonymous and the interviewees picked at random. The participants were informed of their rights and the survey was administered, collected, analyzed and stored according to an approved the Internal Review Board protocol.

The Likert-type section included eight questions that were scaled between strongly disagree and strongly agree. The Likert-type section was scored on a five-point scale ranging from (1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, and (5) Strongly agree. The data were collected from our survey was used to examine the type of responses that we would get and to help in the creation of a rubric for the open-ended questions. The rubric is useful for sorting the data into manageable categories. The rubric was created by attempting to look for patterns in the explanations that were provided in the answers of open ended questions. For the open-ended questions that we collected, we used a rubric to give a value to each answer, a score of 1 is applied if there was an overall negative response, a score of 3 is applied for a neutral answer, and a score of 5 is applied when the student gave an overall positive response. The first and second authors scored the open-ended responses based on the rubric independently. The agreement was found to be 90%. The two co-authors discussed the discrepancies until consensus was reached. Then the individual values were combined and converted into averages. For two of the open ended questions, we compiled all the answers, placed them into categories, converted them into percentages, and were able to obtain a pie chart for the results.

3. Results

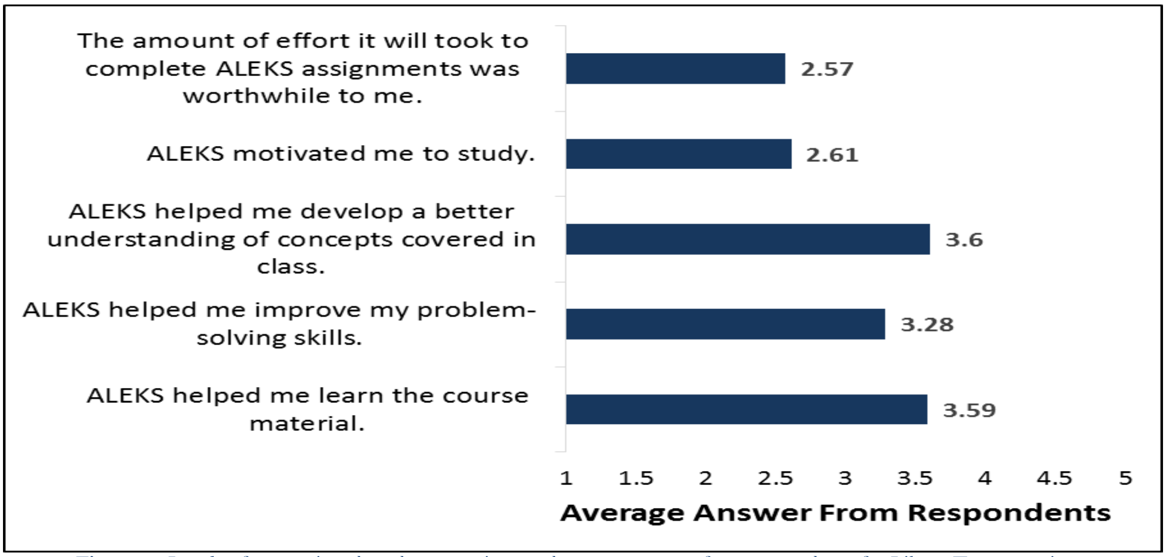

Figure-1. Levels of perceptions based on questions and average answer from respondents for Likert-Type questions.

As can be seen from Figure 1, which is a depiction of five Likert-type questions and average answer from respondents, students exhibited positive perceptions the role ALEKS online homework platforms played on the development of concept understanding and the learning of the material. This is supported by research in the field that shows students exhibiting positive perceptions about online homework (Smolira, 2008) and that online homework is beneficial in understanding of concepts and topics (Doorn, Janssen, & O'brien, 2010).

Furthermore, the instant feedback provided by online homework system positively impacts students' grades and attitudes towards chemistry (Parker & Loudon, 2013). Additionally, according to one research project in mathematics education, feedback for multiple attempts from online homework positively impacted students' understanding and performance (Zerr, 2007). Feedback for multiple attempts is credited with improving motivation due improving the learning in students (Riffell & Sibley, 2003).

On the other hand, students' had neutral perceptions about the worthiness of the amount of effort put into ALEKS, its roles in motivating them to study, and its assistance in improving problem solving skills. This can be improved by setting deadlines and making the online homework as a required part of the course with a contributing component of the overall grade which may increase students' motivation and attention toward homework (LaRose, 2010).

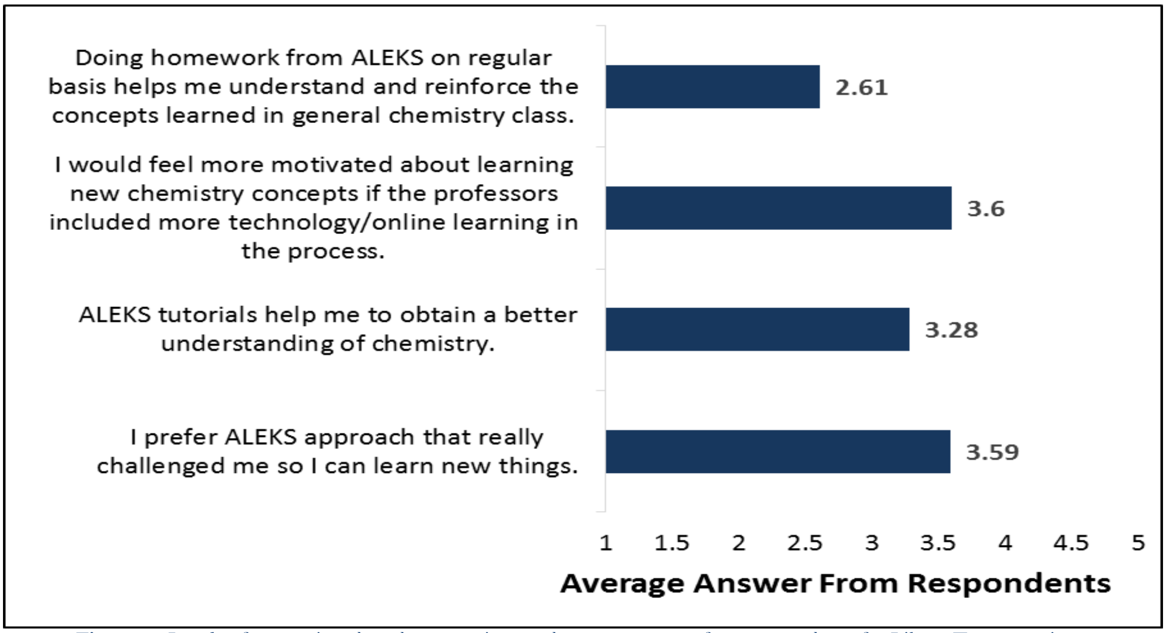

Figure-2. Levels of perceptions based on questions and average answer from respondents for Likert-Type questions.

Figure 2 presents four more questions from the Likert-type survey. Students reported positive perceptions about use of technology and motivation about learning and a preference to the ALEKS approach in learning. Research in the field reports that online homework systems have been found to challenge students by forcing them students to spend additional time solving individual problems while taking advantages of hints and multiple attempts (Smithrud & Pinhas, 2015). On the other hand, students exhibited neutral perceptions about the role of ALEKS in reinforcing and understanding concepts learned and the role of ALEKS tutorial in the development of understanding. Students spend significantly more time on adaptive-responsive online homework systems than traditional responsive systems (Eichler & Peeples, 2013) which could impact their perceptions of it.

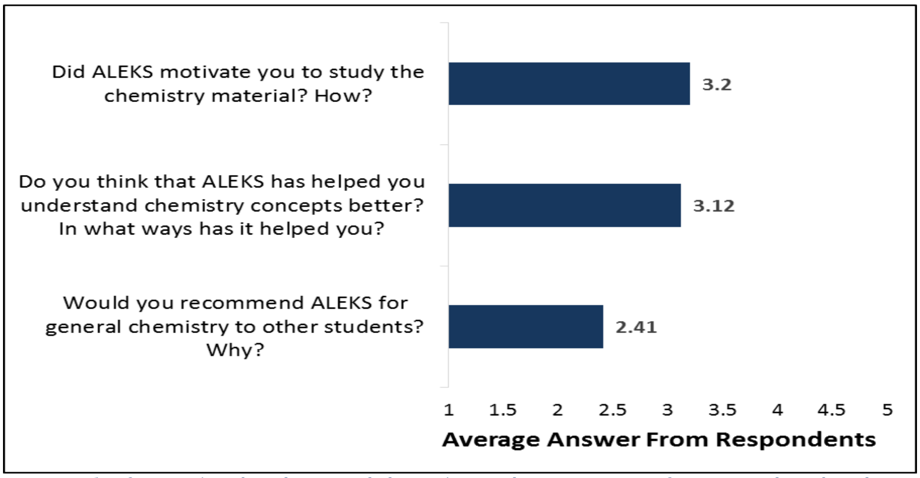

Figure-3. Levels of perceptions based open ended questions and average answer from respondents based on rubric.

Figure 3 is a depiction of the students' perceptions about ALEKS's motivation impact, role in learning, and attitudes. Our data indicate that the students' perceptions of ALEKS as motivating factor, role in understanding chemistry concepts, and their recommendations of it, are neutral. Although, we should mention that students rated motivation with the highest averages of the three. One explanation is that online homework has a set weekly time for submission and that might negatively affect students autonomous part of motivation. The continuous and periodic assessment causes frustrations with ALEKS in some of the weaker students who have to complete additional 20 to 30 problems weekly which might negatively impact their perceptions of ALEKS. Similar results have been found on adaptive-responsive systems, which positively impacts students' performance and study habits. However, students view it less favorably than traditional online homework system (Richards-Babb, Curtis, Ratcliff, Roy, & Mikalik, 2018). Furthermore, better performing and more motivated students exhibit more satisfaction with online homework (Doorn et al., 2010).

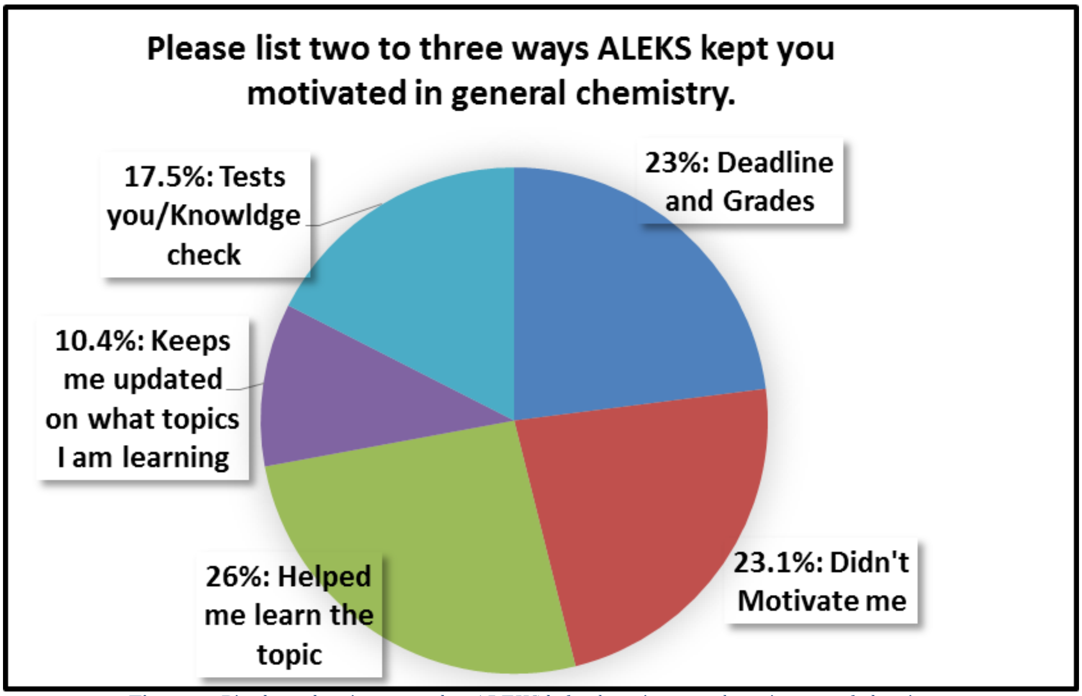

Figure-4. Pie chart showing ways that ALEKS helped motivate students in general chemistry.

Figure 4 is a depiction of ways that ALEKS online homework platform helped motivate students. 26% of students reported that it motivated them through the help it provided learning about the topics, whereas, 23% found the deadline and grades as the most motivating factors. Providing students with an active learning environment and allowing them to be actively involved in the learning and teaching processes has a positive impact on their motivation and self-efficacy (Cicuto & Torres, 2016). Furthermore, 17.5% of participants reported that knowledge checks and continuous assessment as top motivating factors. This is supported by other findings that suggests ALEKS online homework system conducts periodic assessment on individual students to assess their mastery of the content which has a positive effect on learning and knowledge retention through practice retrieval (Karpicke & Grimaldi, 2012). 10.4% of the students viewed updates on topics as ways to motivate them.

We should note that 23.1% of participants reported that ALEKS did not motivate them. One explanation is that ALEKS did not motivate them, another, is that some of the weaker were frustrated with ALEKS due to the continuous assessment and knowledge checks and that they have to solve 20 to 30 additional problems periodically. Also, loss of autonomy due to deadlines set by instructors might affect students' motivation. Another explanation could be lack of instructor support. It was reported that the students' perceptions about teacher support and completion of tasks have a positive effect on their motivation in online learning (Fryer & Bovee, 2016).

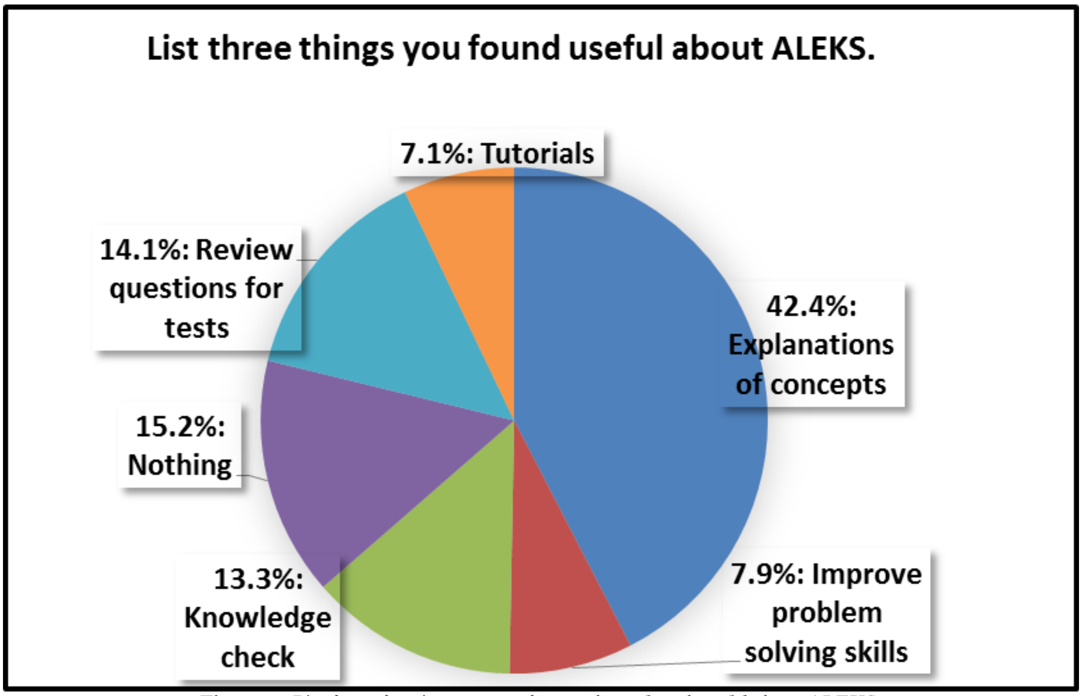

Figure-5. Pie chart showing aspects that students found useful about ALEXS.

Students' perceptions of useful aspects of ALEKS online homework platform are presented in Figure 5. 42.4% of students found the explanation of concepts in ALEKS as most useful to them. 13.3% reported that knowledge checks, which measures student's mastery of the topics and operates as a personal tutor, as most beneficial aspect of ALEKS, as most useful. Additionally, 14.1% of students viewed review questions for tests, 7.9% reported that improve problem solving skills, and 7.1% suggested that tutorials, as the most useful aspects of ALEKS. Online homework tutorials have been found to be appreciated by students and have a positive impact on their learning (Chamala et al., 2006). Students reported that they found online homework useful for learning, revealed positive attitude towards online homework, and suggested that it improved their study habits (Richards-Babb, Curtis, Georgieva, & Penn, 2015).

It is interesting to report that 15.2% of participating students suggested that nothing was useful about ALEKS which again might be attributed to the frustration of weaker students with the additional large number of problems required to achieve mastery. Some students who struggle with online homework and view it as an obstacle that they cannot overcome might display a helplessness trait which they attribute to ability and might do very little and engage in online homework avoidance (Middleton & Spanias, 1991). It has been reported that better performing, higher motivated students demonstrate higher satisfaction with online homework (Doorn et al., 2010). Another research study found that students with higher motivation have view online homework as helpful and effective way to study (Peng, 2009) whereas, students with lower motivation put in additional effort to solving online homework, which could benefit them.

4. Conclusions

Our data seem to indicate that students exhibit positive levels of perceptions about the role ALEKS online homework platforms plays in the development of concept understanding and the learning of the material. The data also suggests that students report positive levels of perceptions about use of ALEKS online learning platform. They view ALEKS as a contributor to their motivation about learning and indicate a preference to the ALEKS approach of learning.

Students hold positive perceptions about ALEKS online homework platform as a motivating factor for their learning through helping them learn the concepts, continuous assessment, knowledge checks, and updates on topics. Additionally, students' data suggest that there a several aspects that the students found useful about ALEKS. These include: explanation of concepts in ALEKS, knowledge checks, review questions for tests, and tutorials.

Data collected from some students suggest that ALEKS had no influence on motivation of students, which is one possibility. Another possibility is that some of the weaker viewed ALEKS negatively because they were frustrated with ALEKS due to the continuous assessment and knowledge checks and that they have to solve 20 to 30 additional problems periodically. It is noteworthy that lack of control on deadlines for ALEKS might negatively influence motivation due to loss of students' autonomy. Further, some participants suggested that they did not find any aspect of ALEKS useful for their learning.

We recommend that instructors provide students with support, setting deadline, and making the online homework grade an integral part of the overall grade which might positively influence students' motivation.

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